CALIFORNIA DEPARTMENT OF WATER RESOURCES

BOTTLE ROCK
GEOTHERMAL POWER PLANT,
LAKE COUNTY, CA

DRAFT
ENVIRONMENTAL IMPACT REPORT

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P700-79-013

CALIFORNIA ENERGY COMMISSION

D R A F T

ENVIRONMENTAL IMPACT REPORT

CALIFORNIA DEPARTMENT OF WATER RESOURCES

BOTTLE ROCK GEOTHERMAL POWER PLANT

Application No. 79-AFC-4

State Clearinghouse No. 78112070

SUMMARY

The California Department of Water Resources (DWR) proposes to construct the Bottle Rock power plant, a 55 megawatt (MW) geothermal power plant, at The Geysers Known Geothermal Resource Area (KGRA). The plant is projected to begin operation in April of 1983, and will be located in Lake County near the Sonoma County line on approximately 7.2 acres of the Francisco leasehold. The steam to operate the power plant, approximately 1,000,000 pounds per hour, will be provided by McCulloch Geothermal Corporation.

The power plant's appearance and operation will be basically the same as the units in operation or under construction in the KGRA. The power plant and related facilities will consist of a 55 MW turbine generator, a 1.1 mile (1.81 km) long transmission line, a condensing system, cooling tower, electrical switchyard, gas storage facility, cistern, and an atmospheric emission control system. DWR plans to abate hydrogen sulfide (H_2S) emissions through the use of the Stretford Process which scrubs the H_2S from the condenser vent gas stream and catalytically oxides the gas to elemental sulfur. If the Stretford Process does not meet emission limitations, a secondary H_2S abatement system using hydrogen peroxide/iron catalyst is proposed.

The project, by itself, will not result in significant adverse environmental impacts if mitigated as proposed and if applicable laws and standards are met. Compliance with air quality standards is particularly important to ensure that significant impacts are minimized.

The Bottle Rock project and other existing and future geothermal projects in the KGRA may result in cumulative impacts to soils, biological resources, water quality, geothermal steam resources, air quality, public health, land use, recreation, cultural resources, and aesthetics.

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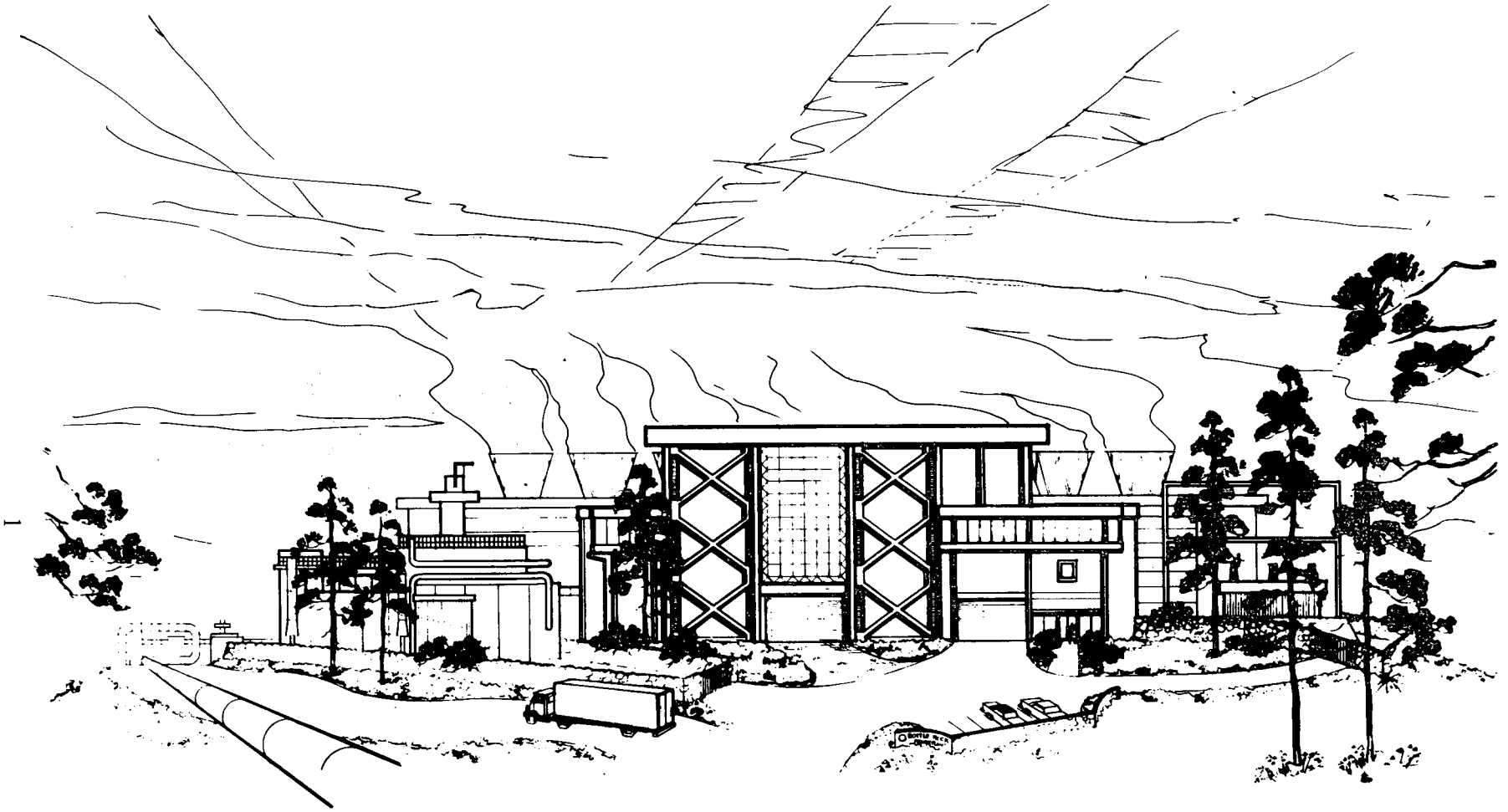


Source: DWR, 1979

Figure A: **BOTTLE ROCK GEOTHERMAL POWER PLANT**

INTRODUCTION

The California Department of Water Resources (DWR) proposes to construct a 55 megawatt (MW) geothermal power plant, Bottle Rock, and a 1.1 mile (1.81 km) long transmission line in The Geysers-Calistoga Known Geothermal Resource Area (KGRA), herein referred to as The Geysers KGRA. DWR proposes to have Bottle Rock in operation by 1983.

The purpose of this Environmental Impact Report (EIR) is to provide the general public and those evaluating the project with information concerning: 1) the environmental consequences of the project; 2) the manner in which significant adverse effects of the project may be mitigated; and, 3) any feasible alternatives to the project. The EIR is to be used by the California Energy Commission (CEC), in combination with other materials, to determine the environmental acceptability of the proposed project. In addition, the EIR includes a discussion of the geothermal steam wells, pipelines, and reinjection facilities because of the relationship of these facilities to the proposed power plant. The CEC only has regulatory jurisdiction over the power plant.

The Bottle Rock EIR was prepared by staff of the California Energy Commission in accordance with the California Environmental Quality Act (CEQA) Cal. Pub. Res. Code § 21000-21176, the State EIR Guidelines, 14 Cal. Admin. Code § 15000-15203, and the Energy Commission's regulations to implement CEQA, 20 Cal. Admin Code § 2300-2309. The data used were compiled from both published and unpublished sources. Primary documents used were the Department of Water Resources Bottle Rock Power Plant Notice of Intention (NOI) and The Bottle Rock Power Plant Application for Certification (AFC), and the Francisco Leasehold EIR by Ecoview (1979). Additional information was collected from the Energy Commission's NOI and AFC proceedings; federal, state, and local agencies; and private groups and individuals.

As specified in Section 15149 of the State EIR Guidelines, information from these sources has been identified, incorporated by reference, or briefly summarized in this EIR. Other sources are referenced as noted in the text. Material and conclusions that are referenced to another source have been verified to the satisfaction of the Commission staff. The information contained in this document has been reviewed and evaluated by the Energy Commission staff. The conclusions expressed are those of the staff.

The following chapters discuss the proposed project, and its natural and social environments. The EIR includes discussions of: feasible alternatives to the project; long-term and cumulative impacts; irreversible changes; growth-inducing impacts; adverse and beneficial consequences of the project; and, potential mitigation measures to reduce the effects of significant adverse impacts. Impacts that the staff considers insignificant are identified in the Impact Identification Matrix, Appendix A. This matrix provides a focus on the potentially significant impacts to be discussed in the EIR and documents why insignificant impacts were identified as such.

The contents of these chapters are divided into the following environmental components: earth resources; air resources; water resources; biological resources; health; safety; energy and material resources; cultural resources; socioeconomics; land use; public services; transportation; and aesthetics.

These components are used throughout the report to facilitate reference and organization. Where possible, technical environmental data are depicted on tables or graphs, and a glossary of possibly unfamiliar terminology is provided.

This draft EIR will be subject to a 45-day public review period. During the review period, publicly noticed hearings will be held. The final EIR will reflect comments made at the hearings and during the review period. The proposed schedule for public review and Final EIR is:

December 10,1979 - Draft EIR Approved For Circulation
January 24, 1980 - End of Review Period
March 28, 1980 - Commencement of Hearings on FEIR and Proposed Decision
April 7, 1980 - Final EIR Certified and Decision on Project

Comments on the Draft EIR may be submitted at the public hearings or may be submitted in writing before January 24, 1980, to:

Ilona Perry
California Energy Commission
1111 Howe Avenue, MS-32
Sacramento, CA 95825
Telephone: (916) 920-7512

Interested members of the public are encouraged to participate in the regulatory proceedings on the case. Questions on how to participate may be directed to Mr. Dan Parker, Public Advisors Office, (916) 920-6906, or toll free (800) 852-7516.

PROJECT DESCRIPTION

Project Objectives

DWR proposes to construct and operate the Bottle Rock geothermal power plant to provide an economic and nonfossil fuel source of baseload electrical generation for the State Water Project (SWP).

The SWP provides water conservation, flood control, recreation, and fish and wildlife enhancement benefits throughout most of California. The SWP, which is designed to ultimately supply over four million acre-feet of water annually, includes water storage facilities, pumping plants, power generating plants, and a total of 540 miles (864 km) of aqueduct. Thirty-one public water agencies (Water Contractors) who wholesale and/or retail water to over two-thirds of the people in California, have contracted for water supplies from DWR. (DWR, 1978)

Electric energy is needed to operate the pumps of the SWP and the Bottle Rock power plant will provide a portion of this electricity requirement. Bottle Rock will expand the electrical generating capacity in The Geysers KGRA by 55 MW and reduce the need for constructing other types of electrical generating facilities, (i.e., coal, nuclear, gas turbine, combined cycle, or hydroelectric).

Overview

In The Geysers KGRA (Figure B), a geothermal development area contains steam wells, well pads, access roads, steam supply pipelines, power plants, and transmission lines connecting the power plant with the intended electricity service area. In many cases, ownership of the surface rights where the steam wells and power plant are located are privately or federally owned. For Bottle Rock, the surface rights and mineral rights are privately owned. The resource is leased to a steam developer who supplies the steam to an electric utility company. The steam supplier is also responsible for disposing of or reinjecting any steam condensate generated by the power plant. McCulloch Geothermal Corporation is the steam supplier for DWR's Bottle Rock project.

Pacific Gas and Electric Company (PG&E) currently operates 13 geothermal power plants in The Geysers KGRA equalling a total installed electric capacity of 663 MW. PG&E's geothermal power plant Units 13 and 14, presently under construction, are planned for operation in 1980 and Unit 17 is scheduled to begin construction in 1982. These units (Figure C) will provide an additional 355 MW of electric capacity. In addition to the power plants proposed by PG&E and DWR, the Northern California Power Agency (NCPA) has proposed to construct two power plants in The Geysers KGRA (Figure C). By 1983, the proposed electrical capacity from The Geysers KGRA will be 1579 MW.

Project History

On October 5, 1978, DWR submitted a Notice of Intention (NOI) to file an Application for Certification (AFC), which began the California Energy Commission's (CEC's) two-part siting process for thermal power plants.

MENDOCINO NATIONAL FOREST

BOTTLE ROCK

Figure B: **THE GEYSERS—CALISTOGA KGRA**

Scale 1:250,000

0 5 10 Miles

SOURCE: USGS 1:250,000 Santa Rosa and Ukiah Quads.

Figure B: **THE GEYSERS — CALISTOGA KGRA**

BOTTLE ROCK

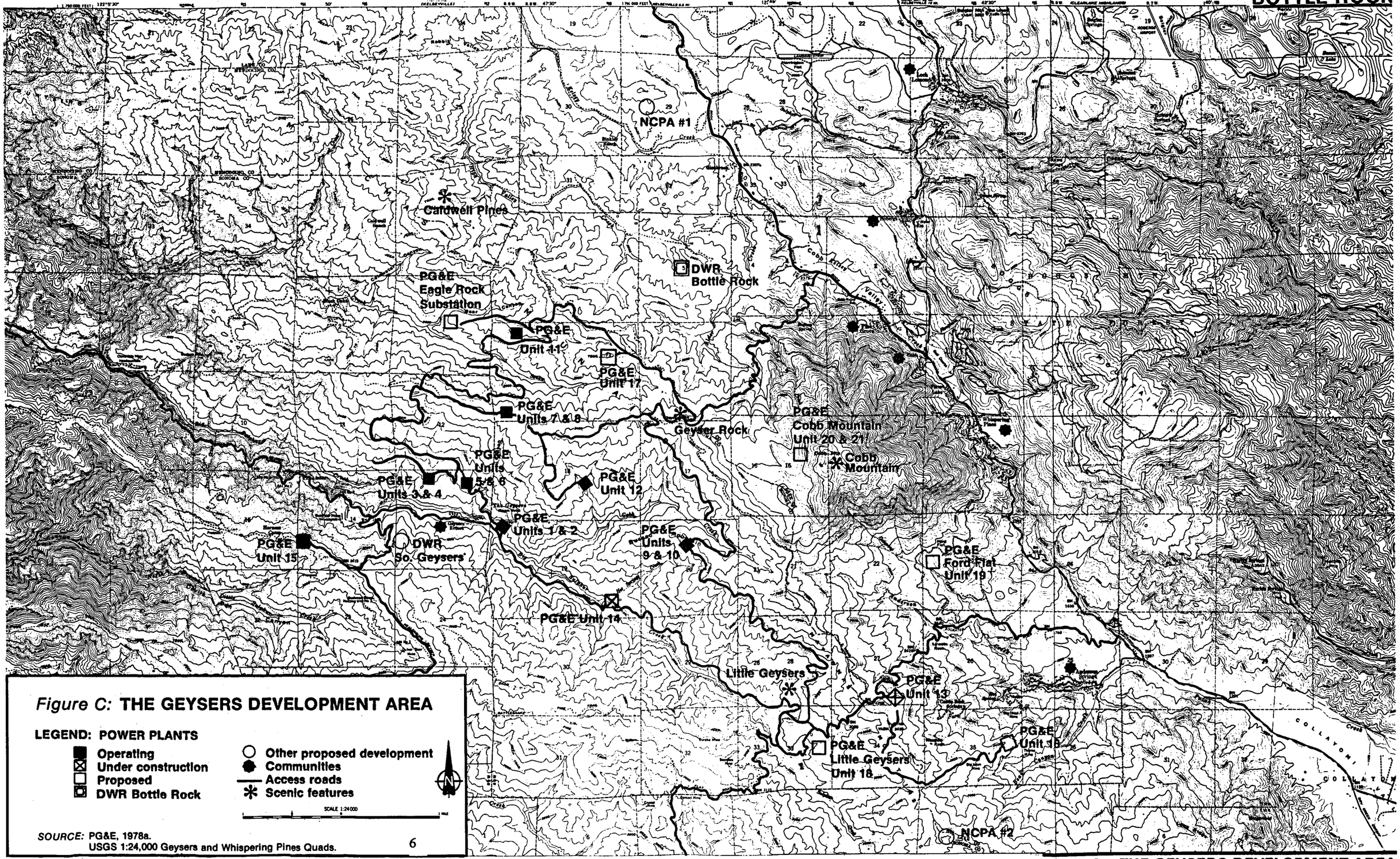


Figure C: **THE GEYSERS DEVELOPMENT AREA**

LEGEND: POWER PLANTS

- Operating
- Under construction
- Proposed
- DWR Bottle Rock
- Other proposed development
- Communities
- Access roads
- Scenic features

SCALE 1:24000

SOURCE: PG&E, 1978a.
USGS 1:24,000 Geysers and Whispering Pines Quads.

Figure C: **THE GEYSERS DEVELOPMENT AREA**

The NOI phase has four main objectives (CEC, 1978):

1. To determine the need for the proposed facility.

2. To determine the relative acceptability of the proposed facility at each of the sites.

3. To determine the suitability of the proposed sites to accommodate the facility.

4. To determine whether there are alternatives to the applicant's proposal which better carry out the policies and objectives of the Warren-Alquist Act (Cal. Pub. Res. Code 25000, et. seq.).

In the Final Report for the Bottle Rock NOI (May 1979), the Energy Commission determined that the Bottle Rock project met the necessary qualifications to continue on to the AFC phase. DWR submitted the AFC on July 26, 1979. The purpose of the AFC phase is to determine if the proposed project can be constructed and operated in a manner which is safe, reliable, economically and environmentally acceptable, and complies with all applicable laws, ordinances, regulations, and standards.

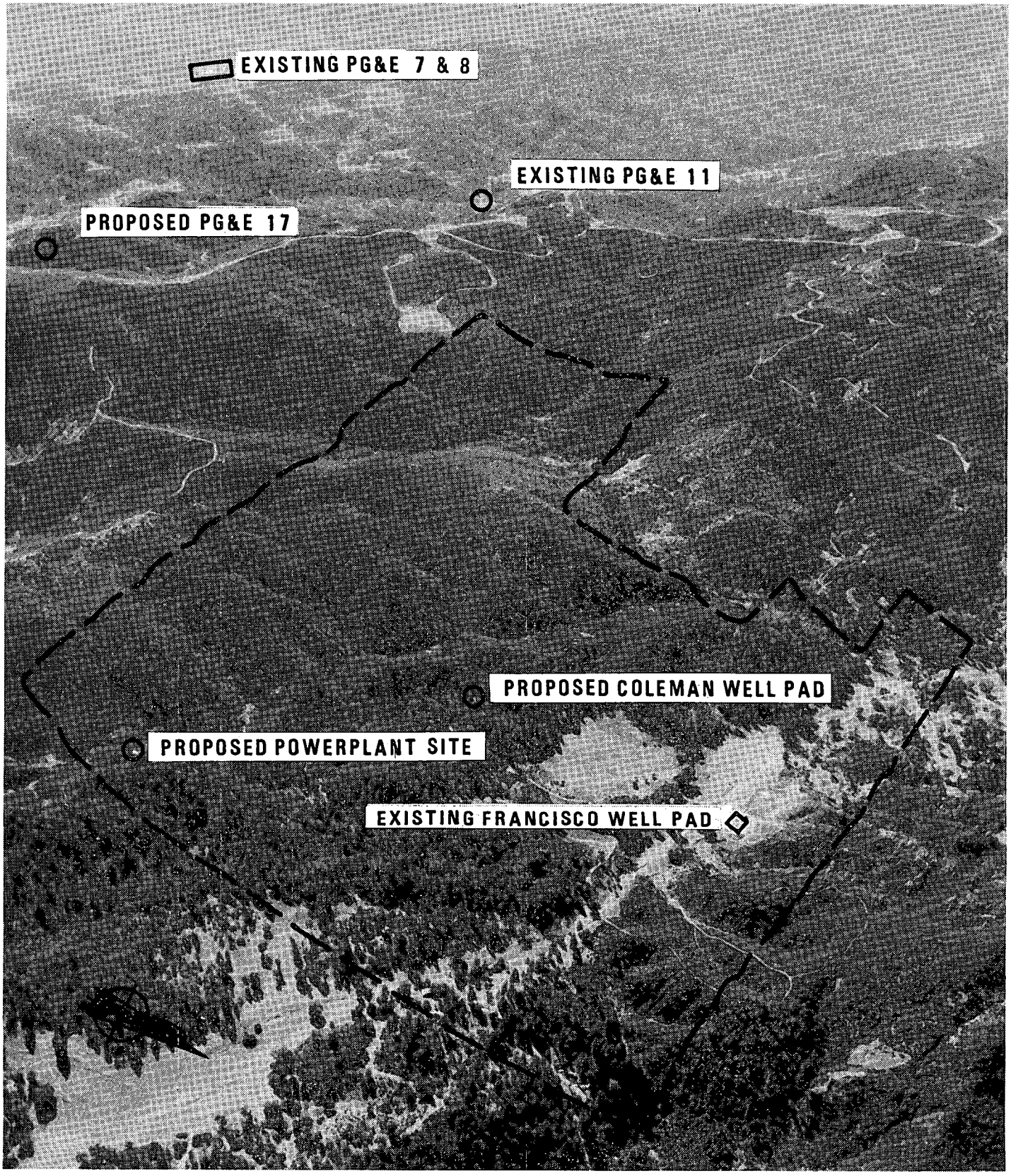
The time generally allotted for the Energy Commission to process a geothermal NOI/AFC is 18 months - 9 months for each phase (Pub. Res. Code § 25540). Because the California Environmental Quality Act (CEQA) mandates that an EIR be prepared in one year (State EIR Guidelines 14 Cal. Admin. Code § 15054.2), the EIR for Bottle Rock was begun during the NOI phase of the process.

Project Location

The Geysers KGRA is a mountainous, rugged, and sparsely settled area located in the north central portion of the coast ranges (Figure B). The Bottle Rock project is approximately 70 miles (112 km) north of San Francisco and 65 miles (104 km) northwest of Sacramento. The proposed site for the Bottle Rock power plant is located on the 370 acre Francisco Leasehold which is in portions of Sections 5 and 6, Township 11 North, Range 9 West, Mt. Diablo Baseline and Meridian (MDB & M). The leasehold is in the County of Lake approximately 3.4 miles (5.4 km) northwest of the village of Whispering Pines. Bottle Rock Road and State Highway 29 pass within a mile east of the plant site providing main north-south thoroughfares through the area (Figure C). Clustered along the two main access roads are a number of small resort communities including Whispering Pines, Forest Lake, Cobb, Pine Grove, Hobergs, and Loch Lomond. In addition to the main resort areas, there are a number of homes and weekend cabins. Bottle Rock will be situated near PG&E's operating Units 7, 8 and 11 and proposed Unit 17 (Figures C and D). Bottle Rock will be similar in appearance and general operating characteristics to these power plants and others under construction.

Access to The Geysers KGRA from the Lake County side is via Highway 175 and Bottle Rock Road. Bottle Rock Road is a major access route for the towns of Pine Grove and Cobb.

The steam supply field for Bottle Rock is situated on the Lake-Sonoma County line, a few miles northwest of Cobb Mountain, southwest of Glenbrook, and near the northern border of The Geysers KGRA.



AERIAL VIEW OF FRANCISCO LEASEHOLD LOOKING SOUTH
The dashed line indicates approximate boundary of the leasehold.

Source: DWR, 1979

Figure D: **PROPOSED SITE**

The power plant will be constructed on a 5.9 acre multi-level pad with elevations ranging from 2690 to 2700 feet (818-820 m). An additional 1.3 acres will be used for the steam suppliers facilities adjacent to the power plant pad (DWR, 1979).

Project Features

The principal features (individual parts) of the proposed power plant are illustrated in Figure E and include:

1. A turbine-generator, which will be mounted on a reinforced concrete pedestal and housed in a concrete structure, approximately 105 feet (32 m) long, 75 feet (23 m) wide, and 65 feet high.

2. A multiple cell, forced draft, cooling tower, 280 feet (85 m) long, 57 feet (17 m) wide and 57 feet (17 m) high, which will provide cooled circulating water to the turbine condensers.

3. A Stretford hydrogen sulfide abatement system (Figure F), that will scrub hydrogen sulfide (H_2S) from the vent gas stream and catalytically oxidize the H_2S to elemental sulfur. This system will cover an area approximately 140 feet (43 m) long and 100 feet (30 m) wide. A hydrogen peroxide/iron sulfate secondary H_2S abatement system (condensate treatment) will be used in addition to the Stretford system to reduce the amount of H_2S emitted to the atmosphere.

4. A transmission switchyard approximately 120 feet (37 m) long and 130 feet (40 m) wide, located adjacent to the turbine generator building, which will contain:

    - The main transformer, a 56.6 megavolt ampere (MVA) three phase, oil-air cooled, power transformer (power generated at 13.8 kV), which will step up voltage to 230 kV for economic transmission;

    - The line breaker; and

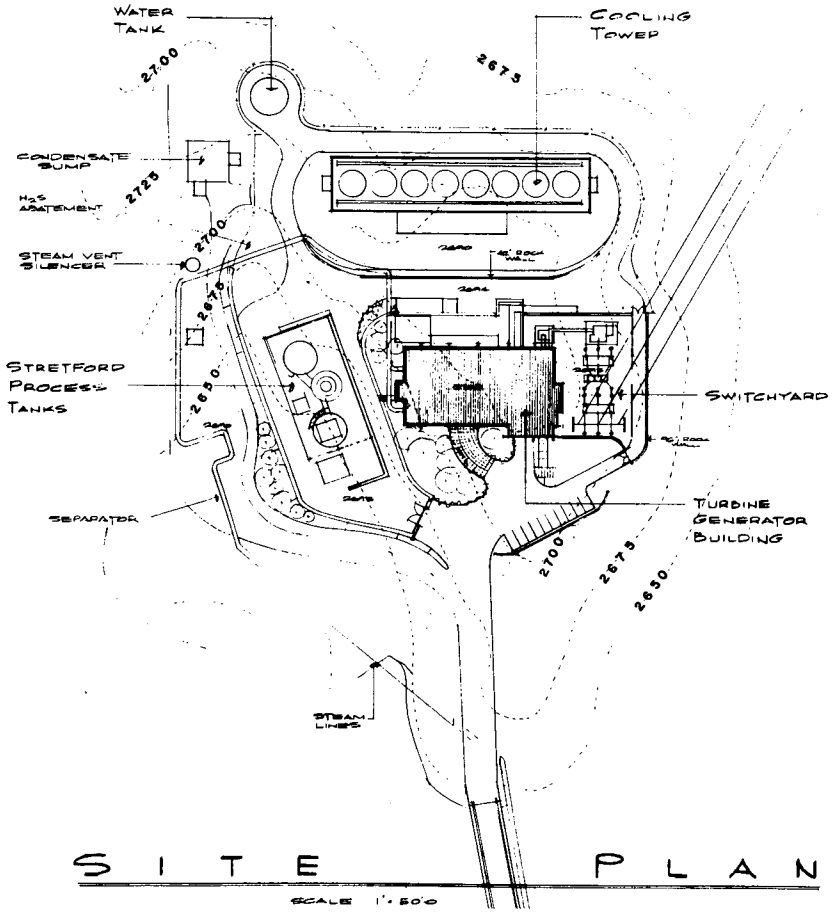
    - The generator breaker.

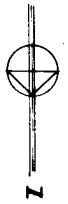
Steam Supply Field - Three steam supply wells have been drilled within the Bottle Rock steam supply area. Depending upon productivity, DWR estimated that two well pads, each pad supporting six wells, will be required to provide the necessary steam supply (Figure G). DWR has estimated that 12 wells will be drilled to supply the steam supply for the power plant. (DWR, 1979)

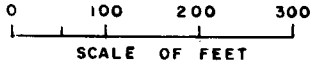
During the drilling phase of the project, the principal features of the steam supply wells are: the well head drilling rig (which may stand over 100 feet (304 m) high); cooling water storage tanks; drilling mud storage tanks; pipe racks; mud pumps; air compressors; diesel electric generators; an 80 by 150-foot (24 x 46 m) mud pit and sump; and emissions and noise control equipment. These components (except for the mud pit and sump) are situated on the well pad. The mud pit and sump are located adjacent to the well pad.

A well pad, which is positioned on a leveled area cleared of all vegetation, must be large enough to accommodate the drilling rig and related components,

BOTTLE ROCK



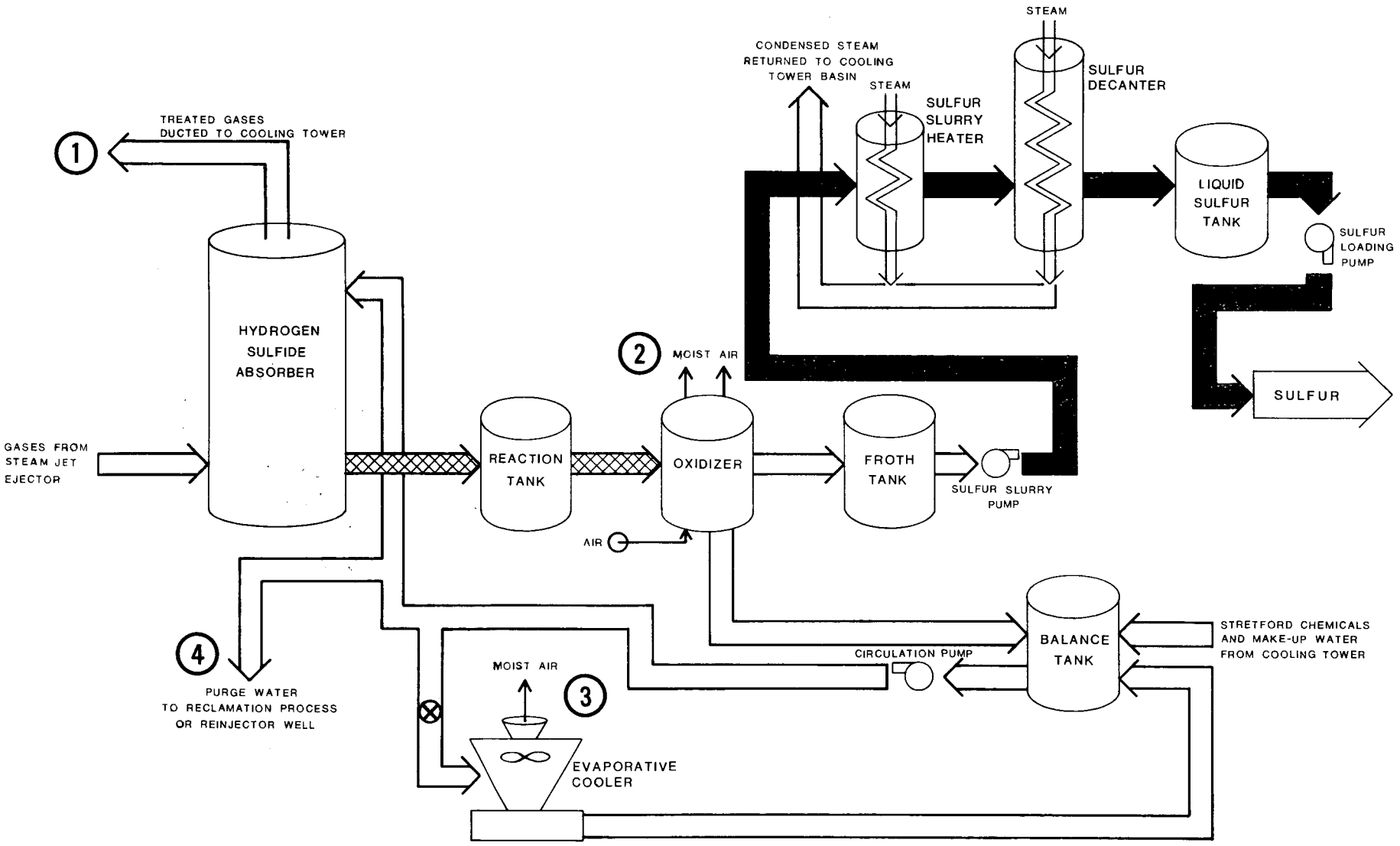




Source: DWR, 1978

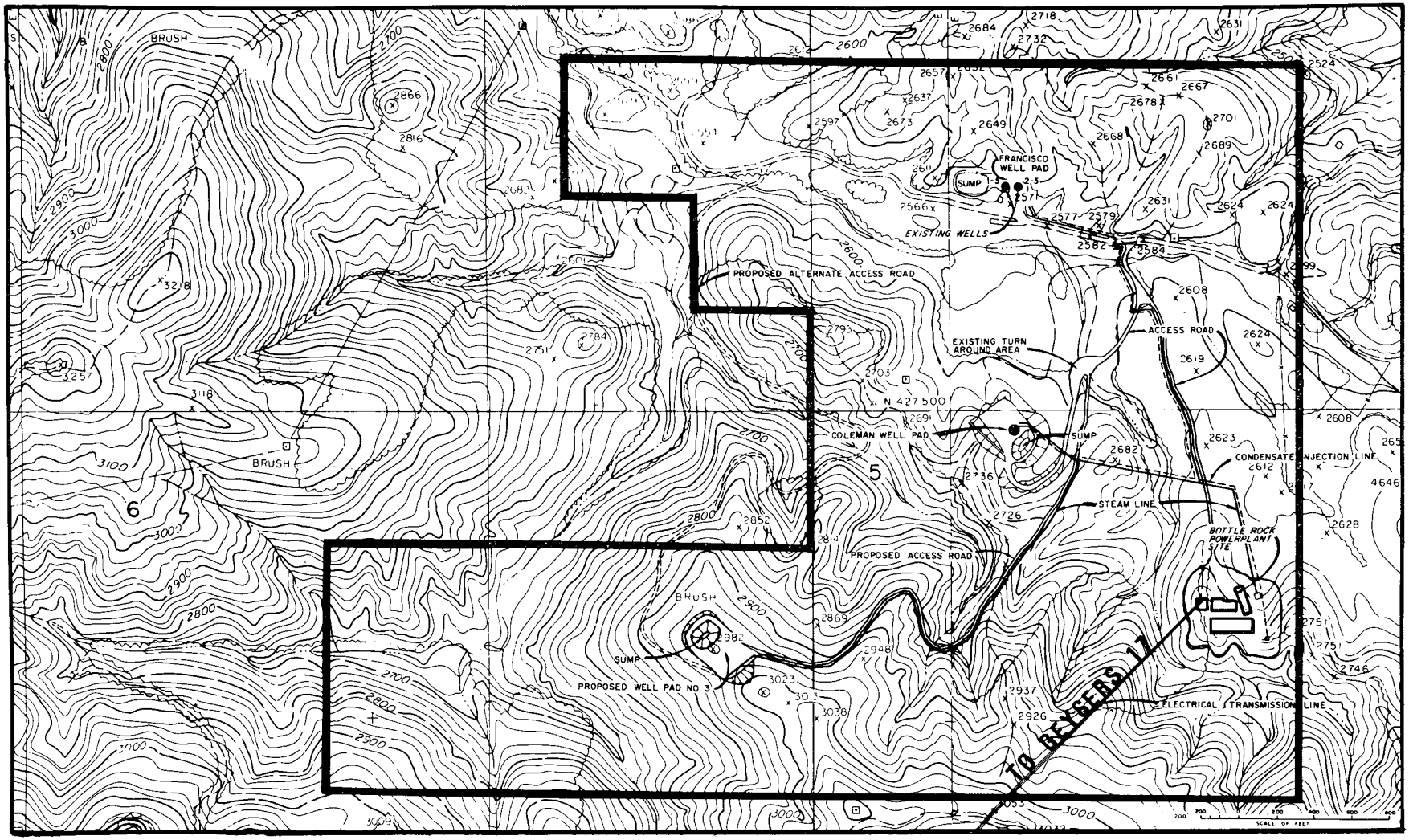
Figure E: **BOTTLE ROCK POWER PLANT SITE PLAN**

BOTTLE ROCK



Source: PG&E, 1978

Figure F: **STRETFORD HYDROGEN SULFIDE ABATEMENT SYSTEM**



Source: DWR, 1978

Figure G: **LEASEHOLD SITE MAP**

temporary structures, and crew parking. The required surface area of the well pad varies from less than one acre to approximately three acres. Construction of the steam supply wells requires cut and fill techniques to level the necessary well pad and mud pit areas.

Once the drilling phase of the steam supply well is completed, much of the equipment and well pad are removed. In addition, after completion of drilling, the contents of the mud pit and sump are analyzed. If the contents are deemed to be nontoxic by state and local regulatory agencies, the sump will be sealed with earth to provide a permanent disposal site for the drilling wastes. If the contents are deemed to be toxic, they will be removed to an approved disposal site outside the project area.

Because of the hilly terrain, access roads to the steam supply wells will require cut and fill techniques. Each steam supply well pad will have one access road.

Steam Pipelines - Approximately 2 miles (3.2 km) of steam pipelines with steel support structures will be constructed to transport steam from the proposed supply wells. Pipeline systems from each well pad will vary in length depending on distance from the power plant. Initially, an area approximately 30 feet (9.1 m) wide will be cleared (but not maintained) along the pipeline corridors to reduce fire hazards during construction.

Water Supply - Make-up water for the cooling tower will come from condensed steam. The initial supply will be transported from outside sources. DWR has proposed several sources for initial cooling tower water, such as a privately owned spring east of the power plant site; floodwaters from Kelsey Creek or the Russian River; DWR projects, e.g., Oroville Reservoir; or purchase of water from irrigation districts (Dillon, 1979).

The initial amount of water required for the cooling tower is approximately 400,000 gallons (1,520,000 l). Trucking this amount of water will require up to 90 single truck or 45 truck-trailer trips. It is unlikely that springs and wells in the immediate vicinity could supply this amount of water considering the limited groundwater supplies (DWR, 1979).

The water supply for sanitary facilities, maintenance of the turbine building, operation of the Stretford H_2S abatement system (estimated at 300 gallons [1,140 l] per day), and irrigation water required for the revegetation establishment period will be collected from rainfall and stored on site or will be brought in by truck from existing sources.

Transmission System - The principal feature of the transmission line system is a 230 kilovolt (kV) single-circuit tower line, approximately 1.1 miles (1.81 km) long, which will extend in a southwesterly direction and connect with PG&E's proposed Unit 17's 230 kV transmission line (Figure G). The proposed line will require five, 80-foot (24.3 m), single circuit, latticed steel towers strung with three, 1,113 mcm, 61 strand aluminum conductors. A minimum of 30 feet (9.1 m) ground-to-line clearance will be maintained.

Need For Project

Need for Capacity and Energy--DWR operates the pumps of the State Water Project (SWP) primarily during the off-peak hours because off-peak energy provided under

contract with California and Pacific Northwest utilities is substantially less than the prevailing rate for on-peak capacity and energy. In satisfying their energy requirements by purchasing off-peak energy, DWR found that it did not need to own additional generation capacity beyond its hydroelectric power plants and the recovery plants on the aqueduct system. However, in 1983, existing capacity and energy exchange contracts with the suppliers--PG&E, SCE, LADWP, and SDG&E--and with the Pacific Northwest will terminate. Recognizing the need for additional economical energy in 1983, DWR embarked on a program to investigate all sources of energy which might contribute to partial energy self-sufficiency (DWR, 1978).

Given the nature of operation of the SWP and the historical price DWR has been paying for off-peak energy, DWR's capacity and energy needs can now be considered. DWR's most recent resource plan submittal to the Commission identifies 110 megawatts (MW) of geothermal, 160 MW of hydroelectric, and 740 MW of coal by 1990 (Table 1).

The need for Bottle Rock was investigated during the NOI proceedings. Two areas of concern were:

1. Is Bottle Rock needed to meet the future electricity requirements of the California State Water Project (SWP) in accordance with the CEC's adopted forecast?

2. Is Bottle Rock an acceptable generation option?

In the NOI proceedings on this project (October 4, 1978 to June 21, 1979), the CEC staff agreed that DWR needed energy to operate the SWP but questioned DWR's actual capacity needs. The staff found that DWR's existing hydroelectric and recovery power plants were sufficient to meet their own on-peak capacity requirements, but were insufficient to meet both on-peak capacity and off-peak energy demands. DWR could meet its off-peak energy deficits by purchasing off-peak energy as it has and is currently doing or by building economical baseload generation to supplement its existing system. The issue the Commission must determine, raised by staff in the NOI proceedings, is whether DWR can acquire long-term contracts for off-peak energy at a price less than or equal to what it would cost DWR to build and operate a facility of its own.

The NOI final decision took recognition of the staff's capacity and energy assessment for DWR when the full Commission concluded:

> If constructed and operated in compliance with applicable standards ordinances, and laws, a geothermal power plant would be an acceptable means of supplying 385 gigawatt-hours of energy based on an 80 percent capacity factor to meet a portion of the requirements of the State Water Project (emphasis added) (Conclusion 2, Page 28, Final Report, May 29, 1979).

The Commission based its conclusion on its finding that DWR needed energy. For the purposes of the NOI, this fact was sufficient for an affirmative conclusion with respect to need for the project. In the Preliminary Report on DWR's NOI, the Commission directed the staff to discuss DWR's capacity needs in the Biennial Report. With respect to relative economics, the Commission's Final Report directed DWR to provide in its AFC, verified and detailed data demonstrative of the relative merit and cost comparison of energy from the proposed project as compared to the cost of purchased power.

TABLE 1

Potential Resource Additions

YEAR	POTENTIAL RESOURCES	TYPE	MW
1983	Bottlerock Project	Geo	55
1983	Pine Flat Project	Hydro	160 nonfirm
1985	Hybrid Geothermal, wood waste	Geo	55
1985	Reid Gardner (energy only for 15 yrs.)	Coal	250 nonfirm
1986	PG&E Fossil 1 (10%)	Coal	80
1987	PG&E Fossil 2 (10%)	Coal	80
1987	DWR Coal (1/3 share)	Coal	330

While the staff is still studying the issue of the comparative economics of purchased off-peak energy versus the price of Bottle Rock generation in the present AFC proceeding, staff has preliminarily concluded that the price of energy from the Bottle Rock geothermal project would be less than purchased energy from any of the suppliers or the Pacific Northwest. This preliminary conclusion is based on a comparison of DWR's estimate of Bottle Rock's cost at 27.4 mills/kilowatt-hours to SCE's off-peak energy cost (based on oil generation) of 45 mills/kilowatt-hours (DWR, 1979) (both estimates in 1983 dollars).

For the purposes of this draft EIR, the staff concludes that while the Bottle Rock Project is needed for energy, DWR will need to negotiate contracts with the utilities to exchange excess on-peak capacity from Bottle Rock for off-peak energy.

Oil Savings and the National Energy Act - Geothermal power plants enable the state to reduce its reliance on oil-fired generation. Oil savings attributable to Bottle Rock will amount to approximately 642,000 barrels annually. This figure is based on an assumed Bottle Rock capacity factor of 80 percent, a performance demonstrated by the operating history of geothermal power plants in The Geysers KGRA.

The Bottle Rock Project, by reducing the state's oil consumption, conforms to the spirit and intent of the National Energy Act (NEA), which calls for the nation to shift its energy dependence from oil to renewable resources. Specifically, the Power Plant and Industrial Fuel Use Act (1978) portion of the NEA prohibits the use of oil or natural gas as a primary energy source in new electric power plants unless an exemption is obtained.

Consistency with the Commission's Geothermal Policy Report - The Commission's Geothermal Policy Report, dated March 22, 1978, recognized geothermal energy as a preferred technology for meeting electric power needs because: 1) it is indigenous to California; 2) its development offers a stimulus to the state's economy; 3) for dry steam resources, the environmental impacts and power plant technology are well understood; 4) geothermal power plants are relatively small (110 MW or less) and thus enable greater system reliability and flexibility; and 5) geothermal power plants may be planned and constructed in a time frame shorter than power plants using other fuels.

The Bottle Rock Project conforms per se with the Geothermal Policy Report. Furthermore, if the project's average busbar cost (cost as measured at the switchyard) is less than the estimated costs of off-peak purchased power and if the project is constructed and operated in conformance with all applicable laws, ordinances, and standards, the project would be an acceptable means of meeting a portion of the SWP's demands.

ENVIRONMENTAL SETTING

The purpose of this chapter is to describe the physical, biological, and social environment in the vicinity of the proposed Bottle Rock project as it exists before the commencement of the project, and also to identify environmental resources that are valuable, rare, or unique to the region.

As indicated in the introduction to this EIR, this chapter is divided into environmental components to facilitate reference and organization.

EARTH RESOURCES

Geology

Regional Geology - The proposed project and the entire Geysers KGRA are in the central Mayacmas Mountains of the Northern Coast Range. The regional geology of The Geysers area has been mapped and described by McLaughlin (1977, 1978) and McLaughlin and Stanley (1976). The results of this mapping indicate that the central Mayacmas Mountains represent a geologically complex zone which has been uplifted by folding and faulting. The core of the range is composed of rocks of the Franciscan Assemblage. These rocks include graywacke (dark-colored sandstone comprised of quartz, feldspar, and rock fragments engulfed in a matrix of mud), greenstone (altered volcanic rock--primarily basalt,) shale, chert, serpentinite, and melange.

The Geysers KGRA has experienced a series of folding, faulting, erosion and volcanic events over the last several million years. The present mountain range is the product of accelerated folding and faulting which occurred during the last five million years with Cobb Mountain and other volcanic features in the Clear Lake region being formed within the last two million years. A large body of magma is presumed to exist at a depth of more than 3 miles (4 km) below the Clear Lake area (California Geology,1979). Predominant geologic features in The Geysers KGRA are shown in Figure H.

Leasehold and Site Geology - The geology of the proposed power plant site has been investigated and described by the Department of Water Resources (DWR) in the Notice of Intention, submitted to the California Energy Commission (CEC) in October, 1978. The rocks on the site consist primarily of graywacke sandstone, including interbedded chert and shale, serpentinite and a complex unit of vesicular, amygdaloidal and porphyritic basalts and greenstone and diabasic greenstone, all of which appear to be in fault contact.

All the rock units are fractured and strongly weathered to a depth of 20 to 30 feet (8-12m). The weathered rock generally varies in strength from weak to moderately strong. Although much of the site area, including the proposed plant site and the two well sites, is underlain by grey to brown colored graywacke, outcrops of the unit are generally scarce. The site area is essentially mantled by a thick soil (2-4 feet; 0.6-1.2m) containing many rock fragments derived from the underlying graywacke and associated shale and greenstone bedrock.

Two northwest-trending fault zones are located in a 0.6 mile (1 km) radius around the plant site. One fault forms a structural contact between a sinuous, segmented body of serpentine, exposed in the southwestern part of the site area, and the main body of graywacke sandstone (Figure I). The other zone is exposed by the sump pond near the Francisco well pad (Figure I). This fault juxtaposes the basalt complex against graywacke northwest of the proposed site. In the vicinity of the sump pond, the fault zone juxtaposes intensely sheared serpentine against shale and graywacke. The fault appears vertical or steeply dipping to the northeast and strikes 45 degrees west of north. It continues southeast from the sump pond, where it intersects the wells drilled from the Francisco well pad, plunging under recent alluvium. Further to the southeast, outside the Francisco Leasehold, it is again exposed and coincides with the basalt-graywacke structures.

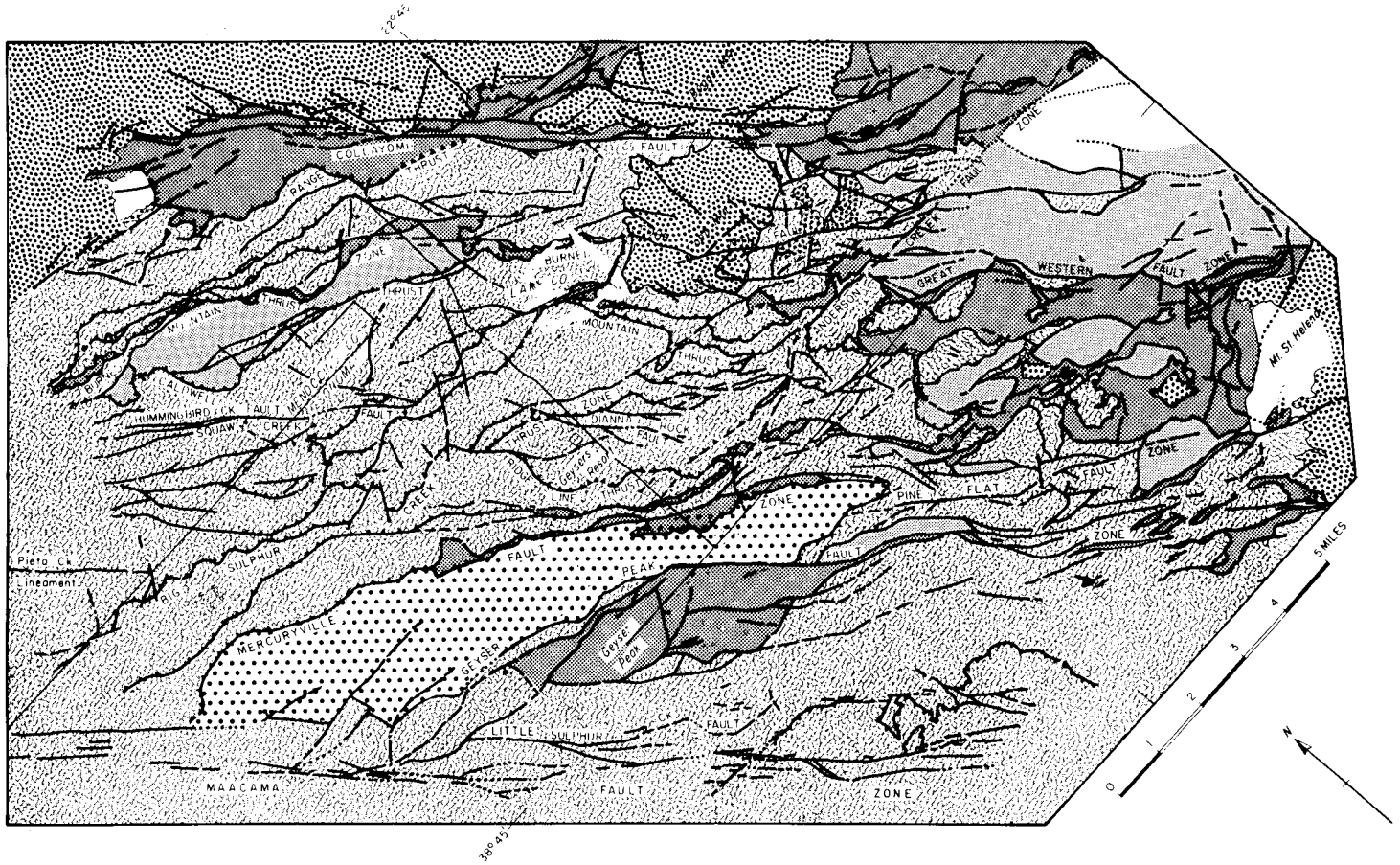


Figure H: GENERALIZED GEOLOGIC MAP OF THE GEYSERS

LEGEND:

Contact

Fault-dashed where approximately located, dotted where concealed, bar and bail on downthrown side; arrows show relative horizontal movement.

Thrust fault—sawteeth or upper plate, dashed where approximately located.

CLEAR LAKE AND SONOMA VOLCANICS—Tuffs, breccias, dikes, and flows ranging from rhyolitic to basaltic in composition; from 0.3 to 5.3 million years in age.

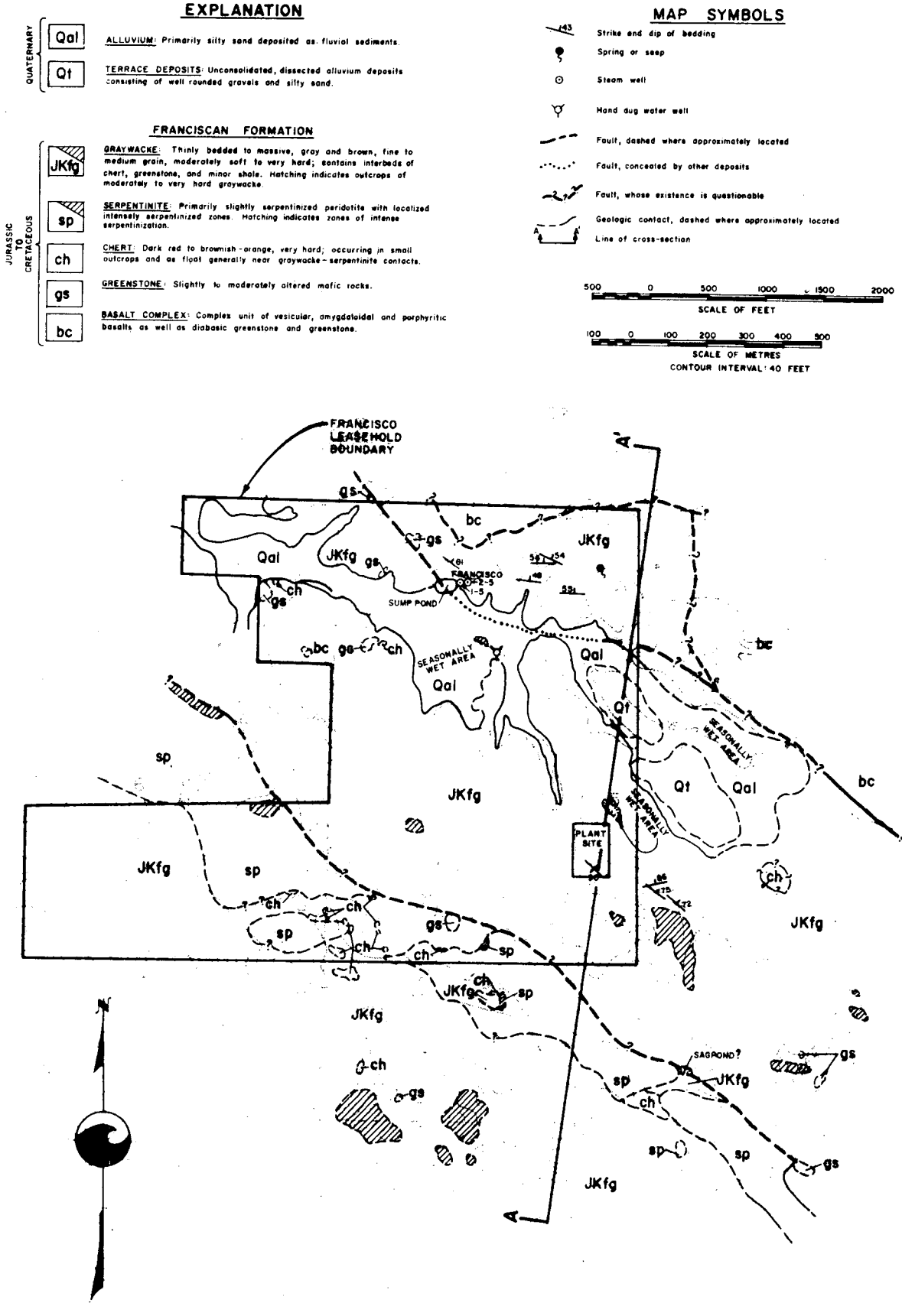
ROCKS IN UPPER PLATE OF COAST RANGE THRUST—Includes upper Jurassic through upper Cretaceous sandstone and mudstone of Great Valley Sequence and upper Jurassic basalt flows, gabbro, diabase, and serpentinite of Coast Range Ophidlite.

FRANCISCAN ASSEMBLAGE, STRUCTURAL UNIT 3—Fine to coarse-grained, locally conglomeratic metagraywacke with minor beds of metachert and greenstone; locally is a melange, general lower blueschist metamorphic grade; upper Jurassic and Cretaceous.

FRANCISCAN ASSEMBLAGE, STRUCTURAL UNIT 2—Undifferentiated melange including intact imbricated slabs of greenstone, chert, and graywacke as much as several kilometers in extent surrounded by pervasively sheared matrix of shale; upper Jurassic and Cretaceous.

FRANCISCAN ASSEMBLAGE, STRUCTURAL UNIT 1—Fine to medium-grained, massive to thin-bedded graywacke and minor interbedded black shale, slight metamorphic fabric; upper Jurassic and Cretaceous.

SOURCE: Preliminary Geologic Map and Structural Sections of the Central Mayacmas Mountains and Geysers Steam Field. Modified from Mclaughlin (1978).



SOURCE: DWR, 1978

Figure I: **BOTTLE ROCK POWER PLANT GEOLOGIC MAP**

Seismicity - The Geysers steam field is located in a seismically active area. It is dominated by northwest trending faults associated with the San Andreas fault system. Those faults which occur in The Geysers area are the Cobb Mountain, Dianna Rock-Big Sulfur Creek, Collayomi, Maacama, and Healdsburg-Rogers Creek faults (Figure H). Of these, all but the Dianna Rock-Big Sulfur Creek and Cobb Mountain, Collayomi faults are capable of generating a large earthquake in the area. Because of its distance from The Geysers KGRA, a major earthquake on the San Andreas fault would produce less shaking at the site than the closer, active faults. However, the duration of shaking from such an event would be considerably longer than that produced by local sources. The fault which continues from the sump pond, represents a possible northwestward extention of the Cobb Mountain system of potentially active faults. It passes through the leasehold approximately 1,650 ft. (500 m) northeast of the proposed power plant site. The other fault appears to be an older inactive geologic feature.

Recent seismologic studies (Hamilton and Muffler, 1972; Bufe, et al., 1978) show that a large number of "micro-earthquakes" (an earthquake having a magnitude of 2 or less on the Richter scale) occur continuously in The Geysers steam field. This type of activity is common in both developed and undeveloped geothermal areas throughout the world. While some of these events appear to be related to regional geologic forces, others may be related to natural changes in the geothermal system. Preliminary results presented by Marks, et al., (1978) indicate that microseismic activity is increasing as a result of development of the steam resource.

Steam Reservoir Geology - The following discussion of reservoir geology is summarized from McLaughlin (1977). The most important control to a geothermal system, a potent heat source, is believed to occur as a body of partially molten magma at a depth of 3 miles (4 km) or more below the Clear Lake region (Figure J). Fractured graywacke sandstone forms the subsurface reservoir for the geothermal water and steam. This reservoir rock is underlain by a relatively impermeable caprock, predominantly shaley melange and serpentinite, which generally inhibits both rapid percolation of cold water descending from the ground surface to mix with the hot geothermal fluids, and the escape of ascending geothermal fluids from the reservoir itself. As the geothermal fluids diffuse upward, they are deflected westward into The Geysers area by the east-dipping bedrock structures. The Geysers steam field appears to be bounded by the Collayomi fault on the northeast and the Mercuryville fault on the southwest.

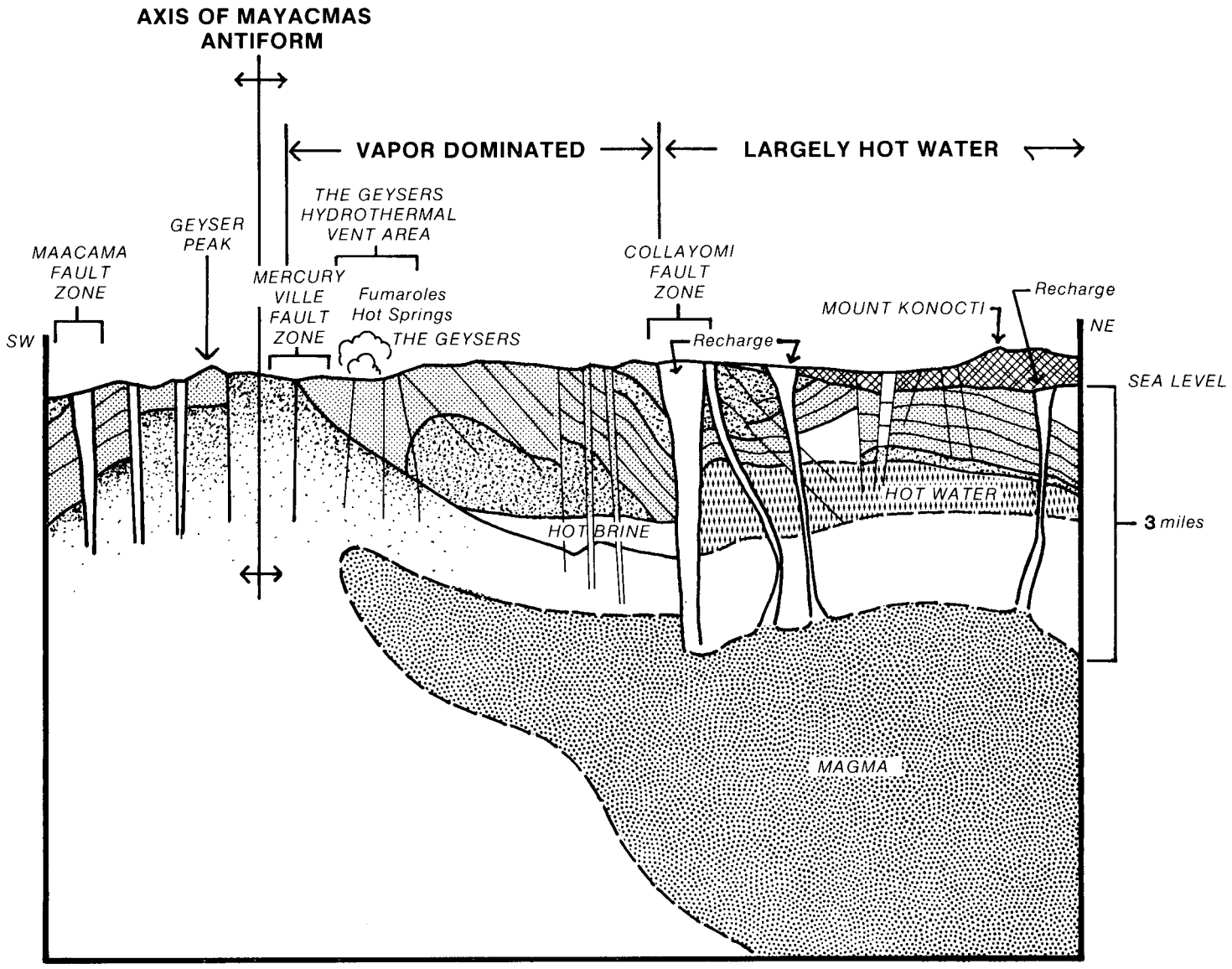


Figure J: **CROSS SECTION THROUGH THE GEYSERS — CLEAR LAKE REGION**

- Impermeable cap rocks (Serpetinite, greenstone, melange, metagraywacke)
- Fracture networks in graywacke reservoir rocks
- Clear Lake Volcanics and associated vents providing recharge to geothermal system
- Partially crystallized magma body inferred to be at depth with center below **3 miles (4 KM)**
- Water vapor in steam reservoir above boiling water table
- Hot water

Structural model for the Geysers geothermal system. Cross-section through The Geysers-Clear Lake region, from the Maacama fault zone on the southwest, to Mount Knocti on the northeast, depicting structural elements of The Geysers-Clear Lake geothermal system.

Source: "Field-trip Guidebook Castle Steam Field, Great Valley Sequence," April 29, 1978, 53rd Annual Meeting, Pacific Sections AAPG, SEPM, SEG. Modified by the California Energy Commission, February, 1979.

SOILS

Soil development, in general, is controlled by five soil-forming factors: climate, organisms, relief, parent material, and time. The interaction of these soil-forming factors is described in Soil Taxonomy (USDA, 1975).

The proposed site is located in the Mayacmas Mountains at an elevation of 2,700 feet (820 m). The estimated mean annual precipitation is 52 inches (1.3 m). Soil characteristics and locations in the Francisco leasehold are presented in Table 2 and Figure K. Combinations of steep slopes, high precipitation and moderate to high erosion hazards make portions of these upland soils very susceptible to erosion and consequent stream sedimentation. In general, the best use of these soils is as natural watershed. Experience in similar areas has shown that disturbing soils by construction practices increases the existing baseline soil losses approximately six times (Anderson, 1975; California Department of Conservation, 1971). Without proper control measures, a significant percentage of this sixfold increase would be delivered to adjacent streams.

The proposed transmission route will extend southwesterly from the Bottle Rock power plant, rise into the uplands of the Mayacmas Mountains, and terminate at PG&E's Unit No. 17. The erosion hazard of the various soils along the transmission corridor range from moderate to very high.

TABLE 2 GENERAL SOIL CHARACTERISTICS OF THE FRANCISCO LEASEHOLD

SOIL SERIES	POSITION	SURFACE SOIL	SUBSTRATUM OR PARENT MATERIAL	RUNOFF	EROSION HAZARD
Henneke Loam	Strongly sloping to steep uplands	Reddish brown gravelly loam (GC), slightly acid	Serpentinite	Slow to rapid	Slight to very high
Josephine Loam	Steep uplands	Reddish brown loam (CL or ML), medium acid	Fine-grained sandstone and shale	Medium to very rapid	Moderate to high
Laughlin Loam	Moderately steep uplands	Brown massive loam (SC), medium acid	Fine-grained sandstone and shale	Slow to very rapid	Slight to very high
Los Gatos Loam	Steep to very steep uplands	Gray brown to red brown loams and gravelly laoms (SM or SC), slightly acid	Weathered sand-stone (graywacke) and shale	Rapid to very rapid	High to very high
Maxwell Loam	Alluvial fans and flood plains	Dark gray gravelly clay (CL), moder-ately alkaline	Ultra-basic alluvium	Very slow	Slight
Yorkville Loam	Moderately steep mountain-ous uplands	Gray brown massive light clay loam (CL), slightly acid	Metamorphosed graywacke, serpentinized igneous rocks, and glaucophane-schist	Medium to rapid	Moderate to high

Source: DWR, 1978

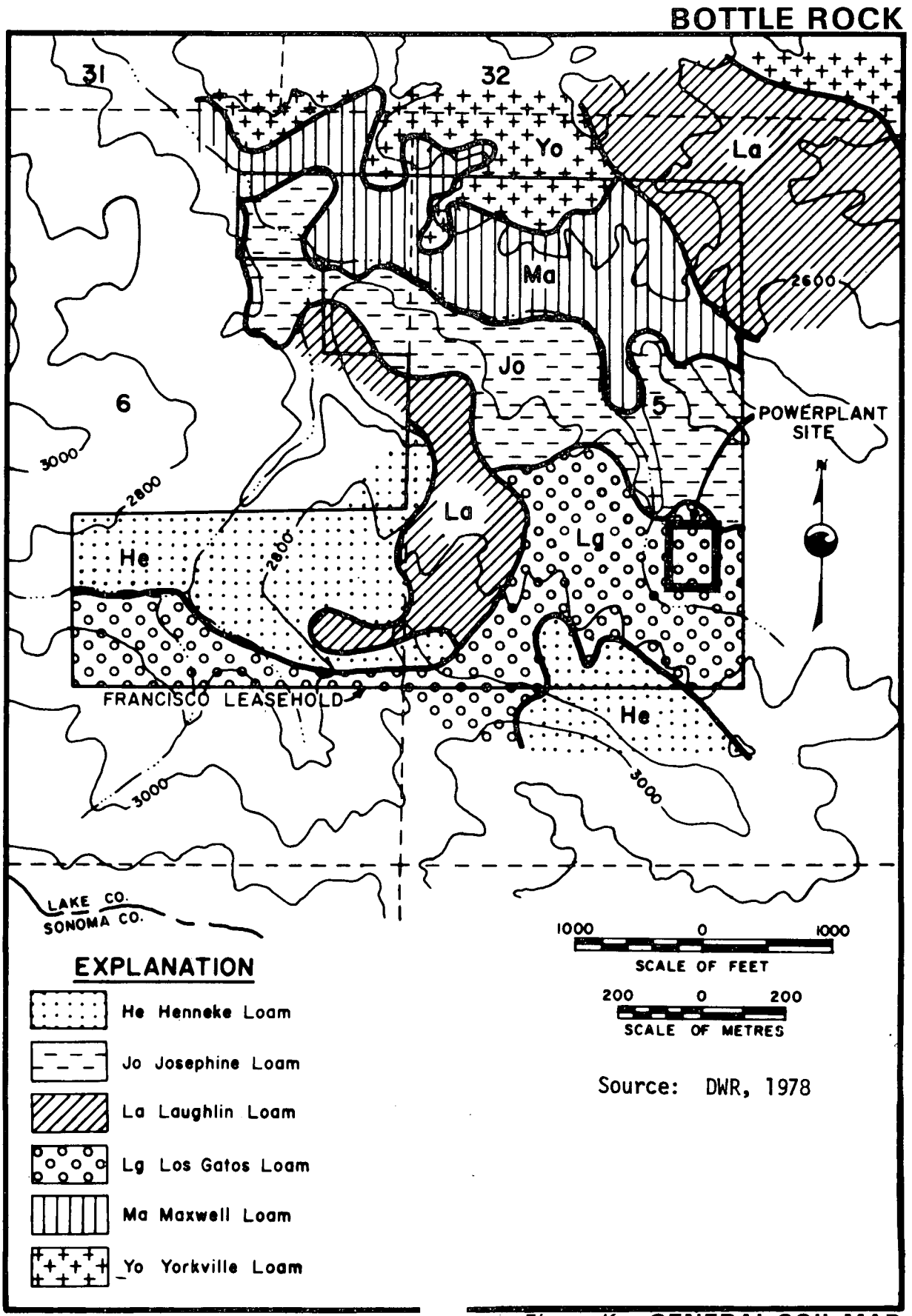


Figure K: **GENERAL SOIL MAP**

AIR RESOURCES

The most difficult environmental effects to analyze and evaluate are the impacts of geothermal power plant emissions on ambient air quality and the effects that deterioration in air quality have on surrounding plant, animal and human populations. Several factors account for this difficulty:

a. Reliable up-to-date information on the existing ambient air quality is seldom available for the specific plant site;

b. Emissions from the plant cannot be accurately predicted prior to actual operations because the exact composition and concentration of chemicals in the incoming steam are not known;

c. The effectiveness of pollution control equipment has not been determined over a period of time long enough to assure the assumed figures are reliable; and

d. There is little scientific certainty regarding the nature and extent of harmful effects of geothermal plant emissions, even after abatement to meet governmental standards, upon plants, animals and humans.

The air resources section examines available information on the ambient air quality at the proposed site, and the meteorological and climatic conditions that affect air quality. It also examines available information on steam content and ambient air conditions. The purpose of the discussion is to provide baseline information against which the proposed project's emissions and the changes in ambient air quality which result from those emissions, can be measured and their effects evaluated.

METEOROLOGICAL CHARACTERISTICS

Preproject Meteorological Conditions

Weather conditions in the general vicinity of the site have been monitored at various times for several years. Three air quality and meteorological monitoring stations established by the Stanford Research Institute (SRI) are located near enough to the proposed DWR site so that data collected there in 1976-77 can be used to determine ambient and meteorological conditions at the plant site.*

The SRI station, SRI-1, is located on the general ridgeline of the Mayacmas Mountains above the plant site, about 1 1/2 miles (2.4 kilometers) south of the plant site. Station SRI-7 is located about 1 1/2 miles (2.4 km) to the east, near the southern end of Cobb Valley. The Lake County community nearest the proposed project area is Pine Grove approximately 2 miles (3.2 km) east southeast of the proposed site. Station SRI-4 is located about 2 3/4 miles (4.4 km) to the northeast of the proposed project area. Between 1976-77, these stations monitored ambient concentrations of hydrogen sulfide (H_2S) and meteorological conditions such as temperature, wind speed and direction.

*The data and results from all eight of SRI's meteorological stations are contained in a report prepared for PG&E in June 1978; see Ronald E. Ruff, Leonard A. Cavanaugh, Janet D. Carr, "1977 Executive Summary Specialized Monitoring Services," (SRI International 1978). Hereafter, cited as Ruff, et al.

In addition, DWR placed a meteorological and ambient H_2S monitoring tower on the peak of the existing knoll on which the proposed DWR power plant would be located. The locations of these and other monitoring stations is shown in Figure L.

Meteorological conditions at the proposed plant site are typical of the general climate in The Geysers KGRA, which is characterized by wet winters and dry summers. This general climate is affected by the Pacific High, a semipermanent high pressure system off the Pacific Coast which influences air flow and precipitation over the entire state. The clockwise flow of air around this high pressure area results in northwest winds over California and is also responsible for the persistent subsidence inversion which extends over much of the state during the summer months.

Ambient Air and Dew Point Temperatures

The complex terrain of The Geysers KGRA is a major factor which affects local climate. The Mayacmas ridge deflects incoming marine air, moderating temperatures within The Geysers KGRA. Even so, monthly temperatures at the site can range from 20°F (-6.6°C) in January to over 100°F (37.8°C) in August. Monthly average ambient temperatures measured at SRI-4 and at the DWR station on the proposed plant site are shown in Table 3.

The cold winter temperatures indicated by the DWR station data included in Table 3 are important for several reasons. First, the H_2S abatement system proposed by DWR must be maintained at temperatures at or above 60°F (15.6°C). Second, low winter temperatures associated with high wind speeds may result in a "down-wash" condition, in which pollutants from the project site could be driven down the Mayacmas Ridge towards Cobb Valley. Such temperatures also appear to be associated with "drainage" conditions at Cobb Valley during which cold air containing pollutants can be pulled down the ridge towards the community of Pine Grove.

The hot summer temperatures indicated by SRI and DWR data contributed to inversion conditions which trap pollutants below hot air layers, preventing dispersion. A condition called "fumigation" can also occur in hot weather, causing pollutants to be transported downward from vigorous vertical mixing of air flows beneath a low inversion. In this condition high concentrations of pollutants can accumulate in relatively small areas such as the southern Cobb Valley region.

Air quality is also affected by the relationships between dew point temperatures and cooling tower plume rise. In general, if the dew point temperature is higher, water vapor or steam emitted from a cooling tower condenses less rapidly. This allows the hot vapor or steam to rise higher, be carried aloft by wind streams, and be dispersed over wider areas. Conversely, when dew point temperature is lower, the water vapor or steam tends to condense more rapidly. Heat energy is lost, the resulting plume rise is lower, and dispersion is less extensive.

The effects of dew temperature on plume rise are not as strong as the effects of wind speed. Mean dew point temperatures recorded at PG&E Geysers Unit 13 (PG&E, 1979b) during 1977-1978 show a fairly narrow range of 34°F (November) to

43°F (August). Although a wider range could be expected at a ridge-top site, both Geysers 13, and Bottle Rock are at a lower, more sheltered location. CEC staff do not believe this difference would make dew point the predominant factor in determining plume rise or would have a major effect on determining "worst case" meteorological conditions for air quality analysis purposes.

Precipitation

In general, the amount of precipitation can affect the ambient air concentrations of total suspended particulates (TSP). Heavy rains and snow "scrub" or "wash" these particles from the air. Precipitation also helps dissolve certain water soluable gases that can be emitted from geothermal plants, such as hydrogen sulfide (a major concern in The Geysers KGRA), ammonia, boron, and others.

Average annual precipitation at the proposed plant site is approximately 60 inches (1.50 cm). (See following Water Resources section for additional discussion) Winter precipitation often occurs as snow above 2,000 feet (600m) and averages about 20 inches annually. Average relative humidity near The Geysers KGRA ranges from about 30 percent during the driest months to near 80 percent in the winter.

The high levels of precipitation during winter months are responsible for the fact that the ambient air concentrations of H_2S measured at the SRI stations were generally lower in the winter than in the summer.

Wind Speed and Direction

Wind speed in the project area generally increases with elevation. The proposed project site is at approximately 2,700 feet (821 m) elevation. Measurements taken at the DWR meteorological station at the site indicate average wind speeds of approximately 10 mph. SRI data indicate that the frequency of calms (winds less than 1 or 2 mph) is less than 0.3 percent at exposed, elevated peaks.

The directional frequency distribution of local wind flow is more complex. At elevations above 3,000 feet (900m), the average annual wind is either from the NE $\pm$ 45° or the SW $\pm$ 45°. This distribution pattern is observed during all seasons, although the NE direction is more prevalent in winter, and the SW predominant in summer. The likelihood of southwestern winds is particularly important since emissions from the plant can be carried toward Cobb Valley (2 miles [3.2 km] to the NE).

Directional frequency of wind flows at the SRI-1 meteorological station located on Geyser Rock, south of the proposed project site, exhibits the typical NE/SW high elevation pattern. At lower elevations, directional patterns bear little similarity to patterns found at high elevations, as local terrain becomes increasingly important in determining directional distribution. The more dominant wind directions are northwest and southeast, which is significantly different from ridgeline meteorological stations. Lower elevation stations such as SRI-7 also exhibit a higher frequency of relative calms. Topographic features may cause channeling of moderate or strong flows within the Cobb Valley and around obstacles. Heating and cooling of slopes tends to create upslope flows over sunheated surfaces and downslope flows at night. Downslope drainage flows are most developed in winter and upslope flows are stongest and most frequent in summer.

TABLE 3

MONTHLY AVERAGE AMBIENT TEMPERATURES IN PROJECT AREA (°C)

Location	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pine Summit SRI-4[1]	6°	9°	5.0°	11°	8°	20°	22°	22°	17°	14°	10°	7°
Proposed Plant Site[2]	-1°	-1.6°	2.6°	4.3°	11.7°	13°	19.3°	18.4°	14.9°	13.6°	3.4°	1°

1. Ruff, Cavanaugh and Carr, 1977. Data shown were measured from January 1977 through December 1977.

2. Environmental Systems and Service (contractor for DWR's met station). Data shown were measured from April 1978 through March 1979.

Worst Case Meteorological Conditions

In order to determine the maximum extent of adverse impacts from power plant air emissions on air quality, one must first determine what meteorological condition would create the "worst case" conditions for transport and concentration of pollutants. Several studies have been conducted by PG&E and DWR consultants to determine the worst case conditions.

SRI's 1976-77 study established the data base for determining the dominant meteorological conditions at various points in the KGRA, including two points, SRI-1 (ridgetop) and SRI-7 (Sawmill Flats), relevant to the DWR project. SRI also sought to determine whether there are any strong correlations between specific meteorological conditions (temperature, windspeed and direction) and high concentrations of H_2S. Essentially, SRI found a strong correlation between wind speeds in excess of 5 miles per hour coming from the southwest and high H_2S concentrations at the ridgetop. The ERT Report* then took the SRI data, confirmed the SRI conclusions, and additionally determined that H_2S concentrations peaked at the ridgetop during the cool night or early morning hours.

Subsequently, The Geysers Cobb Valley Air Quality Impact Study, a tracer study and analyses conducted by Meteorology Research, Inc. (MRI), evaluated the SRI and ERT data in order to determine which meteorological condition would have the worst case impacts at the Bottle Rock site and, more importantly, at the nearest communities, including Pine Grove, Hobergs, Cobb, Loch Lomond, Harrington Air Strip, Glenbrook, and Jaddikers. Essentially MRI determined that the conditions which maximized H_2S concentrations at the ridgetop (plant site) were not necessarily the same conditions that produced maximum H_2S concentrations at these communities which are at lower elevations in the Cobb Valley.

In the tracer studies conducted by MRI, sulfur hexafloride (SF_6) or freon ($CBrF_3$) was released under certain defined meteorological conditions. The releases were made at DWR's proposed plant site, at NCPA-1 proposed plant site, and at PG&E's Geysers 17 plant site; the conditions included nocturnal drainage, downwash, deep mixing, and limited vertical mixing (the four conditions found to contribute most to downwind impacts). The releases were carried out during periods when wind speeds and direction would be most likely to transport the tracer gases to populated areas. The results of MRI's tracer studies are contained in the previously cited MRI study and referenced in DWR's AFC.

In determining the hypothetical worst case conditions for H_2S impacts, MRI's study does not conclusively establish what the worst case would be. Although the tracer gases were released during periods when each of the hypothesized worst case conditions occurred, it was not determined if in fact a worst case condition was studied. During the period of the study (September 1978 to April 1979) there was no indication that these four conditions occurred simultaneously.

*D. Steffan, L. Wang, G. Hidy, The Geysers Geothermal Area Emissions and Aerometric Data Set (1976-1977), (ERT, August 1978) prepared for The Geysers Geothermal Environmental Committee, hereinafter referred to as "ERT Report."

AIR QUALITY

Ambient air quality in The Geysers KGRA is influenced predominantly by geothermal steam emissions. Seventy-one billion pounds of steam were used in 1976 by the 11 operating units of PG&E's Geysers Power Plant. Water vapor constituted about 98 percent of these emissions; the remaining two percent was comprised of noncondensible gases and solids.

Characteristics of Steam Content as They Relate to Air Quality

Composition of the steam varies according to the location of the source within the KGRA. A comparison of the composition of geothermal steam produced from wells supplying earlier PG&E units and those which will supply the Bottle Rock power plant are presented in Table 4. The figures in this table are averages based upon the range of values measured for a number of steam wells. Based on information from earlier PG&E units, the table also indicates the amount of each steam component going through a 55 MW power plant each hour.

As the table demonstrates, the concentration of regulated pollutants in the steam from DWR's two wells is generally higher than the average concentrations from other geothermal projects. Less than half of the DWR wells have been drilled and measured, and a total of 12 or more wells will be required for initial operation of the plant. Thus, no firm conclusion about ultimate concentrations of these pollutants can be made. However, information from wells drilled for nearby units (Geysers 17 and 11) suggests that the concentrations of pollutants in the northern part of the KGRA will be greater than the concentration experienced in most other developed areas of the KGRA. These facts imply a greater need for a highly efficient H_2S abatement system to meet air quality standards and avoid adverse environmental impacts.

Pending receipt of data on mercury levels from DWR wells, and based upon mercury levels from existing wells in The Geysers KGRA, CEC staff projects that mercury levels will be relatively low.

Characteristics of Existing Ambient Air Quality

As geothermal development in The Geysers KGRA has increased, ambient air quality has been monitored, along with meteorological conditions, at the locations shown in Figure L. In addition, a number of studies have been conducted to determine the presence of pollutants in the ambient air.

In 1975, the California Air Resources Board (ARB) measured seven major air quality contaminants at two sites in southern Lake County. The two sites are Kelseyville, about 10 miles (16 km) northwest of the site, and Middletown, about 10 miles (16 km) to the southeast. The ARB monitored ozone, carbon dioxide, sulfates, total hydrocarbons, methane, nonmethane hydrocarbons, and coefficient of haze (reduced visibility). According to the ARB, no California ambient air quality standards were exceeded during the monitoring period, April 14 through May 12, 1975. No similar or more recent monitoring for these parameters has been undertaken despite the fact geothermal development has increased since 1975.

Pollutants associated with development of geothermal resources which are of concern in maintaining ambient air quality include suspended particulate matter,

TABLE 4

NONCONDENSIBLE GASES AND SOLIDS IN STEAM (AVERAGED)

FROM WELLS SUPPLYING GEOTHERMAL POWER PLANTS

Noncondensible Gases	Flow Into 55 MW Unit (lbs/hr)	Percent By Weight The Geysers*	DWR/Bottle Rock**
Carbon Dioxide	2960	0.326	
Hydrogen Sulfide	222	0.0222	
Methane	176	0.0194	
Ammonia	176	0.0194	
Nitrogen	47.1	0.0052	
Hydrogen	50.8	0.0056	
Ethane	-	Negl	
Total Noncondensibles	-	0.398	
SOLIDS (parts per million, by weight)			
Arsenic***	0.0171	0.019	
Boron***	14.6	16.0	
Mercury***	0.00459	0.005	

*Overall average from 61 producing wells supplying The Geysers Power Plant, measured in 1972-74. (NSCAPCD, 1974)

**Average from two producing wells proposed to supply Bottle Rock, measured in latest McCulloch data. (Final data pending receipt of responses to interrogatories from DWR.)

***Concentrations are given in parts per million by weight.

SRI Kahn Ranch (3)
SRI Hobergs (4)
SRI Sawmill Flat (7)
SRI Whispering Pines (5)
SRI Anderson Springs (6)
SRI Anderson Ridge (2)
SRI Geyser Rock (1)
SRI Aidlin Ranch (8)
PG&E 32
PG&E 33
Unit 11
Unit 17
LCAPCD

Figure L: **HYDROGEN SULFIDE DATA**

LEGEND:

SCALE 1:24000
0 1 MILE

◯ **Sampling locations for ambient hydrogen sulfide concentrations**

SOURCE: PG&E, 1978a.
USGS 1:24,000 Geysers and Whispering Pines Quads.

Figure L: **HYDROGEN SULFIDE DATA**

hydrogen sulfide, sulfur dioxide and sulphate, and radon. The ambient air conditions for each of these pollutants is described below.

Suspended Particulate Matter - Lake and Northern Sonoma County Air Pollution Control Districts recently completed a six-month program to monitor suspended particulate matter in The Geysers KGRA. During the period of February through August 1977, 24-hour average suspended particulate matter concentrations ranged from 1.74 $\mu g/m^3$ on Socrates Mine Road 2 miles (3.2 km) to the north (3/14/77), to 76.05 $\mu g/m^3$ in Middletown (8/11/77). The higher values observed in Middletown probably reflect the contributions from nongeothermal sources in Middletown such as vehicular traffic, construction activities, and agricultural activities. Kahn Ranch (3 1/2 miles [5.5 km] north), Pine Summit (4 1/2 miles [7.2 km] northeast), and Geysers Rock ranged between 1 and 30 $\mu g/m^3$, while Sawmill Flat (2 miles [3.2 km] west), ranged between 8 and 66 $\mu g/m^3$. Nearby road construction probably accounted for the higher valve at Sawmill Flat. All reported concentrations are below the California ambient air quality standard of 100 g/m^3 averaged over 24 hours.

Hydrogen Sulfide (H_2S) - Hydrogen sulfide is present in the geothermal steam in The Geysers KGRA and is one of the most noticeable pollutants associated with geothermal development. H_2S emissions from natural sources, such as geothermal springs, fumeroles (a natural surface crack emitting steam), or streams carrying H_2S from other sources have been measured and reported by several investigators, including Environmental Systems and Services (ES&S) (1978), Frazier (1978), and Tolmasoff (1975).*

Generally, these studies indicate that individual natural sources can contribute as much as 75 to 250 lbs/day H_2S to the ambient air. However, there is no evidence of such natural sources at the proposed plant site, and only limited evidence of such sources near the project area. Two natural sources of moderately defined extent have been noted in a recent study by Environmental Systems and Services (ES&S). According to ES&S, the first source is located about 1 mile (1.6 km) northwest of the proposed project near Glenbrook (Tantarelli Springs), and consists of six small springs; however, no H_2S odor was detected. The second source is about 1 mile (1.6 km) west of the DWR site, and consists of a clear, apparently odorless spring near Kelsey Creek (Gordon Springs) (ES&S, 1978).

*Characterizations of background hydrogen sulfide concentrations in and around The Geysers area have been the subject of several studies, including:

- Swanson and Mooney H_2S survey of 1972 (PG&E);
- Altshuler H_2S Air Quality Study, starting 1970 (PG&E);
- Unit #11 monitoring, starting 1974 (PG&E);
- Lake County Air Pollution Control District H_2S monitoring, starting 1975;
- SRI, Inc., H_2S Study, starting 1976 through 1978;
- Environmental Systems and Service H_2S monitoring at Klau Mines No. 1 Well Site, May 17 to June 19, 1977

Thus, H_2S concentrations in the vicinity of the site are not likely to result from these natural causes. Moreover, the ERT Report (Steffan, et al, 1978) found that cooling tower emissions could only be predicted within a range of +50 percent. This range of possible error is substantially greater than any likely contribution to H_2S concentrations that could be attributable to natural sources. Although certain wind patterns might result in detectable levels of H_2S from natural sources, the areawide emission of 30,000 to 40,000 lbs/day of H_2S (Steffan et al, 1978) from all sources make the small levels of H_2S from natural sources relatively insignificant.

As part of its study, SRI measured ambient concentrations of H_2S at eight locations in The Geysers KGRA during 1976 and 1977. SRI then derived hourly averaged concentrations of H_2S. Tables 5 and 6 present the distribution and frequency of times when the concentration equaled or exceeded the state ambient air quality standard of 0.03 parts per million (ppm) of H_2S, at each monitoring point.

The SRI data indicate that H_2S levels in The Geysers Rock area (SRI-1) and on the ridgecrest above Cobb Valley are somewhat higher than those of other areas monitored (i.e., SRI-4 and 7). This site is near producing geothermal fields. SRI-4 and SRI-7 are the monitoring stations near the proposed project site (1 mile [1.6 km] to the north and 1 mile [1.6 km] to the west respectively). The data indicate that 1976 H_2S levels at this site exceeded the state standard approximately .5 percent of the time (39 hours from a total of 7,168 hours monitored) at SRI 4 and .5 percent of the time (37 from a total of 6,608 hours monitored) at SRI-7. During 1977 the 30 ppb standard was exceeded approximately 7 percent of the time (64 hours from a total of 8,353 hours monitored) at SRI 4, and .3 percent of the time (21 hours from a total of 8,300 hours monitored) at SRI-7. Data for 1978 and 1979 are not available.

SRI-1, the ridge site, generally records high H_2S levels when the winds are from the southwest. The distribution of H_2S concentrations versus time-of-day also peak during the midday. According to the ERT study, it is probable that natural fumarole activity coupled with emissions from geothermal development activities (nearby operating PG&E Units 7, 8, 9, and 10, and Union Oil Company wells) to the southwest of Geysers Rock are the primary contributors to H_2S concentrations recorded at SRI-1 during west or southwest winds.

Data from SRI-4 (Pine Summit) for 1977, located below the ridge in Cobb Valley, indicates that most of the violations in 1977 occurred during southwesterly winds. Data from SRI-7 (Sawmill Flat) for 1977, located below the ridge in Cobb Valley, indicates the distribution of higher H_2S concentrations is peaked when the winds are from the west or the west-southwest. Generally, higher H_2S values are found during midday when H_2S, being carried across the valley by the upper level flow, is probably caught in a vertical mixing regime or a result of a stagnation condition.

It is impossible to determine the exact sources of H_2S during periods when state standards are violated. The existing Geysers development could well be contributing to these violations since it is possible that wind west of the Mayacmas ridge from the developed areas can be diverted northward or southward by Cobb Mountain. Drainage flow downslope could subsequently dominate this wind flow and cause pollutants to flow around the mountain toward Cobb Valley.

TABLE 5

DISTRIBUTION OF H_2S HOURLY AVERAGES (30 ppb): 1976

Station		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
1 Geyser Rock	≥30[a]	8	45	22	24	49	99	57	103	45	9	27	488	7
	Days[b]	5	17	12	13	17	27	18	26	12	4	9	160	49
	Counts[c]	447	714	699	662	708	696	602	684	727	695	691	7325	91
2 Anderson Ridge	≥30[a]	53	82	22	41	79	112	91	68	56	26	10	640	10
	Days[b]	12	19	10	14	16	20	20	19	14	11	5	160	49
	Counts[c]	399	718	691	330	675	715	646	663	729	598	496	6660	83
3 Kah Ranch	≥30[a]	1	5	0	1	4	7	0	13	7	1	1	40	.5
	Days[b]	1	4	0	1	2	3	0	4	2	1	1	19	6
	Counts[c]	474	713	672	644	712	725	715	661	732	599	691	7338	91
4 Pine Summit	≥30[a]	5	4	0	1	2	6	0	7	10	3	1	39	.5
	Days[b]	2	4	0	1	2	4	0	4	5	2	1	25	8
	Counts[c]	347	710	707	651	702	713	720	594	721	641	662	7168	89
5 Whispering Pine	≥30[a]	0	0	0	1	0	14	3	4	9	0	2	33	.5
	Days[b]	0	0	0	1	0	5	3	3	5	0	2	19	6
	Counts[c]	411	734	676	668	627	633	722	644	715	588	647	7065	88
6 Anderson Springs	≥30[a]	0	0	0	0	2	1	0	0	0	0	0	3	.04
	Days[b]	0	0	0	0	2	1	0	0	0	0	0	3	.9
	Counts[c]	437	724	705	655	651	697	717	594	700	628	647	7155	89
7 Sawmill Flats	≥30[a]	0	0	1	4	9	8	4	7	0	0	0	33	.5
	Days[b]	0	0	1	3	5	3	3	2	0	0	0	17	5
	Counts[c]	594	726	690	667	492	676	710	642	730	579	102	6608	82
8 Aidlin Ranch	≥30[a]	25	0	0	3	5	1	12	2	17	37	84	186	3
	Days[b]	8	0	0	2	2	1	2	2	4	8	17	46	14
	Counts[c]	295	171	699	648	688	624	714	673	622	536	658	6333	79
Monthly Totals:	≥30	92	136	45	75	150	248	167	204	144	76	125	(All stations)	
	≥30	31	9	1	10	22	37	19	33	43	41	88	(Stations 3-8)	

a 30 ppb = number of H_2S hourly averages at or above 30 ppb.

b Days = number of days with at least one hour reading at or above 30 ppb.

c Counts = number of valid hourly averages (percent counts correspond to valid data capture for Feb. 1 thru Dec. 31)

Source: SRI, 1978

TABLE 6

DISTRIBUTION OF H_2S HOURLY AVERAGES (30 ppb): 1977

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
1 Geyser Rock	⩾30[a]	11	17	10	12	8	22	39	33	28	45	10	10	245	3
	Days[b]	5	7	3	6	4	11	16	14	13	17	5	5	106	29
	Counts[c]	673	587	713	685	737	719	713	705	694	718	679	648	8271	94
2 Anderson Ridge	⩾30[a]	11	31	5	11	25	65	80	70	10	51	17	20	396	5
	Days[b]	4	11	4	9	8	20	17	15	5	8	3	7	111	30
	Counts[c]	696	617	706	708	721	718	712	721	693	747	665	668	8372	96
3 Kahn Ranch	⩾30[a]	0	0	0	1	0	1	0	0	2	0	0	0	4	.05
	Days[b]	0	0	0	1	0	1	0	0	1	0	0	0	3	.8
	Counts[c]	700	583	713	697	740	718	712	716	660	709	677	672	8297	95
4 Pine Summit	⩾30[a]	0	0	1	2	1	12	13	17	4	5	5	4	64	.7
	Days[b]	0	0	1	2	1	6	5	6	1	3	3	2	30	8
	Counts[c]	664	654	672	685	738	717	666	731	705	731	690	700	8353	95
5 Whispering Pine	⩾30[a]	0	0	0	4	0	0	0	0	10	2	1	0	17	.2
	Days[b]	0	0	0	3	0	0	0	0	6	2	1	0	12	3
	Counts[c]	700	633	698	713	681	715	705	703	662	721	656	782	7869	90
6 Anderson Springs	⩾30[a]	0	0	0	0	2	6	1	8	0	8	0	0	25	.3
	Days[b]	0	0	0	0	1	2	1	4	0	2	0	0	10	3
	Counts[c]	664	633	670	679	622	717	703	708	703	734	689	679	8201	94
7 Sawmill Flats	⩾30[a]	0	1	0	2	1	3	8	4	1	1	0	0	21	.3
	Days[b]	0	1	0	1	1	3	7	3	1	1	0	0	18	5
	Counts[c]	671	636	662	694	712	713	715	711	698	734	677	677	8300	95
8 Aidlin Ranch	⩾30[a]	15	2	3	0	12	12	5	12	26	122	56	19	284	4
	Days[b]	9	2	2	0	3	6	3	4	7	23	20	8	87	24
	Counts[c]	478	601	682	513	688	689	518	678	660	708	585	542	7342	84
Monthly Totals:	⩾30	37	51	19	32	49	121	146	144	81	234	89	53	(All stations)	
	⩾30	15	3	4	9	16	34	27	41	43	138	62	23	(Stations 3-8)	

a ⩾30 ppb = number of H_2S hourly averages at or above 30 ppb. (The actual measurement per hour must have averaged 29.5 or more.)

b Days = number of days with at least one hour reading at or above 30 ppb.

c Counts = number of valid hourly averages (perfect counts correspond to valid data capture for 1 January thru 31 December)

Source: SRI, 1978

For purposes of determining compliance with the state H_2S ambient standard, the ARB and LCAPCD measure the H_2S ambient concentration at public areas (e.g., Sawmill Flat, Pine Summit, Hobergs, and Pine Grove) since the H_2S standard is designed to prevent a " public nuisance." On the other hand, CAL-OSHA standards apply at the plant site for protection of plant employees. (Refer to additional discussion in Health and Safety section.)

Sulfur Dioxide (SO_2) - As part of its study, SRI measured SO_2 concentrations at Anderson Springs (SRI-6) and Pine Summit (SRI-4). Over 7,000 measurements were taken at each station between February and December 1976. At no time did SO_2 concentrations exceed the state standards for SO_2 (0.5 ppm hourly average or 0.05 ppm 24 hour average). Only rarely (1.1 percent of the time) did the hourly average concentrations of SO_2 at Anderson Springs exceed .005 ppm (Ruff et al, 1978). Thus, staff does not expect SO_2 concentrations to approach or exceed ambient air quality standards.

WATER RESOURCES

HYDROLOGY

Precipitation - The mean annual precipitation for the Bottle Rock site is approximately 52 inches (1.3 m) (Figure M) (DWR, 1978). The probable maximum precipitation for a 10 minute period measured at the nearby Mahnke station is 1.48 inches (3.8 cm) (DWR, 1976). Mahnke station is located 1 1/2 miles northwest of the plant site (Figure M). Assuming a run-off coefficient of 0.8 for the mostly paved site, this Mahnke statistic would result in an amount of run-off from the plant site equal to almost 200,000 gallons (760,000 l) annually.

The steep slopes and shallow soils of the area contribute to a rapid run-off regime and a high soil erosion hazard.

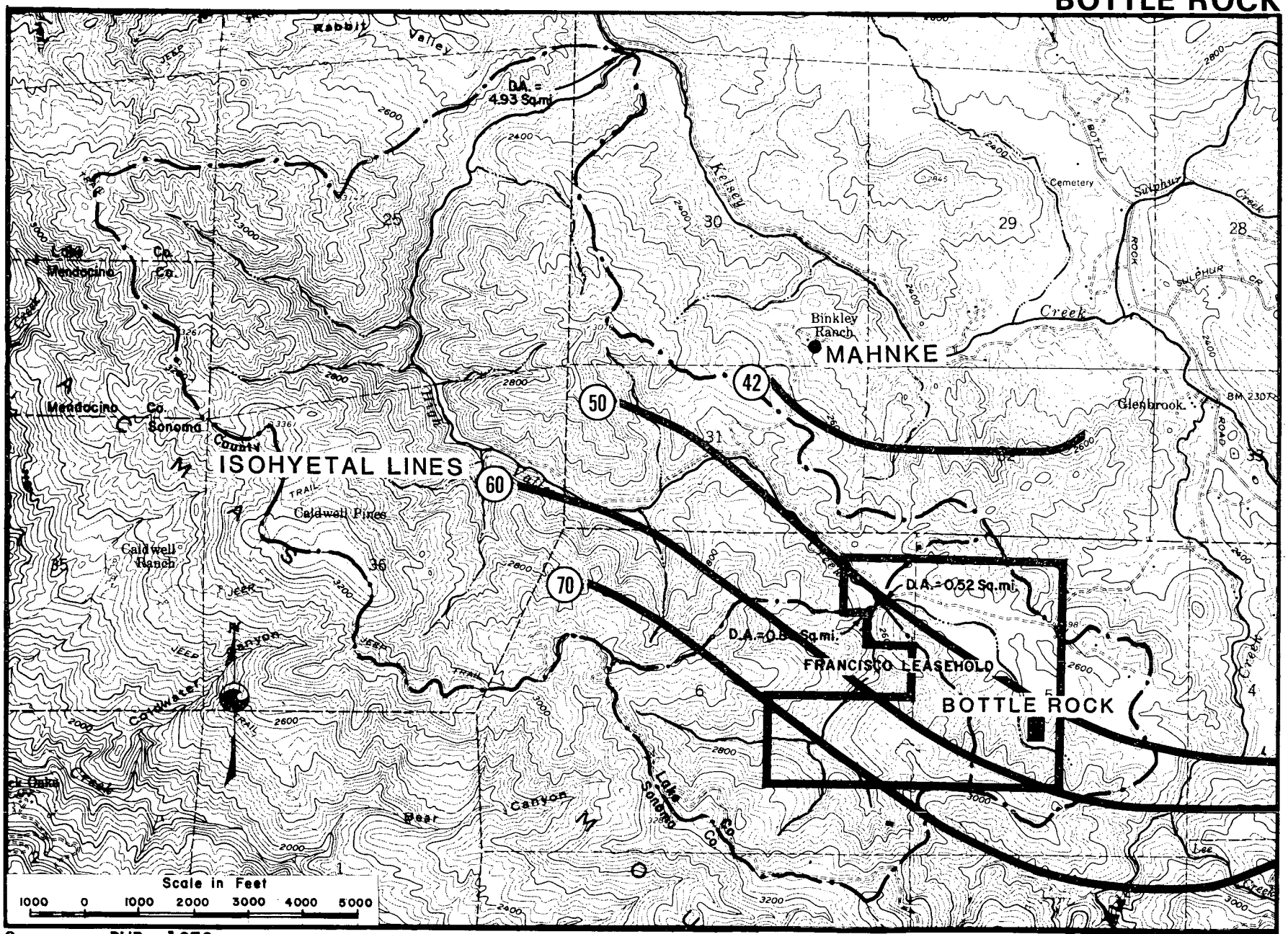
Surface Water - The area is drained by High Valley and Kelsey Creeks into Clear Lake (Figure M).

The Kelsey Creek gaging station near Kelseyville is the nearest gaging station. Using the records of the Kelsey Creek station, the mean monthly flow for High Valley Creek appears in Table 7. Mean annual flow of High Valley Creek is estimated to be 8,500 acre-feet (10.48 cubic hectometers [hm^3]). Mean annual flow of Kelsey Creek is 52,000 acre feet (64.14 hm^3).

The total freshwater requirement for the project is estimated by DWR at about 880,000 gallons or 2.7 acre-feet per year. The source options are: (1) to truck water in; (2) to develop a water well on the leasehold; (3) to utilize the roofs of buildings and the paved parking areas to collect rain; or (4) to treat excess condensate.

Flood Hazard - The actual site is located 100 feet (30 m) from and about 40 feet (12 m) above a small intermittent stream, which precludes any possibility of flood damage.

Groundwater - The rocks underlying the leasehold are generally classified as nonwaterbearing and are impermeable except along fracture zones. Although no aquifers occur in these rocks, minor amounts of water can collect in the rock fractures zones. Early settlers in High Valley and the surrounding areas obtained their water supply from these sources which were just sufficient for limited domestic use. (Chee, 1978).



Source: DWR, 1978

Figure M: **HIGH VALLEY CREEK WATERSHED**

TABLE 7

MEAN MONTHLY FLOWS OF
KELSEY CREEK AND HIGH VALLEY CREEK
Units = cubic feet/second

Month	Kelsey Creek Near[1] Kelseyville 36.6 sq. mi.[3] P = 46	High Valley Creek[2] at Mouth 4.93 sq. mi.[3] P = 56
October		
October	17	2.8
November	40	6.6
December	142	23
January	192	31
February	205	34
March	123	20
April	87	14
May	32	5.2
June	13	2.1
July	6.0	1.0
August	3.8	0.6
September	4.2	0.7
TOTAL - cfs-mos.	865.0	141.0
AF/yr.	52,100	8,500

1/ Mean monthly flows for 1946-68 from U.S. Geological Survey, 1971.

2/ Mean monthly flows estimated from Kelsey Creek near Kelseyville using area-precipitation method.

3/ Mean precipitation.

Source: DWR, 1978.

WATER QUALITY

The Francisco leasehold drains to High Valley Creek, except for approximately 10 acres, which drain to an unnamed seasonal stream tributary to Alder Creek. Both High Valley Creek and Alder Creek are tributaries to Kelsey Creek, which flows to Clear Lake (Figure M).

Because this drainage is on the east side of the Mayacmas Mountain Range, water quality preservation is under the jurisdiction of the Central Valley Regional Water Quality Control Board (CVRWQCB). The Regional Board's Water Quality Control Plan, Sacramento River Basin (5A) (1975), promulgates a nondegradation policy and also establishes beneficial uses of the surface waters within the basin.

Beneficial uses of High Valley, Alder, and Kelsey Creeks within the immediate vicinity of the proposed power plant site include recreation, fish and wildlife propogation and preservation, and aesthetic enjoyment. Uses downstream include irrigation, water supply, and more extensive water related recreation activities (DWR, 1978). Parametrix Inc., Gennis and Associates, Sociotechnical Systems, Inc., Pacific Gas and Electric (PG&E), and the California Department of Water Resources (DWR) have done individual water quality studies on Alder and High Valley Creeks (DWR, 1978). These studies generally indicate good quality waters in those creeks.

There are no regional groundwater aquifers in the area (DWR, 1978). Isolated pockets of groundwater, trapped in fissures of the geology subase, may be found in the immediate area. These isolated subsurface waters are of shallow depths, within six inches (15 cm) of the ground surface, and are usually only present after above-normal precipitation seasons (DWR, 1978).

WASTE MANAGEMENT

Potential Waste Materials - A number of liquid and solid wastes are produced during construction and operation of a geothermal power plant. These wastes include: excess soil and vegetation produced during preparation of the proposed site for construction; a wide variety of construction wastes; condensate from the spent geothermal steam blow-down from cooling towers and power plant systems; by-products from the H_2S abatement system(s); contents of steam well drilling sumps; and sanitary wastes.

The California Department of Health Services, Hazardous Waste Management Section, has informed the Energy Commission that cooling tower sludge, the Stretford solution purge stream and elemental sulfur produced by the H_2S abatement system(s) are potentially toxic substances (Collins, 1978). These substances are therefore presumed to be toxic unless they are shown not to be.

Contents of the well drilling sumps and sanitary wastes may be hazardous. Materials such as excess soil and vegetation produced during site preparation and excess or unusable construction debris are not considered potentially toxic.

Potential Disposal Sites - Wastes produced by geothermal power plant operations must be disposed of either at a Class I or Class II-1 site approved by the responsible regulatory agencies.

Geothermal Incorporated operates a Class II-1 disposal site near Middletown in Lake County, about 13 miles from the proposed project area. This operator has a permit to accept all wastes produced by the PGandE geothermal power plants in The Geysers KGRA. (Kritikos, 1979; Central Valley RWQCB, 1979). Approximately 2,000 cubic yards of sludge (waste from water processing systems at Geysers Units 3, 4, 5, 6, 11 and 12 and waste from cooling tower basins at Units 1-12) are produced each month by these 12 geothermal power plants. Based upon this rate of waste production, the operator of the Middletown site estimates there is capacity to accommodate these wastes for 50 years. (Kritikos, 1979).

IT Corporation operates Class II-1 disposal sites near Kelseyville in Lake County, about 24 miles from the proposed project area. The site operator is fully licensed for disposal of all wastes produced by the existing PGandE power plants in the KGRA. Based upon the current rate of waste production from Geysers Units 1-12, the current site has a design life of seven years. If the operation proves financially feasible for IT Corporation,...there is disposal capacity for 50 years. (Bauer, 1979).

IT Corporation also operates a Class I disposal site near the city of Martinez in Contra Costa County, about 83 miles from the proposed project area. This site is licensed to accept wastes of the type produced in geothermal power plant operations.

BIOLOGICAL RESOURCES

The biological setting of the DWR Bottle Rock project has been extensively discussed in the Environmental Impact Report for Geothermal Development by McCulloch Oil and Geothermal Kinetic Systems for the Study Area on the Francisco Leasehold, Lake County, California (Neilson, 1975), the Department of Water Resources Notice of Intention (DWR, 1978), the Department of Water Resources Application for Certification (DWR, 1979), and the Environmental Impact Report for McCulloch Corporation, DWR Bottle Rock Power Plant, Francisco Leasehold, Lake County, California (Neilson, 1979). The following summarizes the information in these documents.

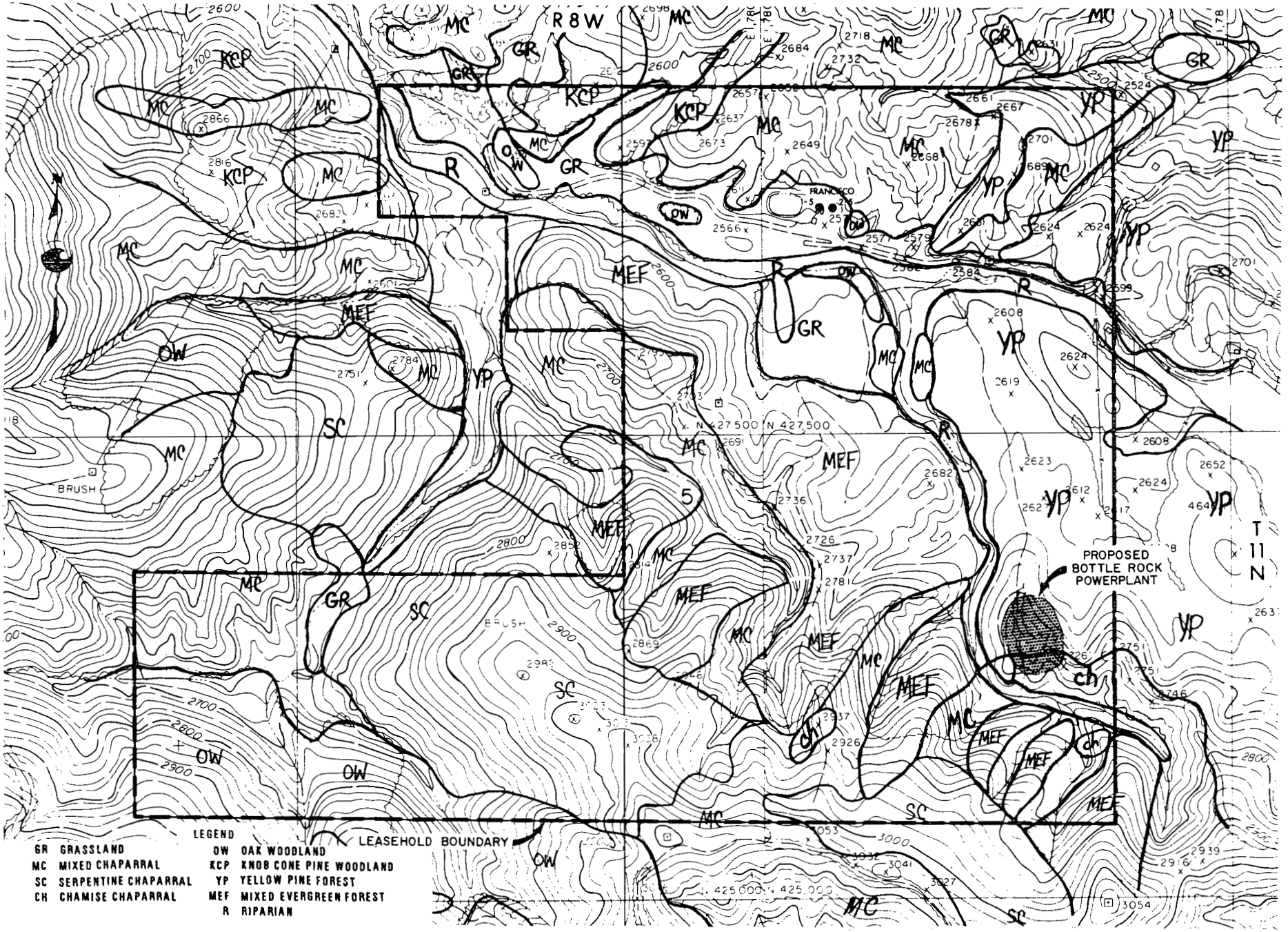
Vegetation - The vegetation found in the vicinity of the proposed project is typical of the central coast ranges north of the San Francisco Bay. It is characterized by a composite of brush (primarily chaparral), and deciduous and mixed evergreen plant communities resulting from a variety of factors including topography, exposure, soil variation, land use, and response to fire.

The plant communities found on the proposed power plant site, the surrounding steam field, and transmission line corridor include: chaparral, yellow pine forest, mixed evergreen forest, oak woodland, knobcone pine woodland, grassland, and riparian (Figure N).

The chaparral community, which covers approximately 40 percent of the leasehold, is divided into three general types: chamise chaparral, serpentine chaparral, and mixed chaparral. The chamise chaparral community is the smallest of the three chaparral types and is normally restricted to southfacing slopes on thin soils. The dominant species of this community are chamise (Adenostema fasciculata) and buckbrush (Ceanothus cuneatus). Serpentine chaparral communities are formed on Henneke loam, which results from serpentine parent material. The dominant species of the community are Stanford's manzanita (Arctostaphylos stanfordiani), Jepson's ceanothus (Ceanothus jepsonii), leather oak (Quercus durata), and chamise. The mixed chaparral community is found on Josephine and Laughlin loams which have somewhat higher moisture regimes than the parent soils of the chamise and serpentine chaparral communities. The dominant species of the mixed chaparral community are interior live oak (Q. weslizenii var. frutescens), canyon oak (Q. chrysolepis), scrub oak (Q. dumosa), buckbrush, Eastwood's manzanita (A. glandulosa), and black oak (Q. kelloggii).

The yellow pine community covers approximately 15 percent of the leasehold. The dominant species of this community include yellow pine (Pinus ponderosa), black oak, madrone (Arbutus menziesii), and Parry's manzanita (A. manzenita). There is a large variety of species in the herbaceous understory of this community. On steeper slopes, the composition of this community enlarges to include douglas fir (Pseudotsuga menziesii) and white-leaved manzanita (A. viscida).

The mixed evergreen forest, which covers approximately 25 percent of the leasehold, occurs in patches on north and northeast facing slopes. The dominant species of this community are douglas fir, madrone, black oak, canyon oak, and bay (Umbellularia california). This community has a complex understory in which the mixture of species is determined by the amount of overhead cover, soil, exposure, slope, and water availability.



Source: DWR, 1978
Modified by California Energy Commission, Oct. 1979

Figure N: **VEGETATIVE COMMUNITIES**

The oak woodland community, which covers approximately 10 percent of the leasehold, is found in scattered patches except for large areas in the southeast corner of the leasehold. The dominant species include canyon oak, garry oak (Q. garryana), interior live oak, and black oak. In places, the tree canopy provides about 90 percent cover, and the dense layer of oak leaf mulch prevents a herbaceous layer from developing (Neilson, 1975).

The knobcone pine woodland, grassland, and riparian communities combined cover approximately 10 percent of the leasehold. The knobcone pine woodland is located in the northwestern portion of the leasehold. The predominant species being knobcone pine (Pinus attenuata). The grassland community is composed of three vegetation types: annual grassland, wet meadow, and California prairie. Of these, wet meadow and California prairie are of special importance. The annual grassland is derived historically from intense livestock grazing and composed of a few native and a variety of introduced annual grasses and herbs (Neilson, 1975). The wet meadow is made up principally of California oatgrass (Danthonia californica) and sweet vernalgrass (Eroderia cristata) (Neilson, 1975). The wet meadow grassland community is floristically unique and rather uncommon for the Mayacmas Mountains. It contains a great variety of plant species which are of high value to wildlife. The best example of a wet meadow community on the leasehold is located between the Franciscan and Coleman well pads. The California prairie once formed the principal native grassland over much of central California, but now, only relic stands occur. A large portion of the prairie located near the Francisco well pad lies buried under extensive spoil from that well pad (DWR, 1979). The riparian community is also of special importance and is probably the most complex of all the communities on this property due to the availability of water, which allows it to support a large variety of species. Common trees in this community include box elder (Acer negundo ssp. californicum), white alder (Alnus rhombifolia), elderberry (Sambucus mexicana), willow (Salix sp), and big-leaf maple (Acer macrophyllum). There are also abundant shrubs and herbs in this community. The riparian vegetation is confined to narrow corridors along permanent and intermittent streams. The riparian zone that runs along Cow Creek from a point directly west of the site up through its headwaters is one of the more important communities on the leasehold, from both a floristic and wildlife standpoint.

The Boggs Lake Natural Area Preserve, which is located three miles north of the leasehold, is also an area of special importance. This preserve is an unusual combination of vernal pool and pond, supporting several rare plant species, four of which are on the California Native Plant Society's list of rare and endangered plants. Two of these, the many-flowered navarretia (Navarretia plieantha) and hedge-hyssop (Gratiola heterosepala), apparently grow only at Boggs Lake.

No rare or endangered plants are known to exist within the leasehold or have been observed in over four years of observation (DWR, 1978). Two species considered rare by the California Native Plant Society are found on the leasehold. The St. Helena fawn lily (Erythronium helenae), a plant of special concern locally, is found in a widespread but sparse population along a ridge within the transmission corridor (Figure 0). A second species of special concern, the lomatium (Lomatium respostum), a member of the carrot family, is

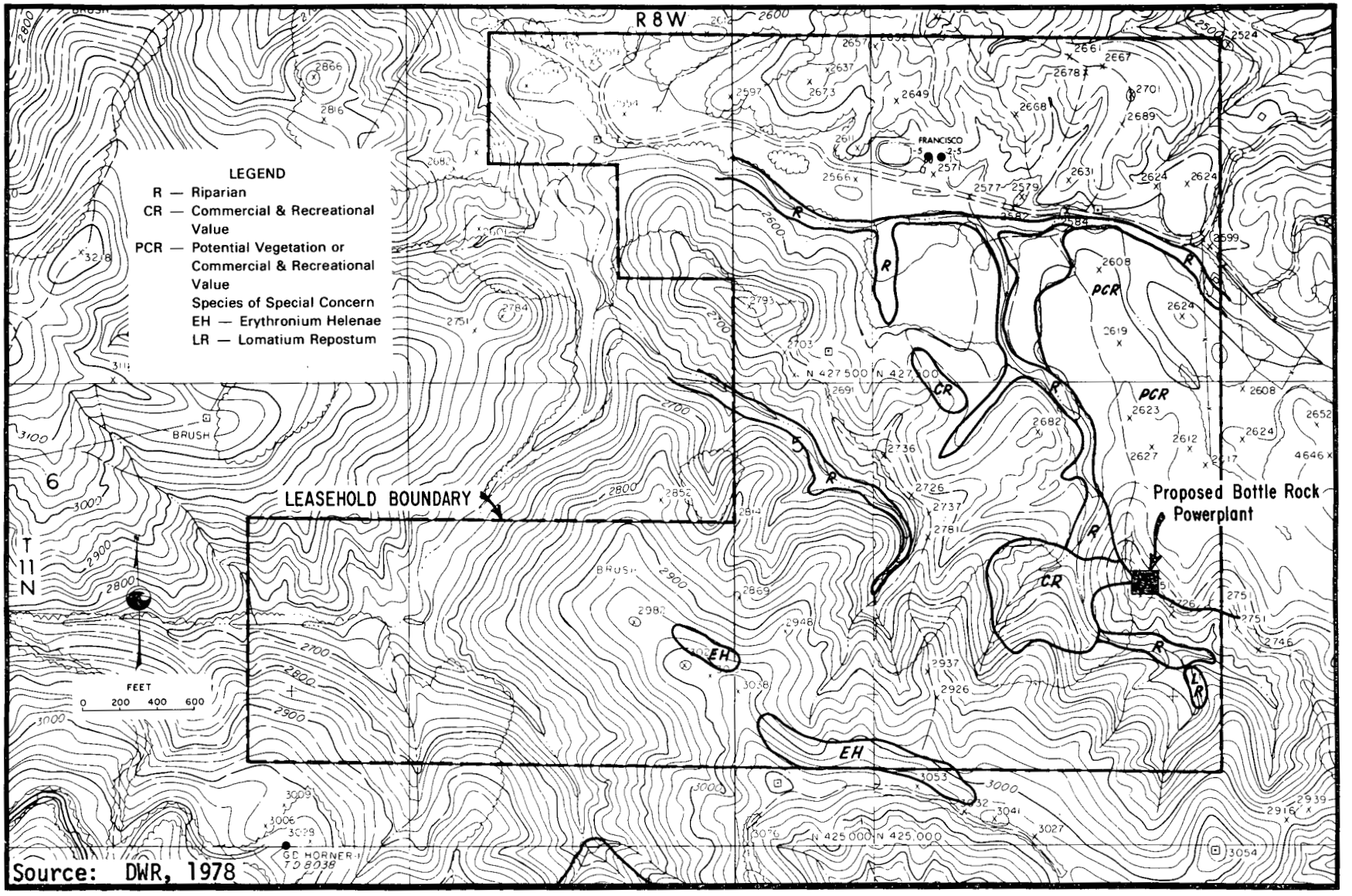


Figure O: **BOUNDARIES OF COMMERCIAL AND RECREATIONAL PLANT SPECIES, PLANT SPECIES OF SPECIAL CONCERN, AND AREAS OF CRITICAL CONCERN**

within the transmission corridor (Figure 0). A second species of special concern, the lomatium (Lomatium respostum), a member of the carrot family, is restricted to a few individuals in the small ravines immediately south of the power plant site. Very little is known or understood about the habitat and ecology of this species. Apparently it occurs occasionally in very small, widely dispersed colonies.

The principal plant species of commercial importance in the project area are Douglas fir, sugar pine (Pinus lambertiana) and yellow pine (Figure 0). Mature stands of these species on the leasehold are presently of marginal commercial value due to logging activities and wildfire, but with proper management, these stands could become harvestable in several decades.

Existing structures (e.g., roads, buildings, well pads) on the leasehold include a fire road which provides access to the leasehold, and access roads to the proposed power plant site and to two drill pad sites. The present access road to the proposed power plant site crosses a narrow portion of the wet meadow community then passes through a stand of large manzanita and continues through the yellow pine community to the proposed site. Two drilling pad sites have been approved for construction on the leasehold: the Francisco site and the Coleman site (Figure D). Presently two wells have been drilled from the Francisco well pad, which is located in chaparral and grassland communities on the northern edge of the wet meadow. One well has been drilled on the Coleman well pad. The Coleman well pad is surrounded by a mixture of black oak, madrone, Douglas fir, and yellow pine. There are two access roads to the Coleman well pad, one on the southern edge of the pad, and one on the northern edge. The latter road was not proposed or discussed in any documents concerning the Francisco leasehold development or the Bottle Rock project development and intrudes on the wet meadow and threatens to silt in a spring. This existing situation, while reversible, is resulting in an adverse impact and may become significant unless corrective action is taken. (See Biological Resources Impact and Mitigation section of this EIR).

Wildlife - The wildlife which inhabit the area in the vicinity of the proposed project reflect the type, density, and diversity of vegetation, availability of water, and nature of human activity. The principal wildlife habitats found in the project area are chaparral, yellow pine forest, mixed evergreen forest, oak woodland, grassland, and riparian. These correspond to the primary vegetative communities. A detailed description of these habitats and their associated wildlife is contained in the NOI (DWR, 1978). In general, the area supports reasonably diverse and abundant wildlife.

The chaparral is one of the most extensive habitats in the project area. It supports a variety of small mammals, migratory and resident birds, and a year-round population of black-tailed deer (Odocoileus hemionus columbianus). Mixed chaparral forms an excellent habitat for small mammals. Population densities of chaparral habitat are usually high and there is a greater variety of species than in other habitats. However, overall wildlife value for chaparral habitat is not considered to be high because of the absence of water and the limited diversity in vegetation type and species.

Of greater wildlife value are the yellow pine forest, mixed evergreen forest, and riparian habitats. These habitats are composed of a variety of plant types and species and as a result support a similar variety of birds, large and small mammals, reptiles, and amphibians. The presence of water further increases the value of the riparian habitat.

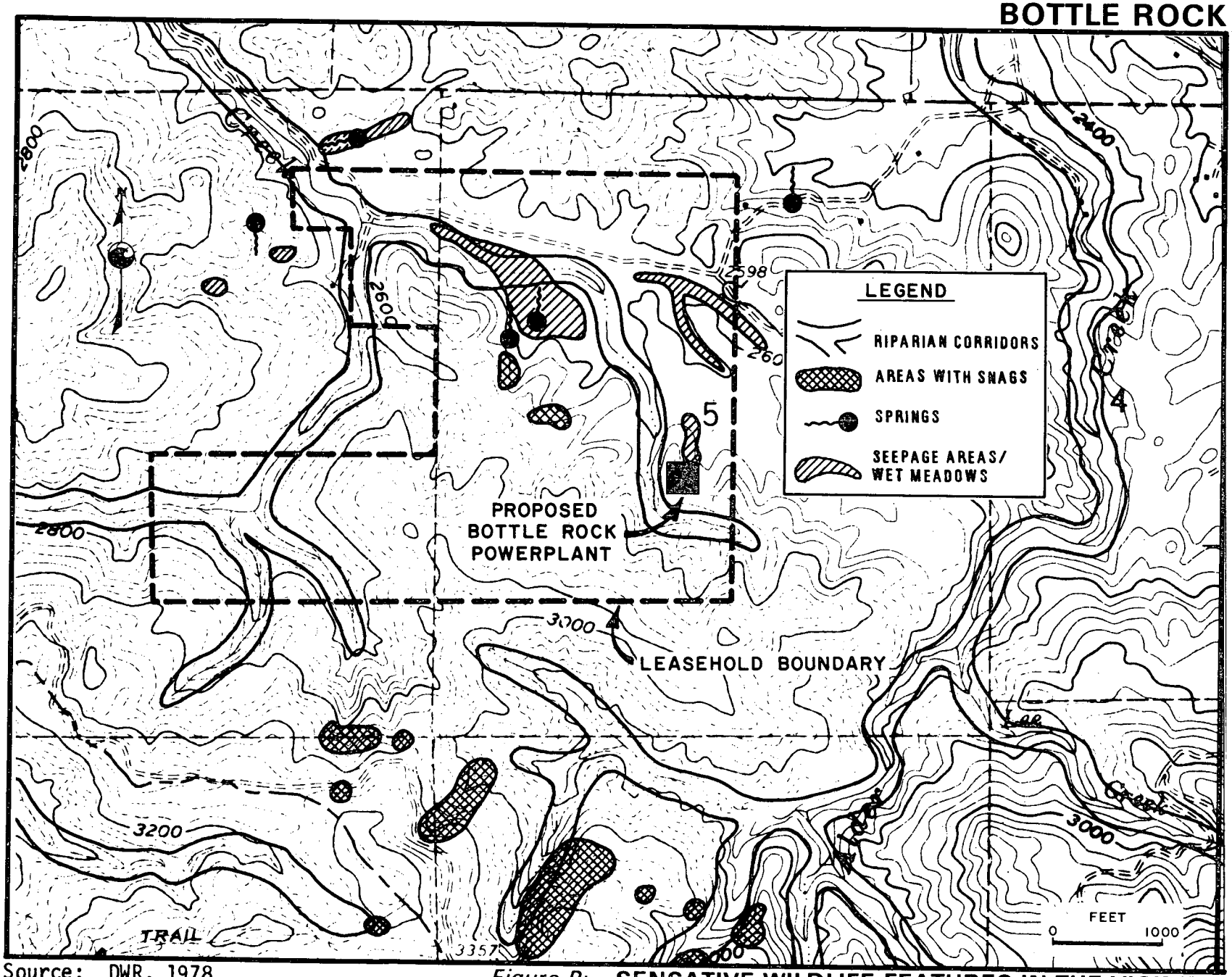
In addition to terrestrial animals, the riparian habitat also supports aquatic life. Most drainages within the project are part of the High Valley Creek watershed, with a small area contributing to the Alder Creek watershed. Alder Creek flows into Kelsey Creek approximately three miles (4.8 km) upstream from the mouth of High Valley Creek. Although Alder Creek and the upper section of the High Valley Creek are not perennial within the project boundaries, both support rainbow trout (Salmo gairdneri), the introduced brown trout (S. trutta), and the Sacramento sucker (Catostomus occidentalis occidentalis). These two streams together account for a trout population greater than that in the rest of the Kelsey Creek drainage (Leitner, 1979). In addition, numerous amphibians also depend on these streams.

The wildlife of oak woodlands is very similar to that of mixed evergreen forests. A number of salamander species are present in large stands of oak woodland. This habitat provides excellent nesting areas for many bird species. The mast crop (acorns and berries) is used by many birds and mammals.

The grassland habitat extends along the tributaries of High Valley Creek. Springs and seeps occur in a number of areas within the grasslands (Figure P). Although relatively few wildlife species are totally dependent upon grassland habitats, they are important as feeding areas for many animals that nest or find cover in adjoining woodland or chaparral.

The American peregrine falcon (Falco peregrinus anatum) is the only endangered wildlife species which occurs near the project area. This bird is listed by both the state and federal governments as endangered. The project area is about 12 miles (19.2 km) northwest of the nearest peregrine falcon eyrie which is in current use. This eyrie is in the vicinity of Mt. St. Helena, an area which has been designated as a "Critical Habitat" for the peregrine falcon (U.S. Fish and Wildlife Service, 1977). Extensive observations have been made of cliffs on the south and west sides of Cobb Mountain, approximately two miles (3.2 km) south of the project area, and there is no evidence of a peregrine falcon eyrie in current use (Stager, 1976; Stager, 1977; Stager and Proby, 1975.) The possibility exists that peregrines hunt over the project area occasionally; however, these appear to be either individuals foraging out from the Mt. St. Helena region or migrating. Two fully protected species, the golden eagle (Aquila chrysaetos) and the ringtail (Bassariscus astutus), may be present in the project area. No significant breeding or feeding areas are known for either species within the leasehold boundaries. The absence of regular sightings suggests that there are few golden eagles in the area (Leitner, 1978). There have been no known sitings of ringtail on the leasehold; however, the ringtail is a secretive animal and is typically found in chaparral habitats (Ingles, 1965).

Wildlife species of recreational value which are known or expected to occur in the area include the mountain quail (Oreortyx pictus), California quail



Source: DWR, 1978

Figure P: **SENSATIVE WILDLIFE FEATURES IN THE VICINITY OF THE BOTTLE ROCK POWER PLANT**

(Lophortyx californicus), band-tailed pigeon (Columbia fasciata), mourning dove (Zenaiduca macroura), brush rabbit (Sylvilagus bachmani), black-tailed jack rabbit (Lepus californicus), western gray squirrel (Sciurus griseus), and black-tailed deer. Of these, the blacktailed deer are of the greatest recreational importance. Limited areas on the leasehold and the area around the leasehold are used for sport hunting.

Recreational fisheries are supported by High Valley Creek and Alder Creek. Runoff to these creeks from their tributaries within the leasehold is important to the maintenance of rainbow and brown trout populations in the perennial sections of these drainages.

No fish or wildlife species of commercial importance are found in the project area.

The primary habitat features of critical concern to wildlife in the project area are riparian corridors, springs, seeps, wet meadows and snags (standing dead trees) (Figure P). Riparian corridors are of critical concern because of their value in supporting fish and wildlife resources and because of the rapid loss of this type of habitat throughout California as a result of human activities. The California Department of Fish and Game and the U.S. Fish and Wildlife Service have expressed specific concern for the protection of riparian habitat. This habitat should be carefully protected during steam field development. Springs and seeps are important water sources for wildlife, especially during the dry summer period. Wet meadows supply forage for wildlife and are used quite heavily by deer during the fawning season. Snags provide nesting areas for various birds and mammals. Most of the snags are located in the riparian or mixed evergreen forest habitats.

HEALTH AND SAFETY

PUBLIC HEALTH

Two aspects of the existing environmental setting of the proposed facility relate to a potential impact to public health: existing levels of pollutants in the environment, and the human population which could experience adverse health effects.

Existing Pollutant Levels - The existing concentrations of hydrogen sulfide, total suspended particulates, sulfur dioxide, and sulfates in the vicinity of the Bottle Rock power plant site are discussed in the air quality Environmental Setting section.

Ambient air concentrations of radon-222, mercury, arsenic, ammonia and boron have not been measured in the immediate vicinity of the Bottle Rock power plant or in areas which could be impacted by the plant. The following paragraphs summarize available monitoring results from The Geysers KGRA.

Radon-222 in the atmosphere at The Geysers KGRA was measured by Lawrence Livermore Laboratory for PG&E during 1975-77 when 11 geothermal power plant units were operational. The highest recorded ^{222}Rn concentrations in air were 0.5 pico Curies* per liter (pCi/1) at Units 1-2, and 1.4 pCi/1 at the Stanford Research Institute (SRI) station 7 (Sawmill Flat) (Figure 1). These values are below the California Department of Health Services standard for ^{222}Rn of 3 pCi/1 above background in uncontrolled areas.

Ambient mercury concentrations have not been monitored in populated areas near The Geysers KGRA. Two studies on mercury concentrations in ambient air within The Geysers KGRA report concentrations ranging from less than .001 ug/m^3 to 0.018 μg/m^3 (Robertson, 1977) and from .005 μg/m^3 to .400 μg/m^3 (Jepsen, 1973).

PG&E reports that ambient arsenic concentrations in air at Unit 11 in 1977 ranged from less than .010 μg/m^3 to .044 μg/m^3 (PG&E, 1979). Ambient concentrations of boron in the atmosphere have not been measured at this time.

There has been relatively little monitoring of ambient air concentrations of ammonia at The Geysers KGRA. Periodic monitoring during 1976 and 1977 at a number of locations in The Geysers KGRA reported one hour average ammonia concentrations ranging from 0 to 0.263 ppm (DWR, 1978).

Existing Human Population in the Vicinity of the Proposed Site - PG&E reports that in January, 1977, 3,737 residents lived within ten miles of Cobb Mountain (PG&E, 1978b). This includes residents of communities near the Bottle Rock power plant proposed site (Figure C). The approximate age distribution for these people is given in Table 8. From data provided in this table it can be inferred that approximately 22 percent of the population in that area could be classified as sensitive to pollutants due to age; (e.g., the very young and the elderly).

* pico Curie = 10^{-12} Curie. A Curie is a unit of radioactivity.

TABLE 8

POPULATION - BOTTLE ROCK VICINITY

Age Group*	Area: Within 7 Miles of Units 5 & 6	Area: Within 10 Miles of Cobb Mountain	Area: Within 30 Miles of Units 5 & 6
0-5	182 (10.5%)	322 (8.6%)	14,487 (8.8%)
6-17	439 (25.3%)	888 (23.8%)	36,342 (22.1%)
18-34	335 (19.3%)	685 (18.3%)	34,715 (21.1%)
35-64	586 (33.8%)	1,321 (35.3%)	53,999 (32.8%)
65+	194 (11.2%)	521 (13.9%)	25,188 (15.3%)
Total Population	1,735	3,737	164,731
Total Area	154 mi^2	314 mi^2	2,827 mi^2
Population density (persons/mi^2)	11.3	11.9	58.3

* January 1977 ages

Source: PGandE, 1978, Response to Staff Interrogatories - taken from The Geysers Demographic Data - C. Bangert, January 4, 1977.

There is one school and one children's camp within five miles of the proposed site. Children can be more sensitive than the general population to the adverse effects of air pollutants. There have been no reported studies describing existing status of public health in the vicinity of The Geysers. Some residents of Lake County, including one individual living within one mile (1.6 km) of the proposed Bottle Rock power plant, have reported health effects attributed to the emissions from geothermal operations (Grew, 1978; Madill, 1978; and Schaaf, 1978).

SAFETY

Several existing standards and regulations will affect worker safety when the power plant is under construction and during operation. These include building standards and standards for hydrogen sulfide (H_2S for power plant operating personnel. The maximum allowable concentration is set at 50 ppm for a period not exceeding 10 minutes per 8-hour day and 10 ppm for 8 hours.

The Department of Health Services sets worker exposure standards for ^{222}Rn at 100 pico curies/liter (pCi/1). Suggested safe levels for other geothermal air pollutants related to public and worker health are described in Tables B-2 and B-3, Appendix B.

The California Occupational Safety and Health Administration (Cal/OSHA) issues noise exposure regulations contained in Title 8 of the California Administrative Code (CAC). These regulations set a 90 dBA employee exposure limit for an eight hour period and a halving of the exposure for each 5 dBA increase in the noise level above 90 dBA. Workers must wear hearing protectors if this noise limit is exceeded.

The Uniform Building Code (UBC) establishes minimum structural design criteria with the intent of minimizing the probability of structural collapses. The UBC is adopted as a legal standard both by California Administrative Code (Title 24) and local ordinance.

NOISE

The proposed power plant site is on a low wooded hill overlooking a small valley. It is located in a rural open space environment where traditional land uses have included livestock grazing, timber harvest, and recreation. Since 1976, two geothermal wells have been drilled within one-half mile of the plant site. The development and use of geothermal resources has become an increasingly important land use in this region.

Several ambient noise surveys have been conducted near the plant site and in the general Cobb Valley area since 1976 in connection with geothermal projects. Figure Q indicates residence locations near where ambient noise measurements have been made. The ambient noise level in the vicinity of the power plant ranges between 28 dBa (L_{50}*) and 59 dBa (L_{50}). (Results of the ambient noise surveys are provided in the Bottle Rock NOI Noise Tables 1, 2A, 2B, 3, 4, and 5.)

Three noise receptor sites are located to the northeast within one-half mile of the proposed power plant site. These residences are just outside the Francisco leasehold boundary.

(A) Coleman residence

A single family residence about 1,900 ft. (576 m) northeast in direct line of sight of the proposed power plant.

Usually occupied in the summer only.

(B) Wright residence

A permanently occupied single family residence about 2,000 ft. (606 m) northeast in direct line of sight.

(C) Schaaf residence

A permanently occupied single family residence about 2,600 ft. (788 m) north-northeast. View of the power plant is cut off by a small ridge.

Only two receptors have been identified to the northwest. They are also outside the leasehold boundary.

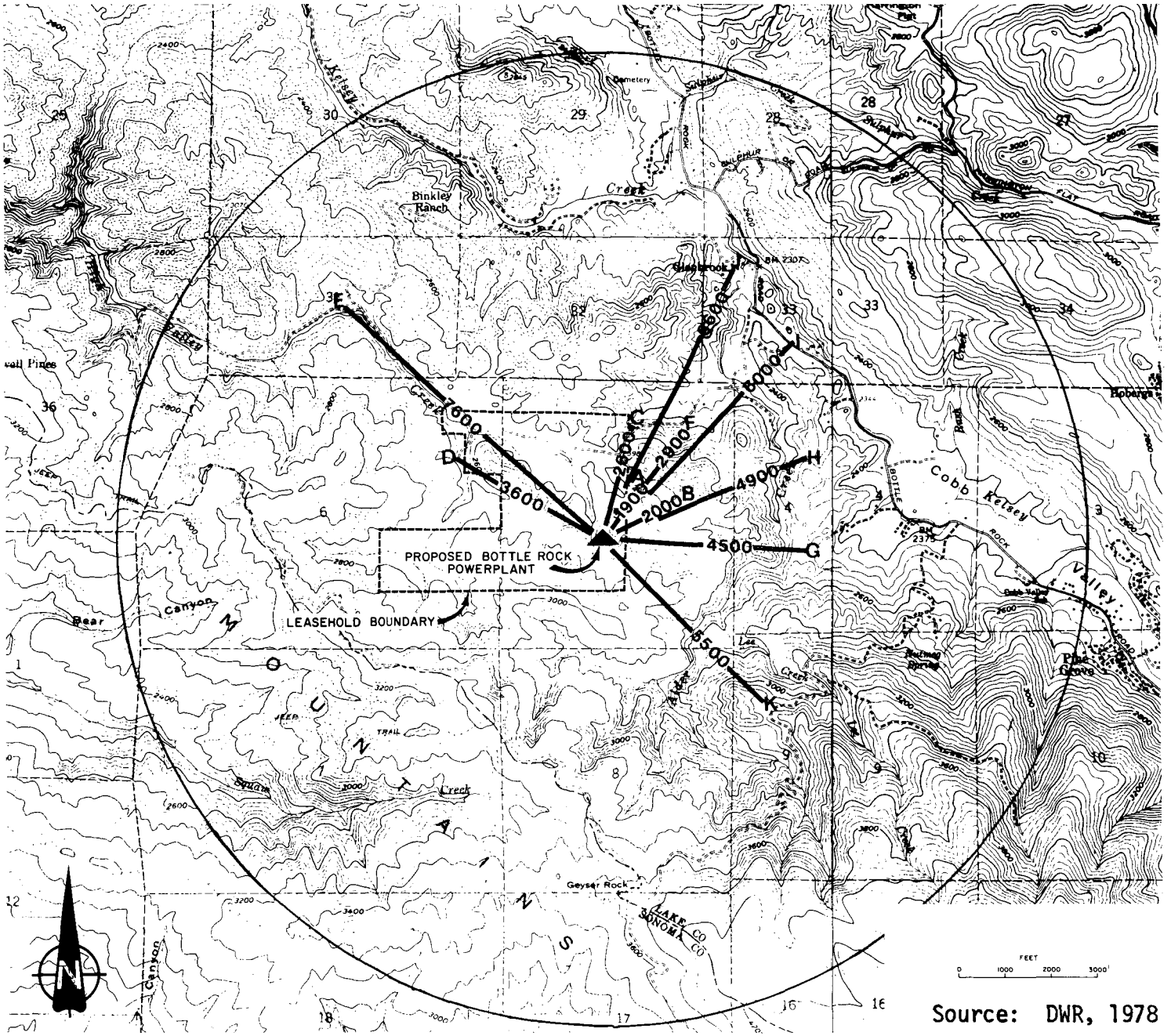
(D) Esperance cabin

Formerly used for recreational purposes, this single family residence is now permanently inhabited. Although only 3,600 ft. (1,091 m) to the northwest, it is shielded from the power plant site by a substantial topographic barrier.

(E) Jadiker residence

A permanently occupied single family residence about 7,600 ft. (2,303 m) northwest, probably in direct line of sight.

*See Noise Glossary (Table 20) in Noise Impact section.



Source: DWR, 1978

Figure Q: **LOCATIONS AND DISTANCES IN FEET OF NOISE RECEPTORS IN THE VICINITY OF THE PROPOSED BOTTLE ROCK GEOTHERMAL POWER PLANT**

A number of residences and recreational homes are located between one-half mile and a mile to the east and northeast in the direction of Bottle Rock Road.

(F) Hagerty residence

This permanently occupied mile home is one of the closest receptors in this group. It is about 2,900 ft. (879 m) northeast, but protected by a wooded ridge.

(G) Jordan residence

A permanently occupied single family residence approximately 4,500 ft. (1,364 m) southeast of the proposed power plant site.

(H) Hess cabins

Two cabins located about 4,900 ft. (1,485 m) northeast are used for recreational purposes.

Along Bottle Rock Road from Glenbrook to Pine Grove are several dozen residences. Some are used as permanent homes, while others are mainly occupied during summers, weekends and holidays.

(I) Residences on Bottle Rock Road

A number of homes are located about 6,000 ft. (1,818 m) from the site.

(J) Glenbrook

Several homes are 6,000 ft. (1,818 m) northeast of the power plant site.

Most of the area to the south and southeast is uninhabited. Only two receptors have been identified.

(K) Phelps cabins

These two cabins are used for hunting and summer recreation. They are about 5,500 ft. (1,667 m) southeast and considerably higher than the plant site.

ENERGY AND MATERIAL RESOURCES

Energy Resources

An Energy Commission report, Projected Geothermal Generating Capacity at The Geysers (Hill, et al. 1978) indicates that an estimated 2,700 MW of dry steam generating capacity is obtainable by 1990 in The Geysers KGRA. There are currently 13 operating geothermal power plants at The Geysers KGRA with a combined capacity of 663 MW. PGandE power plant units 13 and 14, currently under construction, are planned for operation in 1980, and Unit 17 is scheduled for operation in 1982. The Northern California Power Agency proposes to have NCPA #1 and NCPA #2 in operation, and PGandE proposes to have Units 16, 18, and 19 on line for an additional 506 MW in 1983. The proposed Bottle Rock power plant would add an additional 55 MW of electricity in 1983, bringing the total electric generating capacity at The Geysers KGRA to 1,579 MW.

In addition to the dry steam resource, there is a hot water resource. The hot water sources are generally situated north of the dry steam sources. The technology exists to operate a hot water fueled power plant, but it has yet to be proven commercially feasible for the hot water resource at The Geysers KGRA. If developed commercially, an additional 2,000-3,000 MW of generating capacity may be attainable. Figure R shows approximate inferred limits of steam (vapor dominated) and hot water dominated areas.

Material Resources

Materials consumed in the construction and operation of the proposed power plant and related facilites, transmission towers and conductors and related access roads, steam-gathering system and related access roads, and all other facilities associated with this project include concrete, steel, aluminum, expensive metal alloys and catalysts, wood, and paint. Energy consumed for construction and operation would also include fuels such as gasoline and diesel and electrical energy for lighting and other purposes.

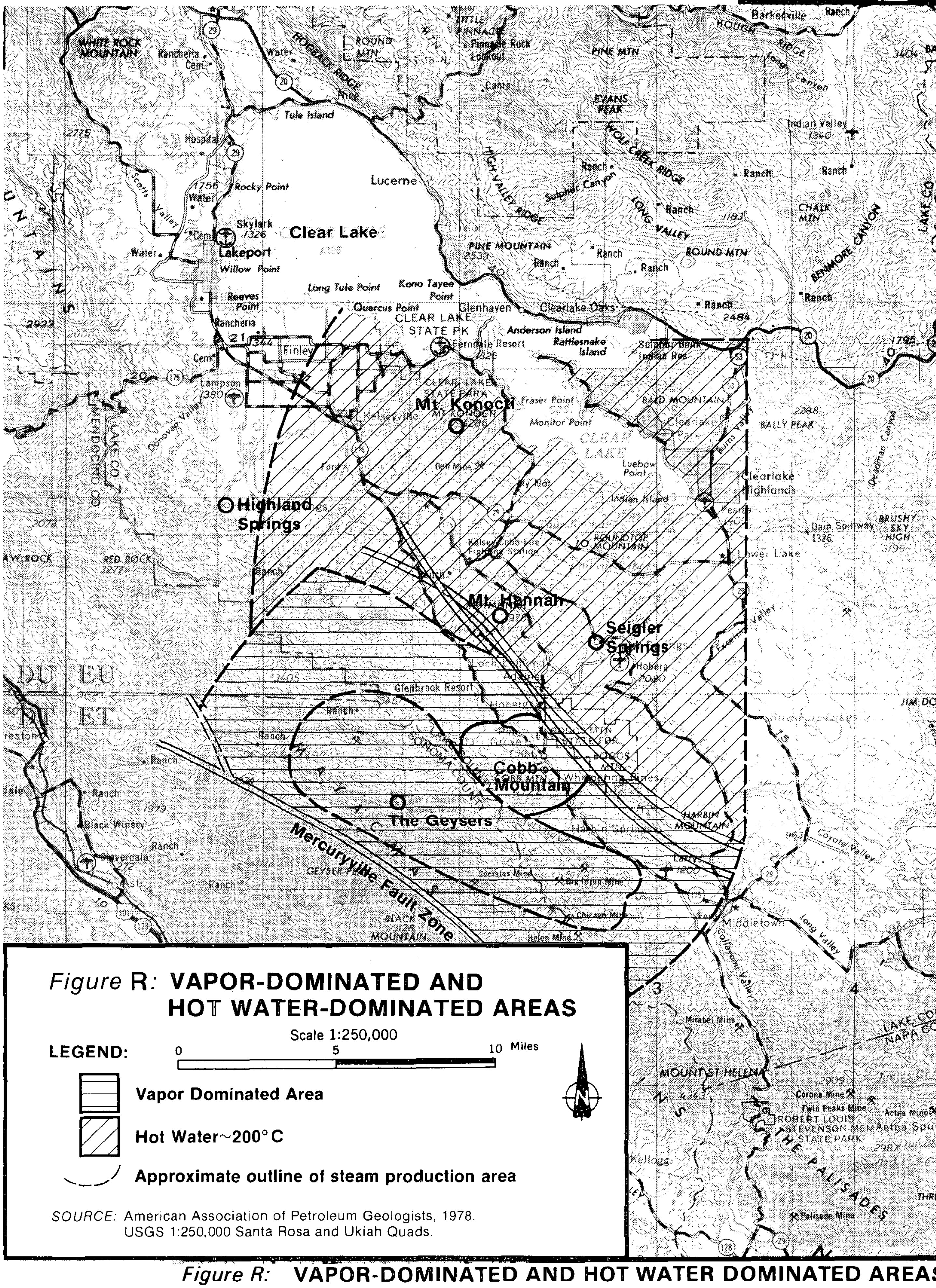


Figure R: VAPOR-DOMINATED AND HOT WATER DOMINATED AREAS

CULTURAL RESOURCES

The Cultural Resources Section of the Bottle Rock NOI, prepared by Dr. David Fredrickson, has a more thorough discussion of the cultural resources. The following is a summary of that information.

PALEONTOLOGY

Based upon paleontological investigations conducted within the study area and its vicinity (Wright et al, 1978), rock units most likely to contain recoverable and identifiable fossils are:

- Chert which contains radiolaris (micro-fossils).
- Sedimentary breccia and conglomerate which rarely contain fossil pelecypods (a class of mollusks including clams, oysters, etc.) in the matrix and radiolaria in chert clasts.
- Massive and bedded graywacke.
- Undifferentiated melange units, likely to contain any of the above.

All other units are highly metamorphosed or are igneous in origin and would not contain fossils.

Four levels of significance with respect to fossil occurrences in The Geysers area have been established (Wright et al, 1978), ranging from Significance A (highest significance) to Significance D (least significance). Those radiolarian chert localities currently under study by R. J. McLaughlin of the United States Geological Survey and E.A. Pessagno of the University of Texas, Dallas, are the only areas of Significance A discovered in The Geysers, KGRA. While no localities of Significance A were discovered in the leasehold, radiolaria regarded as being of similar age and types as those identified by Pessagno (1973, 1977) have been found. However, the six localities within which these fossils have been found are not significant and are categorized as Significance B.

Areas of Significance C consist of chert as mapped by McLaughlin (1978) and Wright et al (1978). Field study indicated that there were, in general, no significantly fossiliferous chert outcroppings. Excavation in these areas, however, might expose rocks which contain fossils.

Areas of Significance D are underlain by melange units which may contain fossiliferous chert or sedimentary breccia. Fossiliferous rocks do not crop out at the present time but could be exposed by deep excavation.

ETHNOGRAPHY AND ETHNOHISTORY

All lands contained within the Francisco Leasehold were a part of the territory of the Habenapo tribelet of the Eastern Pomo people.

After a review of pertinent ethnographic literature, and after conducting an onsite ethnographic resource survey with a Habenapo consultant, Dr. Fredrickson determined that no sites of sociocultural significance to Native Americans are

present within the leasehold. No additional site specific data was obtained concerning the archaeological sites identified by Fredrickson (1975). According to a Habenapo consultant, the area was "good for hunting" and it is likely that these sites were hunting camps with associated butchering activities.

The abundance of black oaks, especially along High Valley Creek, is unusual because the territory of the Eastern Pomo was not known for its abundance of black oaks. The Habenapo favored the black oak acorn for making mush and soup. Several other important food plants also exist in the area and include abundant elderberry, choke cherry, and manzanita berries. Given the abundance of food resources and the availability of water, the area could have supported two or three families under aboriginal conditions.

ETHNOGRAPHIC BACKGROUND

Ethnographic investigations conducted within the study area and its vicinity (Peri et al, 1978) included preparation of an ethnographic overview of the Eastern Pomo, who controlled the study area prior to European entry into the region.

The term "Pomo" was possibly first applied by the California ethnographer, journalist, and pioneer, Stephen Powers, to refer to those linguistically related groups which today are erroneously known as "the Pomo" (Barrett, 1908:116; McLendon, 1973:3; McLendon and Oswalt, 1978:274; see also Powers, 1877: 146-148). Historically, the impression was created of a single Pomo society, when in fact no such cultural or political entity or entities existed. The village community or tribelet level of cultural distinction reflects the socio-linguistic and the sociopolitical distinctions made by Pomoan speakers themselves, and is subsequently, reflected by the distinct cultural expressions and language of the individual tribelets and their relationships to each other. The meaningful unit of study and description is, therefore, the tribelet.

HISTORY

Settlement and Land Use - The area known as the Francisco Leasehold was settled rather late in the history of Lake County, considering that the earliest land patents within the leasehold area were granted in 1909. By that time, the county's major towns were well established, good roads made the county accessible, and commercial activities were well developed.

The Coleman family were the principal owners of the land in the Francisco Leasehold. The Coleman's original home was constructed near the family's present-day picnic area on High Valley Creek (Hodges, 1978). Later, their second home was built on stilts directly over the east fork of High Valley Creek. While the 1959 USGS 7.5 minute quadrangle map of The Geysers shows the house just outside the leasehold, interview data suggests that it was within the leasehold (Francisco, 1978; Kirbyson, 1978).

Local Roads and Commerce - The Francisco Leasehold is connected to Cobb Valley by an access road running through the northern portion of the leasehold along High Valley Creek. Just south of Glenbrook, this road joined the old Boggs Toll Road, the present day Bottle Rock Road, which ran north to Kelseyville and south to Middletown (Mauldin, 1978). From Middletown, the free road built by Andrew

Rocca ran south to the county line where it joined the Lawly Toll Road, which went on to Calistoga and Napa; and taken together they form part of the present-day Highway 29 (Mauldin, 1978). From Calistoga, the route of present-day Highway 12 provided the connection with Santa Rosa. Over these roads commercial products such as apples, cattle, and lumber were shipped to markets by the Coleman family.

Commerce was heavily influenced by numerous resorts. Glenbrook Resort and Gordon Springs Resort, both near the town of Cobb on the Calistoga Lakeport stageline, were the closest of the many early Lake County resorts. Not only local residents, but also many visitors from the San Francisco Bay Area, made use of the mineral springs for health and recreation.

By 1908, however, business at Gordon Springs and many other older Lake County resorts was slowing down. Those resorts which changed with the times survived into the new era. One of the most notable of these was Hoberg's Resort, also located on Cobb Mountain. It was established in 1885. Despite having no mineral springs, the resort grew steadily in popularity. By the 1930s, Hoberg's offered accommodations for more than 1,000 guests. The Hoberg family retained control of and operated Hoberg's for 95 years, finally closing its doors in the fall of 1971 (Anonymous, 1977; Lewis et al., 1949; Geoble, 1972).

Local residents found employment with the resorts in jobs ranging from hotel maintenance to entertainment. Valentine V. Coleman was employed first as a maintenance man and later as a night watchman at Hoberg's for a number of years.

ARCHAEOLOGY

Five prehistoric archaeological sites and one historic archaeological site complex were recorded by Dr. Fredrickson within the Francisco Unit Leasehold. The prehistoric sites were designated CA-LAK-605, 607, 608, 609, and 610; the historic site was designated CA-LAK-974H. Qualitative observations of materials, such as obsidian patina, led to the inference that all but one of the sites were representative of the late prehistoric period. A single site, CA-LAK-610, yielded heavily patinated obsidian flakes and may be a site with respectable antiquity (DWR, 1978).

The complete historic site (CA-LAK-974) consisted of (1) a picnic area which contained two tables and a fire pit; (2) a small, badly deteriorated wooden building; (3) the remains of a smaller wooden structure, which may have been the original Coleman home; (4) an apple orchard of six trees; and (5) two springs that had been developed and fenced. The remains of a sawmill that once may have been situated within the leasehold were not located. Dr. Fredrickson believes that the mill was probably situated outside of the leasehold area on the east fork of High Valley Creek (DWR, 1978).

CA-LAK-605 (Geysers 99; Oak Knoll Site) - Located in the northwest corner of the study area, the site appeared to have some depth with some midden development. Abundant surface obsidian waste indicated that primary tool manufacturing occurred at the site. Also, the major road passing through High Valley cut across the surface of the site.

CA-LAK-607 (Geysers 101; Tripple Confluence Site) - The small site was marked by a scatter of obsidian and basalt flakes in an area no more than 165 ft. (5 m) in diameter. No midden development was visible. It is unlikely that the site had significant depth.

CA-LAK-608 (Geysers 102; Picnic Site) - Located above the flood plain on the north side of High Valley Creek, the site consisted of a dense surface scatter of obsidian flakes over an area approximately 111 sq. ft. (10 m^2). The road which passed through High Valley was situated about 99 ft. (30 m) to the north of the site.

CA-LAK-609 (Geysers 103; High Valley Creek Site) - The High Valley Creek site was located on a terrace on the eastern bank of High Valley Creek and covered an area approximately 330 ft. (100 m) in diameter. It was characterized by an obsidian flake scatter, and juding by soil characteristics, may have considerable depth. The site area appeared to have been logged, and a trail passed over its eastern edge.

CA-LAK-610 (Geysers 104; Shotgun Junction Site) - This site was located on the same terrace as CA-LAK-609. The site was characterized by a scatter of basalt flakes and patinated obsidian flakes, all suggestive of considerable antiquity. These materials were found distributed over an area measuring about 99 by 165 ft. (30 by 50 m). Although the soil is gravelly, the site may have some depth. The site area and its vicinity had been logged and two trails crossed the site.

The five prehistoric sites were initially recorded in 1975. In August 1978, Dr. Fredrickson observed that the trail that passed over the surface of two of the sites (CA-LAK-609 and CA-LAK-610) in 1975 had more recently been developed into a dirt road. Use of the road had caused some damage to the prehistoric sites.

SOCIOECONOMICS

Until recently, the main focus of geothermal development in The Geysers KGRA has occurred in Sonoma County primarily at the PG&E Geysers power plants. Relatively little development activity has occurred in Lake County, even though a majority of the KGRA lies within its boundaries. However, Lake County is now beginning to experience an increase in geothermal exploratory and development activity. The following discussion presents the socioeconomic setting of both Lake and Sonoma Counties.

Lake County

Lake County is a rural county with a 1979 population estimated at 33,000 (Department of Finance, 1979), and has experienced an average annual increase of 5.3 percent since 1970. This growth rate, which is the third highest in California and is exceeded only by El Dorado and Nevada Counties, is due primarily to net in-migration (Gennis, 1978). The population of Lake County is also subject to dramatic seasonal fluctuations during the summer months when there may be as many as 100,000 additional people in residence (Ecoview, 1978). This seasonal influx is due to recreational visitors, use of second and summer homes, and opportunity for employment in agricultural harvesting and processing. Lake County has the highest median age of any California county, 46.4 years, and Social Security recipients accounted for about 37 percent of the total population in 1977, reflecting its attractiveness as a retirement area (Gennis, 1978).

Although Lake County has a population density of about 22 people per square mile, most of the population is located in the area immediately adjacent to Clear Lake. The project site is located approximately 10 miles (16 km) southwest of Clear Lake in an area that is sparsely populated with a relatively limited social and economic base. The community nearest the project site is Pine Grove, which lies about two miles east. The communities of Hobergs and Loch Lomond lie two to three miles to the northeast, while Cobb, Forest Lake and Whispering Pines lie between two and three miles (3.2-4.8 km) southeast of the power plant site. About 12 miles (19.2 km) southeast of the project site is the community of Middletown. The Middletown area is of particular interest to geothermal development because there appears to be an increasing concentration of workers residing in the area directly and indirectly related to geothermal development. However, precise data on the number of geothermal workers is not available (Gennis, 1978). A recent population estimate of the Middletown area, including Anderson Springs, Middletown Rancheria, Hidden Valley Lake, Harbin Springs, and St. Helen Creek, was put at 2,800 (Gennis, 1978). The economy of Lake County is based primarily on the agriculture, retirement, recreation, and government sectors. In terms of business activity, the retirement and associated general recreation sector has gradually replaced agriculture as the most important support of the Lake County economy (Vollentine, et al 1977).

Activity in the retirement and general recreation sector reflects heavily in gross taxable sales as 24 percent of annual taxable sales and is accounted for by the summer seasonal increases in the retail and service business activity (Vollentine, et al 1977). Furthermore, Clear Lake, which is the focal point of

the recreation industry in Lake County, probably accounts for a bulk of the economic base activity generated by the resident population, as a majority live within three miles (4.8 km) of its shoreline (Vollentine, et al 1977).

In terms of employment, the retirement and recreation sector is probably the most important factor, as shown by employment levels in the retail trade and service categories (Table 9).

There is a growing, but still relatively small, labor force directly associated with geothermal development operations in Lake County. As mentioned earlier, this labor force appears to be concentrating in the Middletown-Anderson Springs area.

As of October 1978, there were four drilling rig operators in The Geysers KGRA. Two were residing in Lake County with the other two residing in Sonoma and Napa Counties (Gennis 1978). Typically, a drilling rig will employ a field staff of 21-24 persons (Vollentine, 1977), giving an estimated total of 84-96 employees in The Geysers KGRA. There are also service contractors in the geothermal industry located in Lake County which appear to be the principal element effecting the Middletown region's labor market growth. Three of the five construction-excavation contractors who undertake a large share of road and geothermal well pad work are headquartered in Lake County. The geothermal service workers appear to be settling in the Middletown region on a semi-permanent basis for as long as work is available. This group includes operators, drillers, prime service people, and other contractors who are engaged mainly in service to the geothermal industry (Gennis, 1978).

Sonoma County

Sonoma County has an estimated population of 274,300 (Department of Finance, 1979). The area of Sonoma County closest to the project site is sparsely inhabited. Most of the inhabitants in this area reside in Cloverdale, which has a population of approximately 3,630 and is situated about 20 miles (32 km) west of the proposed power plant site.

The economy of Sonoma County, which is shown by the employment data in Table 10, is more diversified than Lake County.

Although the greatest amount of geothermal development has occurred in northeastern Sonoma County at PG&E's Geysers power plants, the geothermal industry is not a major component of Sonoma County's economic base.

TABLE 9

Estimated Wage and Salary Employment

Employment	1975	1976	1977	1978	1979
Agricultural Forestry & Fisheries, Totals...	895	960	775	800	850
Non-Agricultural Workers, Total.....	4205	4815	5525	5650	5800
Construction & Mining.	230	260	325	300	325
Manufacturing.....	220	290	325	350	350
Transportation and Public Utilities.....	215	240	275	300	300
Wholesale Trade.....	1020	1225	200	200	200
Retail Trade*.....			1100	1150	1175
Finance, Insurance and Real Estate.....	205	240	275	275	300
Services.....	930	1135	1450	1475	1525
Government.....	1390	1440	1575	1600	1625

Source: Gennis, 1978

TABLE 10
Estimated Wage and Salary Employment
In Sonoma County

Employment	1976	1977	1978	1979
Agriculture.....	4,000	4,200	4,400	4,400
Mining.....	400	300	300	300
Construction.....	3,600	4,300	4,300	4,200
Manufacturing.....	10,100	10,700	11,300	11,600
Transportation and Public Utilities.....	3,500	3,800	3,900	4,000
Wholesale Trade.....	3,000	3,000	3,100	3,200
Retail Trade.....	13,800	14,600	15,300	16,200
Finance, Insurance, Real Estate.....	3,800	4,100	4,200	4,300
Services.....	18,300	19,400	20,300	21,300

Source: Gennis, 1978

LAND USE

The current Lake County General Plan designates the area around the Francisco Leasehold east of Highway 175 to the Sonoma County border as "Unclassified." Section 21-10 of the Lake County Zoning Code permits geothermal development in an "Unclassified" district, subject to approval of a use permit. McCulloch Oil has received three separate use permits to drill up to six exploratory wells at two drill sites inside the Francisco Leasehold. In addition, use permits have been granted by Lake County for exploratory drilling on the following leaseholds which neighbor the Francisco Leasehold:

1) NCPA/1 - located one-quarter mile north of Francisco leasehold;

2) McCulloch Seigler Mountain - located three miles northeast,

3) McCulloch Newfield - located one-quarter mile northeast,

4) Union Oil Cobb Mountain Estates - located one mile southeast.

In May 1979, Lake County was notified by the State Attorney General's Office and the Governor's Office of Planning and Research (OPR) that its General Plan is deficient and must be updated. Portions of the Plan specifically identified were the Land Use, Housing, and the Open Space and Conservation Elements. There is also concern about the large portion of the county remaining in the "Unclassified" zoning designation. A citizens' advisory committee was appointed by the county to assist in preparing policies for updating the General Plan, but no date is available for adoption of a revised General Plan. In the meantime, Interim Policies were adopted by Lake County on July 3, 1979. However, OPR has yet to act on the Interim Policies.

In April 1972, Lake County adopted the Conditions, Procedures, and Performance Standards For Geothermal Regulation. This document contains the existing policy criteria for governing geothermal development in Lake County. It states:

> No geothermal well shall be drilled within one-half mile of any populated area (10 or more dwelling units established within one-quarter mile area) or within one-half mile of any recorded subdivision, without written consent of a minimum of 75 percent of the owners having been obtained.

It further states that any well must be drilled a minimum of 500 (152 m) feet from the nearest residence. Lake County has indicated that these regulations will undergo some revision, but a date has not been set for completion of a final product.

Until recently, the predominant land uses in the vicinity of the Francisco Leasehold have been recreation and open space with some limited residential activity.

Recreational opportunities in this area have in the past included sightseeing, hiking and hunting, as well as a number of small resort facilities. With the exception of sightseeing, recreational activities have been limited in the leasehold, since private ownership has restricted public access. Most of the sightseeing occurs along Bottle Rock Road, which runs north-south within one mile (1.6 km) east of the Francisco Leasehold. Approximately two miles (3.2 km) east of the leasehold is an area designated by the Lake County General Plan as Residential-Recreation. Much of the recreation-resort activity in the area occurs within this designated area. However, Camp Beaverbrook, which is an 80-acre summer camp for children, is located about one and one-half miles (2.4 km) northeast of the project site.

Residential activity is also limited in the area of the leasehold. There are no residences within the Francisco Leasehold (Ecoview, 1979) and less than 20 permanent residences within one mile (1.6 km) of the leasehold (DWR, 1978). Most of the population and associated residential and commercial activity in the area is located in the communities lying east of the project site along Highway 29. There are also a number of subdivisions located east of the leasehold, comprising a total of 761 parcels (DWR, 1978). The closest recorded subdivision is Pine Summit Estates, which is approximately two miles (3.2 km) northeast of the project site.

The predominant land use to the south and west of the Francisco Leasehold is geothermal development by PG&E of its Geysers power plant. The PG&E complex is comprised of 13 on-line generating units (Units 1 through 12 and 15) and two under construction (Units 13 and 14). All the units are located in northeastern Sonoma County with the exception of Unit 13, which is located approximately five miles (8 km) southeast of the Francisco Leasehold. This unit represents the first major encroachment of geothermal development into southwestern Lake County and is expected to become fully operational by early 1980. More recent expansion of geothermal development into southwestern Lake County has been limited to leasing and exploratory activities. As a result, however, geothermal development has become a predominant land use consideration in this area.

AESTHETICS

The proposed project area is typical of the upper elevations of the Mayacmas Mountains. The terrain is steeply rolling and plant cover consists mainly of low to medium height shrubs and trees, with isolated stands of taller trees occurring in protected draws and along water courses. The proposed plant site is located on the eastern slope of a steep-sided ridge which rises to an elevation of approximately 3,000 feet (912 m). The site itself sits below the ridgeline at an elevation of approximately 2,700 feet (82 m). The site and immediate surroundings have been disturbed to some extent by the construction of well pads and access roads.

The Scenic Highway Element of the Lake County General Plan has identified certain routes as meeting the criteria of a scenic route. Bottle Rock Road, which runs in a northwest-southeast direction approximately one mile (1.6 km) east of the proposed power plant site has been so identified.

One of the stated purposes of the Scenic Highway Element is:

> ...to create a favorable public image that will encourage economic development and tourism within the County, thereby protecting property values in areas through which the highway passes.

To achieve this, the Element requires that:

> ...development controls should be applied for purposes of preserving and enhancing nearby views or maintaining unobstructed distant views along the scenic routes.

The proposed power plant site may be visible from some of the scattered residences located just east of the leasehold and from views along Bottle Rock Road. However, an intervening ridgeline east of Bottle Rock Road may block the view of the site from the communities along Highway 175 and Highway 29 south of Cobb.

The Conditions, Procedures, and Performance Standards For Geothermal Regulation adopted by Lake County states:

> All permanent installations and premises, including power, steam and/or fluid transmission lines shall be harmonious in appearance with the area and not of obnoxious, undesirable or unsightly appearance. A landscaping screen shall be installed to the approval of the County Planning Commission.

PUBLIC SERVICES

The proposed project will require the provision by Lake County of certain public services and administrative functions. This section describes those primary services and functions that will be required by the Bottle Rock project.

Administrative Services

In connection with a geothermal project, certain regulatory and administrative functions must be performed by Lake County. However, the scope of these functions has been limited due to the California Energy Commission's (CEC) permit process. The CEC's permit supersedes all local permits that would otherwise have been required. Therefore, the county's involvement in certifying the Bottle Rock geothermal power plant, excluding the steam field, is limited to the following functions:

1. Issuance by the local Air Pollution Control District (APCD) of a Determination of Compliance.

2. Review of the CEC's regulatory documents such as the Notice of Intention (NOI), the Application for Certification (AFC), and the Environmental Impact Report (EIR), as well as participation in related proceedings.

Protective Services

The California Division of Forestry has primary responsibility for fire protection with possible assistance from various volunteer organizations. Police protection is provided by the Lake County Sheriff's Department.

Utilities

The Francisco Leasehold is located within a PG&E electrical source area. Natural gas is not available, but bottled gas can be obtained from local sources. Water for engineering and domestic consumption in the area is typically provided from on-site sources, such as wells or rain water runoff, or may be trucked in. There are no sewer hook-ups provided on the leasehold.

Education

The southwestern Lake County area is serviced by four school districts. The districts are listed below along the current enrollment and enrollment capacities for the 1979/1980 school year:

District	Enrollment	Enrollment Capacity
Middletown	497	645
Kelseyville	963	1,500
Konocti	2,030	1,700
Lakeport	1,270	1,240

Source: Lake County Superintendent of Schools

Road Maintenance

Periodic maintenance on dedicated county roads is performed by the Lake County Department of Public Works. Bottle Rock Road, which is the only access road to

the Bottle Rock project site, is structurally unsuitable for increased use by heavy vehicles that would result from development of the Francisco Leasehold. Evidence of frequent repairs can be seen along the length of the road. Additionally, the road width is not sufficient at all points to safely accommodate heavy truck traffic. The Department of Public Works has proposed a plan to rebuild over nine miles of the road and to widen two of its curves. Preliminary estimates place the cost of this project at over $700,000. Negotiations are underway between Lake County and DWR in an effort to determine what DWR's share of the cost shall be. Lake County has indicated that they are attempting to force DWR to pay a significant part of the cost primarily because of DWR's tax exempt status. However, a final determination allocating the cost among the users of Bottle Rock Road has yet to be made by Lake County.

TRANSPORTATION

The most direct access to the project area from Lake County is via Bottle Rock Road to Geyser Rock Road. Bottle Rock Road is a two-lane paved county road; Geyser Rock Road is a privately maintained road to serve the geothermal developments in The Geyser Rock area (Figure C). There are entrance gates on Geyser Rock Road and public access is restricted (Nielson, 1977). From Sonoma County, access to the entrance of the project area is from The Geyser Rock Road, a two-lane paved county road and then a private road leads to the project site.

Regional access to The Bottle Rock project area is from State Highway 175 on the east, State Highway 128 on the south, and U.S. Highway 101 on the west. Traffic counts for Bottle Rock and Geyser Rock Roads indicate that a large percentage of the traffic on Bottle Rock Road is probably either going to or leaving from The Geysers field (Nielson, 1977).

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The purpose of this chapter is to identify and analyze the direct and indirect significant environmental impacts caused by the construction and operation of the Bottle Rock geothermal project. The project includes the proposed power plant, steam wells and pipelines, transmission lines, and all other related facilities.

This chapter describes both, avoidable and unavoidable significant impacts, and measures which will mitigate the adverse impacts. A general discussion of cumulative impacts resulting from this and other projects in the area is also included.

EARTH RESOURCES

GEOLOGY

In general, any phenomenon which causes significant damage to geothermal facilities is also likely to produce significant environmental impacts. For instance, strong seismic shaking could directly damage the power plant threatening worker safety and causing a shut down. In addition, seismic shaking could induce widespread landslides which, in turn, could damage the power plant, steam wells, and transmission and steam supply lines.

A significant environmental impact would be caused by a well blowout (eruptions of pressurized hot steam, toxic gases, and rock fragments) which would threaten worker safety and cause unabated steam releases to the atmosphere. The geologic hazards posing the greatest threat of causing a well blowout are landslides (including those induced by earthquakes), fault rupture, and subsidence. Other potential geologic hazards (e.g., volcanism, liquefaction, expansive and collapsible soils and subterranean collapse) are considered either insignificant or nonexistent because the geologic conditions necessary for these hazards cannot be inferred to exist in the vicinity of the proposed facility.

Seismic Shaking/Fault Rupture - Possibly the most adverse effect of strong ground shaking could be widespread acceleration or inducement of landslides. Even the additional micro-seismicity induced by geothermal development could increase landslide activity.

Based on present geologic knowledge, it appears unlikely that faults within The Geysers steam field will produce any large damaging earthquakes due to either natural or induced activity during the economic life of the proposed facilities. However, potentially damaging levels of shaking could result from earthquakes along more distant faults. (Table 11).

A possible northwestward extension of one of the Cobb Mountain faults (which has moved within the last 100,000 years) passes through the northern portion of the site. The fault appears to be near vertical (McLaughlin, 1978) and juxtaposes graywacke against a complex unit of basalt and greenstone. The fault passes within approximately 1,650 feet (500 m) of the proposed power plant site (Figure I). The Francisco well pad which supplies 50 percent of the steam supply to the plant is located immediately adjacent to this fault. Ground rupture along this fault would probably not adversely affect the power plant site. However, both the existing and proposed wells drilled from the Francisco pad cut the fault at depth and thus could be destroyed causing a blowout in the event of ground rupture along the zone, and substantially reducing the steam supply to its power plant. However, the probability of such fault rupture appears remote.

Landslides and Slope Instability - A facility sited on an unstable slope may be pulled down hill and torn apart if the underlying materials are involved in a landslide. Landslides and unstable slopes may endanger wells which may be sheared off, or severely deformed below the surface if they are sited on unstable materials at or near the ground surface (within 500 feet [150 m]). Such an event usually results in well blowouts at the surface. Neither the power plant nor the two Bottle Rock well pads, are sited in areas of slope instability. The steam supply lines and trasmission towers appear to be sited on adequately stable slopes.

TABLE 11

INTENSITY PARAMETERS OF MAXIMUM ESTIMATED EARTHQUAKES IN THE GEYSERS AREA

	Earthquake on San Andreas Fault	Earthquake on Maacama Fault	Earthquake on Local Fault
Magnitude	8.3	7.0	5.7 - 6.0
Distance mile (km) from site	30 (50)	9 (15)	3-6 (5-10)
Peak Accel (g)	0.20g	0.40g	0.35g
Bracketed Duration (sec)	30	25	10

Source: Bolt and Oakeshott, 1978.

Subsidence - Subsidence of the ground surface is generally caused by withdrawal of subsurface fluids. Recent evidence (Lofgen, 1978) indicates that subsidence is occurring in The Geysers steam field in response to withdrawal of geothermal fluids. The maximum movement has occurred in the steam production area around PG&E's Units 1-8 and 11 where the ground has settled approximately 5.5 in (13.7 cm) from 1973 to 1977. The rates of subsidence and compression appear to be greatest soon after new sources of steam are on line and diminish as fluid recharge approaches equilibrium. It is not yet known: 1) whether and under what conditions such movements will continue or cease; 2) whether such movements are being concentrated along existing faults and shear zones; and, 3) whether the alteration of geologic stress conditions will reactivate some existing faults which have been inactive or potentially active under natural conditions.

Differential subsidence may occur where there are marked changes in subsurface reservoir characteristics or pre-existing zones of weakness, such as shear zones or faults.

According to DWR, induced subsidence will have a minimal direct effect on the environment unless differential movements induce or exacerbate unstable slope conditions (DWR, 1978) and thus blowouts. However, differential subsidence along faults or subsidence-related fault reactivation could result in all of the hazards and impacts associated with fault ground rupture.

Geothermal Features

Geothermal development reduces the pressure of fluids in the geothermal reservoir and this may reduce the amount of leaked heat and steam resulting in cooling of near-surface rocks. This cooling in turn could reduce or eliminate the fumaroles and hot springs in The Geysers KGRA. These surface manifestations of geothermal activity are directly dependent on rain water and high near-surface ground temperatures. These features show seasonal and yearly fluctuations in activity in response to the amount of precipitation. This rain water percolates down through near-surface rocks where it is heated to near or above the boiling point. It then returns to the surface as hot water and/or steam. The presence of hot near-surface rock is in turn dependent on upward leakage of steam (and the heat it carries) from the deeper geothermal reservoir.

Commercial Geologic Resources

Commercial geologic resources are those which can be commercially exploited by mining, quarrying, or drilling. Other than steam and hot fluid, commercial geologic resources within the leasehold are limited to rock (such as chert) suitable for surfacing roads and well pads. There are no known commercial geologic resources whose exploitation would be restricted by the proposed project.

Although the central Mayacmas Mountain area was a mercury-producing district in the past, world market conditions make it improbable that mercury mining would resume on a commercial basis in the foreseeable future. The closest mine to the leasehold is about 3 miles (5 km) distant.

Noncommercial Geologic Resources

Noncommercial geologic resources are those which are of recreational value (e.g., gem, mineral, and fossil collecting localities, caves) and/or of rare, unique, and scientific value (e.g., caves, geysers, fumaroles). No noncommercial resources such as fumaroles and hot springs are present whose use would be restricted by the proposed project.

Off-Site Impacts

There is a very low probability that landsliding, induced by leasehold development, may extend downslope beyond leasehold boundaries. The severity of impacts will depend on the magnitude of any landsliding occurring and on the off-site area affected.

Mitigation Measures

For many geologic conditions, avoidance is the preferred mitigation. Careful site and alignment selection greatly reduces the risk of damage or impacts due to adverse geologic conditions during and following construction. Other major mitigations are comprised of good engineering geology and engineering practices during project design and construction, and proper long term maintenance. Most of the locations selected by DWR for development or continued use appear feasible from a geologic perspective.

Earthquake Engineering - The proposed facilities can feasibly be designed to adequately withstand seismic shaking. Wells and transmission lines are relatively insensitive to seismic shaking and probably require no special treatment except properly sited and engineered well pads and tower footings.

Fault Rupture - Wells should not intersect such faults in the subsurface except at sufficient depth to minimize the potential for blowouts (greater than about 500 feet [150 m]).

Landslides - The power plant, well pads, steam supply lines, and transmission towers all appear to be sited in areas of adequate slope stability. Normal engineering practices should adequately mitigate project-related inducement of landsliding.

SOILS

Soil Erosion and Sedimentation - The potential for soil erosion and sedimentation due to plant site and steam field development are essentially short-term, while the impacts of access road development are long-term. Construction and maintenance of rural roads is a dominant factor in creating soil erosion and sedimentation problems in California (California Department of Conservation, 1971). Plant site and steam field development are essentially short term because the undesirable impacts can be mitigated by the measures listed below. This is not the case for roadways that expose an unprotected surface to erosion.

In either the case of short-term or long-term erosion and sedimentation potential, there are two major undesirable impacts. One is the loss of the soil resource and the consequence of this loss on the biological community. The other is the soil material entering the streams of the area and the impacts this has on the domestic, agricultural, and industrial use of the water. The material that settles out of the water can also negatively effect the fisheries' resources by filling the spawning gravel beds with silt.

Cooling Tower Drift - Cooling tower emissions could adversely affect and kill vegetation adjacent to the plant site, leading to loss of wildlife cover, increased run-off, increased soil erosion due to greater soil exposure, and increased potential for slope failure in geologically unstable areas. In those areas, the vegetation root systems play a major role in maintaining the delicate equilibrium system which exists between climate, soil, slope, and vegetation. A more thorough discussion of cooling tower drift is found in the Biological Impact Section of this EIR.

Mitigation Measures

DWR proposes several specific erosion control measures (DWR, 1978):

1. The contractor will use dust control measures such as sprinkling during construction, and construction activities will stop during periods of rain or high winds.

2. Until revegetation is completed, small debris dams creating settling basins will be constructed and maintained in channels, gullies, and washes that receive runoff from the site.

3. Slopes will be revegetated with native grasses, trees and shrubs, and fertilized and watered until the plantings are well established. Jute, straw, punching, hydromulching, or a combination of these methods will be used to protect reseeded slopes until plantings are established.

4. Slopes will be monitored for gullying on a periodic basis. Gullies that form on the slopes will be refilled, shaped, and reseeded.

5. Drainage of the access roads will be designed to remove and dissipate water from the road surface. Drainage of the power plant pad during construction will be routed by pipe to a settling basin and then released to natural streams.

6. The entire site will be enclosed by an impermeable dike, and the site will be graded so all rainfall runoff or accidental spills will drain to a common sump and be pumped to a reservoir for reinjection.

7. Transmission towers will be sited to make use of topographic features for clearance. Most of the towers will be constructed along existing access roads to minimize impacts on the environment.

These mitigation measures should effectively control soil loss and consequent sedimentation by stabilizing the exposed soil surface and then protecting it with a permanent vegatative cover, as is the case for the preconstruction environment.

Following construction, DWR will submit an annual report on the amount of sediment accumulating in the settling basin. The success of DWR's erosion control plan will be evaluated by the CEC technical staff (soils) and the North Coast Regional Water Quality Control Board.

A discussion of proposed cooling tower drift mitigation measures appears in the Biology Section of this EIR.

AIR RESOURCES

METEOROLOGICAL CHARACTERISTICS

Impacts Associated with the Proposed Project

Several microclimate variables can be affected by persistent emission of heated water vapor. Addition of this vapor to the atmosphere slightly increases ambient temperature and humidity, and reduces insolation (incoming solar radiation). Due to the relatively low volume of emissions in relation to the absorption capacity of the overlying air mass, staff does not anticipate that emissions from the proposed project will have a significant effect on local humidity and temperature.

During calm winter nights when drainage or down slope wind flows predominate, emission of water vapor may slightly increase the frequency and duration of fog within one-half to one mile of the proposed project site.

Potential Cumulative Impacts

Water vapor plumes from a cooling tower generally disperse rapidly in the atmosphere due to their buoyancy and air entrainment, as well as to atmospheric turbulance. Beyond a radius of about one-third mile (about one-half kilometer) from a particular cooling tower structure, the combined contribution from all operating cooling towers must be considered in evaluating their effects on the environment.

In the absence of an intense inversion, the cumulative contribution of water vapor to the atmosphere from all power plants presently operating in The Geysers KGRA would result in only minor changes to the area's climate.

For the annual average wind speed of 11 miles per hour (5 meters per second), the contribution at downwind distances of 5 to 10 miles (8 to 15 kilometers) from 11 operating units of The Geysers Power Plant is less than 0.1 gram of water vapor per cubic meter of air. At the coldest temperatures expected in the area, saturated air would contain at least three grams of water vapor per cubic meter. This addition of water vapor corresponds to a change of less than 1°F in wet-bulb temperature readings.

During the dry season of April through October, the capacity of the air for water vapor ranges from 6 to 40 grams per cubic meter, so the addition of cooling tower water vapor from all units during this period will not change the wet-bulb temperature more than 0.5°F. During this dry season, the area is generally in or above the inversion so that the relative humidity is low and the addition of cooling tower water vapor causes an insignificant change. (CEC Staff analysis, 1979)

Some concern, however, has been expressed among members of the scientific community that even minor changes in temperature and humidity may impact sensitive plant species and their ability to survive (CEC, 1979d).

Mitigation Measures

- o DWR or its contractor(s) should participate in a cooling tower emission monitoring program which will provide data upon which a decision on the need for mitigation of potential impacts can be made.

AIR QUALITY

Ambient air quality in The Geysers KGRA is influenced by geothermal emissions. Water vapor constitutes about 98 percent of these emissions and the remaining 2 percent are comprised of noncondensible gases and dissolved mineral salts. As indicated in Table 4, noncondensible gases in geothermal steam include: carbon dioxide, hydrogen sulfide, methane, ammonia, nitrogen, hydrogen and ethane. Salts may include mercury, boron, arsenic and other suspended particulate matter.

Of the gases present in the steam, all except hydrogen sulfide are expected to have no significant environmental impact. Hydrogen sulfide (H_2S) has a noticeable rotten egg odor and has occurred naturally in The Geysers KGRA prior to development of geothermal resources for power generation. The presence of H_2S is due both to natural sources, such as fumeroles, and to man-made sources such as well drilling or power plant operation. The portion of H_2S present from natural sources is only a fraction of that present from man-made causes (CEC, 1979).

The Northern Sonoma County Air Pollution Control District (NSCAPCD) reports that complaints about H_2S odor from The Geysers began in 1972 and concludes that an emission threshhold was reached at that time. Emission data shows an average annual H_2S emission rate of 482 lbs/hr in 1971 and an increase to 919 lbs/hr in 1972 (Tomasoff, 1977).

Complaints about H_2S odor had already occurred in Lake County prior to 1972. Winds transport H_2S emitted in Sonoma County across the Mayacmas ridgecrest into southern Lake County. Local air quality is now being affected by geothermal emissions to such a degree that the Lake County Air Pollution Control District (LCAPCD) has declared that significant levels of contaminants are present in the Cobb Valley and adjoining areas. These contaminants are deemed a public nuisance and may have possible health effects which are incompletely understood at this time (refer to Public Health Section).

Potential Sources of Pollutant Emissions

Air pollutants from a geothermal power project can be emitted from two principal sources: (1) the power plant itself, including cooling towers; and (2) steam wells and steam transmission lines. The first source produces emissions during routine operation of the steam turbine-generator, while the latter sources produce significant emissions only when the steam turbine-generator is shut down and steam from the transmission lines is vented (stacked) to the atmosphere.

In addition, small quantities of pollutants can be emitted from the steam transmission line, the well bleedlines, leaky gaskets, or the clean-out of particulate collectors. These emissions are continually released at numerous points throughout the leasehold, but their impacts are generally considered insignificant.

The two most important air pollutants that will be emitted from the Bottle Rock project are hydrogen sulfide (H_2S) and particulates (total suspended particulates, or TSP). Both pollutants are present in the incoming steam and must be controlled by various abatement systems.

Particulate Sources and Quantities

The amount of particulates entering the plant is not presently known with any certainty. Particulates can be emitted from several points in the steam cycle. Particulates that are not removed by the strainers in the steam transmission line will proceed through the turbine and surface condenser and into the condensate. The condensate will eventually pass into the cooling towers where part of the particulates will be released into the atmosphere in the form of drift. Additional particulates can be transported by noncondensed gases into the Stretford H_2S abatement system. The particulates will then be emitted with the gases from the Stretford system's cooling tower.

A third potential source of particulates is the secondary H_2S treatment process, if one is required. Typically, such condensate treatment systems use a peroxide/iron sulfate catalyst to transform dissolved H_2S into ammonium sulfate $[(NH_4)_2SO_4)]$, which can be emitted as a solid, or particulate. Other solids may also be formed in the chemical reaction. Until DWR determines the extent to which a secondary H_2S treatment will be used, the amount of particulates that could be produced and emitted from this process cannot be precisely determined.

Including an assumed contribution from secondary H_2S treatment, the plant's total particulate emissions will be approximately 5 lbs/hr (DWR, 1979; and PG&E 1979), which includes approximately 2 lbs/hr from the main cooling towers and 2.6 lbs/hr from the Stretford cooling tower. The relatively low levels of particulates in the steam is partly attributable to the fact that centrifugal filters will be placed in steam gathering lines to collect particulates before they enter the plant.

Hydrogen Sulfide Sources and Quantities

The greatest potential source of H_2S emissions from the proposed power plant is the amount of H_2S dissolved in the spent steam. Left untreated, the spent steam would violate applicable standards for H_2S emissions.

For the proposed project (as in others recently proposed) the primary H_2S abatement equipment will consist of a surface condenser and the Stretford process.

The success of the H_2S abatement system depends greatly on the efficiency of the partitioning which occurs in the surface condenser. That portion of the spent steam which is partitioned into noncondensible gases will be diverted to the Stretford process for treatment, which will remove virtually all of the H_2S in the noncondensible gas. Any remaining gases can then be exhausted to the atmosphere from the Stretford cooling towers.

That portion of the spent steam which is condensed at the surface condenser eventually circulates through the main power plant cooling towers, becoming the most significant potential source of H_2S emissions. Unless the surface

condenser is able to partition most of the H_2S in the spent steam into the noncondensible gases, DWR will have to resort to some form of secondary H_2S removal in the condensate line, between the surface condenser and the cooling towers. Thus, the critical task of the surface condenser is to provide plant cooling in such a way as to maximize the partitioning of H_2S and other non-condensible gases from the steam, so that the H_2S gas can be treated in the Stretford unit.

Based on the data from the initial McCulloch steam wells, DWR has estimated that the range of H_2S concentration in the steam entering the power plant will be approximately 360.85 lbs/hr from an expected income steam flow of 1,031,000 lbs/ hr.

Emissions Limitations

Emissions from the proposed project are subject to New Source Review Rules and emission limitations of the Lake County Air Pollution Control District (LCAPCD). Under the federal Clean Air Act, the District must determine whether a proposed project's emissions will prevent the attainment, interfere with the maintenance, or cause a violation, of a national ambient air quality standard.

Under state law, the same determination must be made with respect to state ambient air quality standards which may be in addition to or more stringent than federal ambient standards. The California Air Quality Standard for H_2S is 30 ppb (parts per billion) for a one-hour average. The standard was set to reduce annoyance caused by H_2S odors. In addition, LCAPCD rules impose certain emissions limitations for varying pollutants which must be met before a permit can be granted.

The Lake County APCD has adopted H_2S emission regulations which are intended to reduce the total emissions from existing as well as future sources. These regulations are intended to bring the KGRA into attainment with the California standard. Under LCAPCD Rule 421.1(a), H_2S emissions from a geothermal plant cannot exceed 100 grams per gross megawatt hour (100g/GMW). For the total 55 megawatt power plant, 100g/GMW converts to approximately 13.2 lbs/hr.

Commencing on January 1, 1990, all units will have to meet a doubly stringent standard of 50 grams per gross megawatt hour. Under this revision, the equivalent limits will be 6.1 lbs/hr for the entire plant. The more stringent 1990 revision is subject to LCAPCD review prior to its implementation.

Emissions Analysis of Primary H_2S Abatement System

If one assumes that the H_2S content in incoming steam remains within the range expected by DWR (350 ppmw), then the total amount of H_2S entering the plant will be approximately 360.85 lbs/hr.* To meet the 13.2 lbs/hr limitation will require an overall abatement efficiency of 96 + percent. (The final efficiency requirement will be determined when the full field is developed and the unit begins operation.)

*Based on the following calculations:

$$\frac{350 \text{ lbs. of } H_2S}{1 \times 10^6 \text{ lbs of steam}} \times \frac{1.031 \times 10^6 \text{ lbs. of steam}}{1 \text{ hour}} = 360.85 \text{ lbs } H_2S/\text{hr.}$$

The Ralph M. Parsons Corporation, the manufacturer of the Stretford units for PG&E's Geysers Units 15, 17, and 18, now offers guarantees that the treated gas stream leaving its Stretford unit contains no more than 10 ppm by volume H_2S. This constitutes an abatement level above 99 percent and an H_2S emission rate of less than 1 lb/hr for proposed Unit 17, which is estimated to have a flow rate at a high of 900 ppmw.

The feasibility of meeting the 96 + percent total abatement efficiency without secondary treatment of the steam condensate depends upon the ability of the surface condenser to partition approximately the same percentage--96 + percent--of H_2S from the steam as noncondensed gas.

When DWR filed its NOI with the Energy Commission, it anticipated achieving a partitioning efficiency from its surface condenser of 96 + percent; i.e., 96 + percent of the H_2S present in the turbine exhaust steam would be separated from the steam condensate as noncondensed gas. An efficiency of 96 + percent would clearly meet the present emisions limitation for H_2S. However, preliminary test results from PG&E's Unit 15--the first Geysers Unit to employ a surface condenser--suggest that partitioning efficiencies of 90 percent may not be feasible.

The following test results from the Unit 15 project are relevant to the proposed project:

a. The partitioning efficiency so far achieved by Unit 15's surface condenser is about 67 percent. A comparable efficiency at DWR's plant, given H_2S concentrations of 360.58 lbs/hr, would result in H_2S emissions of 119.1 lbs/hr in the absence of secondary treatment.

b. The test results suggest that partitioning efficiency decreases as the concentration of H_2S in incoming steam decreases. For Unit 15 the concentration of H_2S is 180±10 ppm. For DWR it is expected to be 350. DWR's partitioning efficiency may therefore be more than 67 percent.

c. Measurements at Unit 15 slightly overstate the partitioning efficiency. If similar tests were conducted at the DWR plant, and the turbine condenser and gas ejector were of equal efficiency to those used at Unit 15, the partitioning efficiency would be similar for the DWR unit.

d. Unit 15 results indicate that the relative acidity, or pH, of the steam condensate is an important factor in maintaining partitioning efficiency. H_2S tends to remain in the condensate if the condensate is basic (pH greater than 7.0). The presence of ammonia in incoming steam tends to make the condensate basic in the absence of compensating acidic chemicals. The pH level of steam entering DWR's plant cannot be estimated until additional steam wells are drilled.

The foregoing discussion indicates that the probable level of H_2S emissions following primary condensate treatment could be 119.1 lbs/hr, which is considerably in excess of the 13.2 lbs/hr limits of Rule 421.1-A.

Emissions Analysis of Secondary H_2S Abatement System

Whether it is feasible to provide sufficient secondary treatment to meet Rule 421.1-A has been addressed by the CEC in its certification proceedings for PG&E's Unit 17. The incoming H_2S concentration for PG&E Unit 17 is 350+100 ppm. This corresponds to a H_2S flow rate of 516 to 957 lbs/hr.

If one applies the 67 percent partitioning efficiency data from PG&E Unit 15 to the highest expected H_2S content of the steam supplies to the Unit 17 and DWR plants, then the H_2S removal requirement by secondary treatment would be approximately 315 lbs/hr of H_2S for Unit 17 and 119.1 lbs/hr for DWR. This indicates that the required capacity of storage tanks and size of other system components, as well as the reduction of side effects such as sludge creation, makes the problems of a secondary H_2S treatment system smaller for the proposed project than those expected for Unit 17. The Commission found that the PG&E proposals for secondary treatment at Unit 17 were feasible (CEC, 1979d) and therefore staff expects they are also feasible for the Bottle Rock project.

DWR has agreed to install a secondary condensate treatment system (DWR, 1979c) if the necessary degree of partitioning is not obtained in tests to be conducted at PG&E Unit 15. At this time, DWR's choice for condensate treatment is a hydrogen peroxide/iron sulfate catalyst system (DWR, 1979c). Tests of a modified system of this type on PG&E's Geysers Units 3, 4, 5, 6, and 11 have resulted in average abatement levels of 92 to 95 percent (PG&E, 1979). If one assumes that at least 90 percent of the H_2S dissolved in the condensate can be removed by secondary treatment, that a 67 percent partitioning efficiency is obtained, and that the Stretford units removes 99+ percent of the H_2S entering it, the overall H_2S emission rate would be on the order of 12.9 lbs/hr. This would satisfy the LCAPCD requirements by a narrow margin.

DWR has indicated that if a secondary H_2S abatement system is required, it will use a 50 percent hydrogen peroxide (H_2O_2) solution in the condensate, at 4:1 peroxide to sulfide ratio supplemented by an iron catalyst to remove the H_2S from the condensate. Information on the degree of secondary treatment necessary under varying assumptions was supplied by DWR's September 24, 1979 additional information submittal to the CEC (DWR, 1979c).

Compliance With Ambient Air Quality Standards

The California standard of 30 ppb H_2S for a one-hour average has consistently been exceeded throughout The Geysers KGRA and the surrounding areas. As shown in Tables 5 and 6, measured levels of H_2S exceeded the standard 10 percent of the time in 1976 and 5 percent in 1977 at the SRI-2 site on the ridge near the proposed plant site. At the SRI-6 site in Anderson Springs, the standard was exceeded 0.04 percent of the time in 1976 and .013 percent in 1977. With further development of geothermal resources in The Geysers KGRA, even greater and more frequent violations would be anticipated if H_2S emissions from power plants continued, unabated.

The location of a particular emission source influences the direction, distance, and degree of dispersion of emissions. Topographic features influence meteorological conditions and can create a wind flow field which would tend to direct

the flow in a specific direction. The presence of a strong atmospheric inversion will tend to contain emissions within and beneath the inversion layer. Since wind is the transport mechanism for emissions, misplacement of an emission source may cause localized increases in pollutant levels and violations of standards.

During certain wind and/or atmospheric inversion conditions, emissions may be blown or drawn downslope into low-lying valley areas. If the area is populated, there may be an increase in complaints about odor and the unknown potential for long-range impacts to the population and/or the environment.

The MRI Study

In order to calculate the projected impacts of the Bottle Rock power plant emissions on nearby sensitive receptors (i.e., Pine Grove, Hobergs, Loch Lomond, and Cobb Valley), MRI first conducted a study (Knuth and Giroux, 1979) to determine the anticipated ambient H_2S background concentrations in potential receptor areas.

The MRI study was based on a "rollback" analysis. Rollback assumes that baseline air quality, as affected by a diffuse source configuration such as the numerous geothermal power generating units in The Geysers KGRA, is approximately proportionate to the upwind source strength. Rollback analysis was performed to determine what H_2S background concentrations would be in future years when the emissions from existing plants are reduced through retrofit control technology.

MRI tabulated estimated H_2S background concentrations in various areas of The Geysers KGRA and reviewed historical measurements of air quality and meteorological data, such as the ERT report (Steffan, et al, 1978). The MRI study indicated that different Geysers Units create maximum impacts in different downwind areas.

The area of maximum probable Bottle Rock impact, as designated by MRI and confirmed by LCAPCD and CEC staff, includes the entire Cobb Valley. In this impact area, MRI estimated that future maximum baseline H_2S levels for the community of Pine Grove would be about 15 ppb, for Hobergs about 13 ppb, for Loch Lomond about 5 ppb, for Jaddikers about 7 ppb, and for Cobb about 8 ppb. (All values are CEC staff analyses derived from Tables 4-1 to 4-6 of the final Cobb Valley Tracer Study, July 11, 1979, and have not been confirmed by LCAPCD staff.)

Having established the probable future baseline concentrations of H_2S at various sensitive receptors (Table 12), CEC staff determined, from data in the Cobb Valley Tracer Study, (Table 13) the potential incremental impacts that the proposed Bottle Rock project would contribute to the future baseline. A series of tracer tests were conducted during September 1978 and April 1979 from PG&E Unit 17, NCPA #1, and the proposed power plant site to simulate transport and dispersion from the proposed site. The tests were conducted with tracer releases at heights simulating those anticipated for a cooling tower plume under the following estimated worst case meteorological conditions: (Pending resolution of the anticipated plume rise issue in DWR's AFC, CEC staff assumes that all tests are valid and represent the potential impacts from the Bottle Rock project.)

TABLE 12

ESTIMATED FUTURE EMISSIONS LEVELS AT THE GEYSERS KGRA

Unit No.	Total Capacity (GMW)	Approximate Steam Flow (kg/hr)	Average Emissions Rates by Power Plant (lb/hr)		Total Yearly Stacking Emissions (lbs)	
			1977	1983	1977	1983
PGandE						
1	12.5	110,000	30.5	4.7	4,740	1,746
2	13.8	120,000	42.2	5.8	4,886	2,151
3	27.5	230,000	60.6	9.3	71,895	9,082
4	27.5	230,000	67.8	10.8	41,015	4,785
5	55	410,000	216.7	21.7	44,860	4,375
6	55	410,000	261.1	20.4	83,440	8,034
7	55	410,000	169.4	22.0	43,899	3,712
8	55	410,000	101.8	21.7	76,605	7,460
9	55	410,000	48.6	23.4	31,466	3,860
10	55	410,000	55.7	23.7	19,784	2,738
11	110	820,000	198.2	43.6	315,427	23,376
12	110	820,000	--	22.8	--	8,355
13	135	1,240,000	--	28.5	--	8,514
14	110	900,000	--	22.8	--	8,355
15	57	520,000	--	12.3	--	7,344
16	120	820,000	--	24.7	--	8,423
17	120	820,000	--	24.7	--	8,355
18	110	820,000	--	22.8	--	8,355
19	110	820,000	--	22.8	--	8,355
NCPA						
1 and 2	176		--	37.0	--	8,714
DWR						
1	60	453,600	--	13.2	--	7,344
2	60	453,600	--	13.2	--	7,344
Total			1252.6	451.9	738,017	160,777

Source: DWR, 1978

TABLE 13

PEAK EQUIVALENT H_2S CONCENTRATIONS OBSERVED DURING THE GEYSERS COBB VALLEY JOINT AIR STUDIES

Test No.	Meteorological Regime	Tracer Release Site	Peak Equivalent H_2S Concentrations (ppb)		Appropriate Distance to Highest Observed Concentration (m)
			Highest	Second Highest*	
1	Nocturnal drainage	DWR	0.187	0.122	2470
		DWR	0.700	0.371	2470
2	Nocturnal drainage	NCPA	0.187	0.119	4515
		NCPA	1.484	1.222	2740
3	Nocturnal drainage	NCPA	0.626	0.411	3790
		DWR	0.838	0.640	970
4	Stagnation	PGandE 17	0.115	0.090	2500
		--	--	--	--
5	Subsidence inversion	PGandE 17	0.145	0.063	4470
		DWR	4.161	1.907	3670
6	Stagnation	PGandE 17	0.768	0.206	1120
		NCPA	1.329	0.703	1935
7	Nocturnal drainage	DWR	0.313	0.308	2485
		NCPA	0.200	0.000	3705
8	Subsidence inversion	PGandE 17	0.050	0.030	5355
		NCPA	0.142	0.142	1790
9	Subsidence stagnation	PGandE	0.057	0.029	1060
		DWR	0.311	0.273	3280
10	Stagnation	PGandE 17	0.144	0.088	5350
		DWR	0.301	0.197	3910
11	Downwash	PGandE 17	0.445	0.425	5650
		DWR	0.209	0.193	1310
12	Downwash	PGandE 17	0.074	0.066	1590
		DWR	0.167	0.089	2485
13	Downwash	PGandE 17	0.104	0.041	1590
		NCPA	0.375	0.218	2995
14	Downwash	PGandE 17	0.023	0.023	2765
		NCPA	0.023	0.023	1685
15	Downwash	PGandE 17	0.024	0.018	1125
		NCPA	0.165	0.144	975
16	Downwash	PGandE 17	0.035	0.035	2745
		DWR	0.060	0.052	1170
17	Nocturnal drainage	NCPA	3.821	3.338	3780
		NCPA	0.471	0.280	1430
18	Nocturnal drainage	DWR	0.967	0.785	1160
		DWR	0.326	0.287	1160
19	Nocturnal drainage	PGandE 17	0.313	0.112	3165
		DWR	0.082	0.065	3920
20	Nocturnal drainage	PGandE 17	0.039	0.038	2760
		NCPA	0.151	0.148	1100

* Not necessarily at the same monitoring station where the highest value was observed.

Source: DWR, 1979

- o "Limited Vertical Mixing", in which a layer of neutral stability extends above the ridgeline and is capped by a stable layer (subsidence inversion);

- o "Downwash", in which high velocity (greater than 8 meter/second) air movement across a ridge top is deflected downward into an adjacent valley or lee side of the ridge by mechanical fluid motion;

- o "Nocturnal Drainage", in which low velocity (less than 3 m/sec) air flows occur near the ground surface on hillsides and in valleys, trapping pollutants, and confining them near the ground.

- o "Deep Mixing", in which neutral stability, similar to limited vertical mixing, occurs; however, no capping inversion exists over the valley.

Tracer releases were conducted at the proposed site under all meteorological conditions.

Projected Impacts

Utilizing the previously described project pollutant emission rates results from tracer releases from the proposed project site, and a review of MRI's Cobb's Valley impact analyses, MRI projected impacts on various sensitive receptors. These impacts are shown in the DWR AFC, and the results are summarized below:

- o On September 27 and October 25, 1978, tracer releases were conducted from the proposed Bottle Rock site during Limited Vertical Mixing meteorological conditions. Based on an assumed plant emission rate of 13.2 lbs/hr of H_2S, estimated ambient concentrations of H_2S at sensitive receptors would reach levels of approximately 55 ppb maximum at Pine Grove.

- o Downwash meteorological conditions were evaluated on January 8, and 10, and February 25, 1979, and predicted maximum impacts at the same sensitive receptors could reach 2 ppb maximum at SRI-7 (Test 12).

- o Deep mixing (stagnation) conditions were evaluated on October 27, 1978 and predicted maximum impacts at the same sensitive receptors could reach 4 ppb maximum at Hobergs (Test 10).

- o Nocturnal drainage conditions were evaluated by tracer releases on September 12 and 22, October 18, 1978, and April 1 and 3, 1979, and predicted maximum impacts at the same sensitive receptors could reach 9.24 ppb maximum at Jaddikers (Test 1).

Compliance Determination

Given the maximum future baseline H_2S concentrations at sensitive receptor locations and the additional impacts that could be expected from the Bottle Rock project, the final step is to superimpose the results of these analyses and determine if the attainment and maintenance of the California H_2S ambient air quality standard is likely to occur. To make this determination, the combined impacts of all geothermal units in operation when the Bottle Rock plant becomes

operational have been correlated to the state ambient H_2S standard. (See MRI Final Report, July 11, 1979, Tables 4.1-4.6.) In addition, since a violation of the H_2S state standard does exist in the proposed project area, LCAPCD rule 602 requires that the plant make no measurable contribution (10 ppb H_2S) to background emissions. Therefore, the analysis will be twofold, one a check on the state standard violation and the other the measurable contribution standard.

The baseline assumes that all existing geothermal power plants and associated steam supplier equipment are in conformance with Northern Sonoma County Air Pollution Control District (NSCAPCD) Rule 455 (H_2S control strategy) and all new plants that come on line before Bottle Rock emit only 100 grams/GMWH.

CEC staff's analysis of the MRI report indicates that it is likely that, under the assumptions previously stated (calculated background concentrations, and a 13.2 lb/hr emission rate from the Bottle Rock plant), the LCAPCD measurable contribution rule will be violated, the H_2S ambient air quality standard will be violated in areas of sensitive receptors, and there will be interference with achievement of the standard. These predictions are predicated on the fact that The Cobb Valley Tracer Study (MRI) is accepted by LCAPCD to represent Bottle Rock's H_2S impact analysis. Rejection of this report for any reason may change all previously calculated values.

Evaluation of data gathered on ambient total suspended particulate matter (TSP) indicates that no violations of this standard have occurred at sensitive receptor locations. The Bottle Rock plant, as proposed, is not a major source (6 lbs/hr maximum) of TSP and therefore is not likely to cause a violation nor interfere with the maintenance of the standard.

Compliance During Abnormal Conditions

Analysis of project impacts must not only consider anticipated normal operating conditions (a 13.2 lbs/hr H_2S emission rate) but also abnormal conditions. Periodically a geothermal power plant may cease operation, either because of scheduled, routine maintenance, or because of unscheduled, forced shutdown. When this occurs the stream supply is vented to the atmosphere or "stacked". During "stacking" as much as 360 lbs/hr of H_2S may be emitted at the proposed project site. The 360 lb/hr emission rate is based on data in the AFC document concerning steam quality and steam flow rates. (350 ppm H_2S x 1,031,000 lbs steam/hr = 360 lbs/hr H_2S).

Using the MRI tracer study findings, the estimated ambient H_2S levels resulting from maximum H_2S emissions during stacking (360 lbs/hr H_2S)* show numerous violations of the ambient air quality standard at the sensitive receptor locations. The H_2S ambient concentrations at Pine Grove may reach in excess of 1,400 ppb above background and this value is a public health concern. (See Public Health section).

*Final H_2S emissions may be higher or lower pending full field development.

However, if these impacts are added to the assumed 1983 background, MRI's results would predict that even more violations would occur at most sensitive receptor locations.

Under LCAPCD Rule 602 (New Source Review) a new source cannot be permitted if the source's pollutant contribution to ambient background concentrations will result in a violation of the ambient air quality standard for that pollutant or result in a measurable contribution. Since steam stacking episodes are predicted to result in violations, McCulloch will not be permitted to stack steam during unit outages (the conditions under which the 350 lbs/hr H_2S emission maximum is possible) without additional abatement.

Mitigation Measures

During normal operating conditions, DWR will employ the following mitigation measures:

- To reduce the H_2S emissions of the proposed power plant, DWR plans to construct a Stretford process unit as part of the proposed project. The unit will be capable of processing approximately 300 pounds of H_2S per hour. Although DWR has not yet selected a manufacturer, it has specified in its bid requests that the unit must have an H_2S removal efficiency of 95 percent or greater.

- PG&E Geysers Unit 15 was the first power plant to use the proposed Stretford process and surface condenser system for H_2S abatement. If tests and analyses of the Unit 15 system indicate that H_2S emissions would not meet required limitations, DWR will install a secondary abatement system to treat the condensed steam before it reaches the cooling towers.

During abnormal operating situations the following abatement measures will be implemented by DWR and McCulloch:

- The proposed plant will employ 100 percent backup systems for many critical components, including condensate pumps.

- McCulloch will use automated control valves which will throttle back supply wells during plant outages.

- McCulloch's control valves will be capable of reducing steam flow by 50 percent within 30 minutes of an unscheduled outage. CEC staff believes this response time is inadequate to keep stacking emissions in compliance with the Lake County stacking rule H_2S ambient standard. The staff conclusion has not yet been verified by the LCAPCD.

- To further address staff concerns for stacking controls, DWR supplied additional information on a chemical abatement system using hydrogen peroxide (H_2O_2) and caustic soda (NaOH) to control the H_2S. The chemical system will be operational during the second hour of steam stacking and a 96 percent theoretical efficiency is estimated. If the 30 lbs/hr H_2S emissions, under stacking conditions, are allowed by LCAPCD Rule 421.2b, then only 83 percent efficiency may be needed. To date no test data

has been presented by DWR to demonstrate the capability of this system to achieve the levels of control required by the Energy Commission (CEC, 1979c).

Recommended Post-Certification Procedures

There are great areas of uncertainty concerning (1) H_2S concentrations and pH levels in incoming steam; (2) achievable partitioning efficiencies for the surface condenser; (3) extent of necessary secondary treatment systems; (4) reliability of and amounts of solid wastes produced by the secondary treatment system. Because of these uncertainties, CEC staff recommends the following post-certification procedures to ensure compliance with Rule 421.1-A.

- o DWR should file with the Commission and LCAPCD an analysis of available information on the H_2S abatement performance testing at Unit 15 and its applicability to the proposed DWR plant. Such a report should include test data on the Stretford process, condenser partitioning and steam characteristics.

- o In the event the primary H_2S abatement system (Stretford surface condenser combination) at Unit 15 does not provide adequate abatement performance, DWR should augment its proposed H_2S abatement system with the necessary secondary treatment and provide to the Commission and the LCAPCD design and test information on the secondary system prior to its procurement and fabrication.

- o Upon DWR plant operation, DWR shall monitor H_2S abatement system performance. If compliance with Rule 421.1A is not achieved, DWR should prepare, prior to its implementation, a plan for additional treatment of gases to achieve H_2S discharge requirements. The plan should be submitted to the Commission and the LCAPCD for their review and approval.

- o If a solids removal system (for the secondary treatment process) proves necessary at the plant, DWR should provide design criteria and specifications to the LCAPCD and Commission for review and approval prior to the system's procurement and fabrication. The system shall be installed and operating according to the approved design criteria prior to commercial operation.

- o Prior to DWR plant operation, DWR will submit to the Commission and the LCAPCD a specific H_2S monitoring plan of the abatement system performance of the facility. LCAPCD will advise the Commission as to the acceptability of the monitoring plan.

- o Results of the monitoring program are to be submitted to the Commission and the LCAPCD, as follows:

    a. DWR shall provide a report on the results of the monitoring program within 90 days after the facility commences commercial operation, provided the report covers a minimum period of 75 operating days, including, if possible, a period of 30 consecutive operating days. The data used for the report shall be based on the highest levels of emissions and electrical power generation achieved.

b. If, during the first 90 days of monitoring described in item (a), 100 percent rated power has not been achieved for a cumulative period equal to 30 days, a second report shall be issued. This report shall be based on data obtained at 100 percent rated power for a cumulative period equal to 30 days.

c. Upon review of information in the above items, the Air Pollution Control Officer of the LCAPCD shall present to the Commission findings of conformity to air quality standards and/or acceptability of proposals to achieve those standards.

WATER RESOURCES

HYDROLOGY

Plant cooling will be done with condensed geothermal steam, and therefore, the affects of the plant on local water supplies will be minimal. Fresh water will be required only for maintenance of the buildings, sanitary facilities, landscaping, and operation of the H_2S abatement system. Bottled water will be provided in the plant for human consumption.

Surface Hydrology - Because the cooling water supply will come from condensed steam, and because the site is located away from any stream flooding hazard, the only consideration here is the possibility of short duration, high-intensity rainfall which may fill and overflow the site retention barrier causing bank erosion.

Mitigation Measure

The surface drainage system will be designed to convey the one hundred year flood. (Defined as a flood event that occurs on the average once in one hundred years.) By designing the drainage system to convey this event, staff believes that the possibility of an overflow event is safely mitigated.

Groundwater - The lack of high quality aquifers in the area, and the fact that excess condensate will be reinjected into the geothermal reservoir preclude the possibility of groundwater contamination.

Mitigation Measure

To prevent accidental spills from percolating into the groundwater basin, the entire plant site will be paved and graded. Spills will be routed to the drainage sump where the spill will be pumped back to the cooling tower or reinjection well.

WATER QUALITY

The primary water quality concern is the preservation and maintenance of the beneficial uses of the area waters, both in the immediate vicinity and downstream from the project.

Potential impacts on these beneficial uses which may result from this project include sedimentation/siltation, the discharge of toxic wastes/substances, cooling tower drift deposition, and wastes and their disposal.

Siltation and Sedimentation - Development of the sites for the proposed power plant, tranmission tower pads, steam supply well pads, and access roads will increase the potential for siltation/sedimentation in the drainage basins fed by runoff from the proposed project area. An increase in sediment yield could increase the suspended solids and turbidity, decrease the dissolved oxygen content, and fill in or cover existing shallows, holes, and gravels of the perrenial and intermittent creeks. Any or all of these conditions could be deleterious to aquatic plant and animal life.

Toxic Spills - A number of toxic substances are associated with the development and use of geothermal resources. These include: contents of drilling mud sumps, cooling water and condensate from spent steam (which can include boron, arsenic, ammonia, mercury, and sulfur), any of the various waste materials from power plant or steam field operation, and supplies for and byproducts from the hydrogen sulfide abatement process(es) or other specific units of the power plant. Seasonal runoff could be contaminated by any of these preceding substances. Discharge of any of these substances into ground or surface waters could have a deleterious effect on the beneficial uses of these waters.

Spills have occurred sporadically in the past, averaging 1-2 times per year for steam generation associated spills, and 4-5 times per year from power plant sites. These records were compiled by the North Coast Regional Water Quality Control Board (NCRWQCB) and the California Department of Fish and Game (CDFG) and show that pollution incidents usually were caused by construction activities, well discharges or leaks, condensate spills, and condensate line breakages (NCRWQCB-CDFG, 1979). Most of these spills were short-lived, and no long-term adverse effects were noted. Spills from wells or steam lines will probably continue to occur at the same frequency rate since these have been caused by machinery or pipe breakage.

Spills from the plant site, however, will no longer be likely, because they will be controlled and contained on site. Spills have occurred in the past because of the lack of containment berms or collection sumps; these features are included, however, by DWR for the proposed project.

Cooling Tower Drift - Water quality within the proposed project drainage basins may be affected by cooling tower drift. New geothermal power plant design will allow for only 0.002 percent of the incoming contaminants to be emitted with the cooling tower vapor. Lawrence Livermore Laboratory analyzed the problem of cooling tower drift in their 1978 Geysers-Calistoga KGRA Environmental Overview and concluded that cooling tower drift is not presently a water quality concern, but soil and water monitoring should be an ongoing program. (For additional information on cooling tower drift, see Biology Section of this EIR.)

Mitigation Measures

Siltation and Sedimentation - Drainage and erosion controls (grading, water bars, energy dissipation devices, drainage channels, hydroseeding, mulching, compaction, etc.), as described by DWR throughout the NOI and AFC, along with proper revegetation of cut and fill slopes, will adequately reduce the potential for significant runoff and sediment/siltation loading in the affected streams. (For further discussion on mitigation for the steam field and power plant, see Soils and Biology Sections.)

The California Department of Oil and Gas (DOG) has responsibility for regulating the development, construction, and operation of the steam wells. Control of these activities would be through the DOG permit system, requiring adequate construction methods and well-drilling processes.

Lake County has responsibility for the issuance and compliance of land use permits, for other than the power plant site itself.

The Central Valley Region Water Quality Control Board (CVRWQCB) regulates the water quality concerns for well drilling and operation. This is done by requiring stabilized and erosion resistant impermeable sumps at the well-drilling pad sites, capable of containing all wastes generated during the project's lifetime. The CVRWQCB also requires grading of the pad surface away from the waste sump and that all exposed earth surfaces be protected from erosion. These measures have been employed on other steam wells in the area and staff believes they are adequate measures.

Toxic Spills - At each steam supply well pad near the well head(s), a sump is constructed which is designed to contain the maximum probable accidental discharge until the steam or fluid can be shutdown or redirected. Regional Water Quality Control Board waste discharge requirements (CVRWQCB, 1979) for the well drillers require that these sumps be lined with an impervious material to prevent seepage into the groundwater, be erosion resistent, and be of sufficient size to contain wastes and discharges anticipated during the lifetime of the facility.

Discharges of toxic substances deleterious to plant or animal life are prohibited by the Regional Water Quality Control Boards (Basin Plans). Discharges of wastes are regulated by the Regional Water Quality Control Boards (Porter-Cologne Act). The CVRWQCB has required that DWR, as a condition to waiving waste discharge requirements, file a spill prevention and contingency plan and has recommended that the plan be required as a condition to receiving CEC certification for operation of the proposed geothermal power plant (CVRWQCB, 1979).

This spill contingency plan must contain the following:

- o The kinds of spills that could occur at the site;
- o The chemical composition, temperature, volume, duration, and any other characteristics of the potential spill material;

- o A description of potential harmful effects of the spill material;
- o A description of safeguards which will be used to prevent and deal with spilled material;
- o Immediate diligent cleanup action; and
- o A detailed contingency plan of persons to be contacted and procedures to be followed in case a spill occurs; procedures should include a discussion of containment, disposal, and possible restoration of impacted areas.

To minimize the possibility of these toxic substances entering the groundwater, DWR will cover the six-acre power plant site with an impermeable surface of asphalt (DWR 1979), having a permeability of 1×10^{-6} cm/sec (less than one foot per year). This surface will collect and help contain on-site spills. The permeability factor is standard engineering terminology accepted as adequate to provide protection between groundwaters and undesirable substances, such as toxic materials, brines, or garbage leachate.

The maximum potential spill from the cooling towers and condensate basin could be as much as 170,000 gallons (DWR, 1979). To prevent a discharge of toxic substances or pollutants from the plant site to the drainage channels below the proposed project site, DWR will surround the entire site with berms that are high enough to fully contain greater than twice the maximum anticipated spill (170,000 gallons) of on-site liquids. This will be enough to contain any spills for a sufficient period to allow reinjection procedures to be initiated and any needed emergency actions taken.

To ensure that any potential contaminants are contained on-site until they can be safely and appropriately disposed of, all gates to the off-site drainage system will normally remain closed. During periods of heavy precipitation the plant will be allowed to drain through the designed drainage systems, which empty to the sedimentation basin (an erosion control measure) located north of the power plant site in the High Valley Creek watershed. From there runoff will flow down and mingle with High Valley Creek and Kelsey Creek waters.

Runoff from the first major seasonal storm should be contained and appropriately disposed of, either by reinjection with the cooling tower condensate excess, hauled to an approved waste disposal site, or rendered harmless by some type of pretreatment. CEC and RWQCB staff suggest this should be done to assure that surface and groundwaters are not contaminated by toxic substances that may accumulate on the site proper during the dry months and be washed off during the first rains.

Cooling Tower Drift - No mitigation measures for water quality impacts are necessary if the power plant is constructed as proposed.

WASTE MANAGEMENT

Potential impacts of wastes are discussed in the preceding Water Quality Section.

MITIGATION MEASURES

Construction wastes mitigation measures are discussed in the preceding Water Quality Section. Liquid wastes have historically been disposed of by reinjection into the steam reservoir through nearby dry or underproductive wells. Although there have been no studies made to determine the effects of reinjection of any of these fluids, no adverse effects are anticipated by either RWQCB OR CEC staff because the reservoir lies far beneath any groundwater aquifers and is separated from these aquifers by natural barriers (tight and clayey soils) and deep well casings (Stanford Research Institute, 1977).

Sanitary wastes are of limited volume (approximately 200 gallons/day) but cannot be disposed of on-site because the slope and soils of the proposed site do not allow for construction of an adequate leachfield disposal system. Therefore, DWR proposes to reinject the liquid portion along with the other liquid wastes from the cooling tower basin and air pollution control equipment and to dispose of the solids at an appropriate and approved waste disposal site for this type of waste (DWR, 1979b). If reinjected into the steam reservoir, any pathogens in this waste would be killed by the intense heat and pressure of the steam reservoir. The responsible regulatory agencies (Regional Water Quality Control Boards and Department of Health Services) have indicated that reinjection of these liquid wastes back into the steam reservoir is an acceptable practice (Ed Crawford, CVRWQCB, 1979).

Cooling tower sludge, considered as hazardous, will be allowed to accumulate in the cooling tower basin (at a rate of approximately 400 barrels per year) and will be emptied once every two or three years. The sludge is proposed for disposal at a Class I site owned by Western Contra Costa Land Fill, and located in Richmond, California.

Hazardous wastes, such as oils, thinners, solvents, and the elemental sulfur byproduct must be disposed of at an approved Class I or Class II-1 waste disposal site for geothermal wastes.

Limited quantities of potentially toxic or hazardous wastes may be stored on-site for a limited period of time in conformance with Department of Health Services (DOHS) Hazardous Material Management Section (HMMS) regulations. Those regulations require an operations plan stipulating volume of waste, storage, disposal, and handling methods.

The Stretford Unit will produce approximately 221 lbs/hr of sulfur, which initially will be stored in an 1,100 cubic foot (31.4 m^3) storage tank; DWR proposes to sell the sulfur to a commercial buyer (DWR, 1979).

Transportation of these wastes, both liquid and hazardous, is also regulated by DOHS/HMMS. These regulations allow for only registered haulers for such transporting. In the event of a spill during handling or transporting of these wastes, DOHS and the appropriate Regional Water Quality Control Board would respond; issue an order requiring needed abatement, clean-up, or other preventive measures as may be required.

CEC staff have analyzed each impact versus its appropriate mitigation measure, have weighed the protection of the possibly affected beneficial uses, and have

concluded that the mitigation measures, both those proposed by DWR and those proposed by CEC staff, if implemented, will protect the quality of the waters in the project area.

BIOLOGICAL RESOURCES

Vegetation - The primary impact on vegetation associated with the proposed project will result from (1) direct disturbance or removal of vegetation during construction and maintenance activities; and (2) aerosol deposition of toxic substances on vegetation or accumulation of these substances in the soil (cooling tower drift). These impacts will result from activities associated with the power plant, transmission lines, and steam fields. They are also of concern because of their cumulative nature over time and over the full Geysers KGRA.

Development of the proposed power plant and its associated steam supply field will result in the loss of at least 22.5 acres of vegetation (DWR, 1978). This includes eight acres for the power plant pad (six acres of mixed evergreen forest and yellow pine forest will become graded surface and about two acres of chaparral will become cut and engineered fill), 2.5 acres for each of three well pads, one of which is located in mixed evergreen forest, one in chaparral, and one in chaparral and grassland (only two are developed at this time), and .25 acres for each of the seven transmission line towers in addition to the acreage for access roads and the steam transmission line corridors (DWR, 1979). The transmission line passes through a series of communities to Unit 17. Beginning at the power plant, lines will traverse mixed evergreen forest, chaparral, and oak woodlands; however, it is not known at this time where the exact route will be.

While impacts resulting from vegetation removal are easily understood and well documented, impacts from toxic substances associated with geothermal development are not. Substances toxic to vegetation such as boron, hydrogen sulfide (H_2S), and salts are contained in geothermal steam. Immediate damage to vegetation can result from cooling tower drift, steam well venting and other releases of steam or steam condensate, or from the accumulation of toxic substances in the soil depending on the concentration of boron in the steam, effectiveness of the cooling tower drift limiting technology, and wind patterns in the area. Cumulative stress and vegetation damage due to cooling tower drift has been documented by PG&E as part of a six year serial photography study. The extent and severity of stress differs at each unit; however, the total extent of stressed vegetation in this area as of 1979 covers 247 acres (six percent) of the total leasehold area of PG&E Units 1-11 (Malloch et al, 1979).

Analysis of boron concentrations in steam samples from Francisco Wells 1-5 and 2-5 indicates levels well below the monthly averages measured in the steam at virtually all other Geysers units (DWR, 1978). The drift elimination specification for the Bottle Rock power plant cooling tower is set at a drift loss rate of 0.002 percent of the circulating water mass (DWR, 1978), which is considerably below specification drift loss rates for existing power plants in the area (.2 percent for PG&E Units 1-10 and .015 percent for PG&E Unit 11 (Malloch et al, 1979)). If the remaining wells necessary to supply the power plant also show low boron concentrations, and the 0.002 percent drift rate is achieved, vegetation stress due to cooling tower drift should be less than the currently operating power plants.

Boggs Lake Natural Area Preserve is located three miles (4.8 km) north of the DWR Bottle Rock project site. The steam stacking emissions or cooling tower drift could directly affect this area with damage from H_2S or boron deposition on the foliage, or indirectly through accumulation of boron in the soil. The latter could also have an impact on Boggs Lake itself if rain runoff carried high concentrations of boron into the lake water. Information on wind directions in this area indicate Boggs Lake could be affected (CEC, 1979), although sufficient information is not available at this time to determine how significant this impact will be.

Some of the unusual vegetation found in the project area that may be directly affected by the project (Figure 0) are the wet meadow near the access road, the St. Helena fawn lily and the lomatium. Both of the developed well pads, the power plant access road, and the Coleman well pad access road border on three sides the best representation of a wet meadow community in the leasehold. This wet meadow is already showing signs of deposition of sediment derived from the Coleman well pad. A spring located in the southern portion of this wet meadow, near the road on the north side of the Coleman well pad, is severely affected by fill from the construction of that road. If corrective action is not taken, the spring will become completely silted in.

The St. Helena fawn lily population lies near a proposed tower pad and the transmission line passes overhead but the construction activities as proposed should not effect this plant population. The impact of power plant construction on the lomatium, located in ravines immediately south of the proposed site, is uncertain and therefore should be carefully monitored during plant site construction to prevent damage to this community.

Species of commercial importance, the Douglas fir, sugar pine, and yellow pine, will be impacted to a limited extent due to removal for power plant site and access road construction. The power plant site will occupy at least four acres of yellow pine forest. These stands are currently of marginal value due to past logging and fire, but with proper management could become harvestable in several decades.

These impacts discussed above, resulting from vegetation removal and cooling tower drift, will have greater significance on a cumulative than on an individual basis. In view of current and proposed geothermal development, 2,008 MW by 1987 (CEC, 1979), there is the potential for losing a substantial amount of vegetative cover in The Geysers KGRA. The significance of the impacts from this development will depend on their location and distribution in The Geysers KGRA and the development, implementation, and effectiveness of mitigation plans.

Wildlife - The primary impacts on the area's wildlife will occur as a result of vegetative loss, disturbance from construction activities, and the release of toxic substances. The loss of any vegetation will necessarily result in the loss of some wildlife. The significance of this impact depends on the type, amount and uniqueness of the vegetative habitat, the animal species present, and the activities for which the habitat is used.

Development in the project area will affect a variety of habitat types, each of which differs in its value to wildlife. Power plant construction will eliminate

both yellow pine forest and mixed chaparral. The wildlife species most likely to be directly affected will be the smaller, more sedentary species such as salamanders, lizards, songbirds, and small mammals. Some individuals of these common, widespread species will be eliminated or displaced. However, due to the large areas of both these habitat types in and around the leasehold, this will not be a significant impact. Opening of chaparral areas for roads, pipelines, well pads, and the power plant will increase "edge" (an area where two vegetation types meet, considered of high value to wildlife) in the area and create areas of grass or low herbaceous cover which will improve the habitat to some extent for the blacktailed deer and seed-eating rodents and birds.

Disturbance to wildlife will also be a result of increased human activity and noise in the area. This will occur at the power plant, steam wells, and roads associated with the project. Some reduction in bird nesting and wildlife use is likely to occur adjacent to areas of high human activity and noise. Species sensitive to this activity, such as gray fox, bobcat, and mountain lion, may entirely avoid the area.

Streams most likely to be affected by increased soil erosion and possible accidental releases of toxic materials from the proposed project will be the east branch of High Valley Creek, High Valley Creek downstream from the east branch, and Kelsey Creek downstream from High Valley Creek. Alder Creek and Kelsey Creek downstream from Alder Creek could be indirectly affected.

Soil erosion and sediment deposition will increase because of vegetation removal and soil disturbance during construction. The proposed power plant site is located on Los Gatos Loam; runoff is rapid to very rapid, and the soil erosion hazard is high to very high (See Soils Impacts and Mitigation).

If large quantities of sediment are allowed to enter the creeks, they can directly affect fish and other aquatic animals by coating their respiratory organs, or indirectly by covering aquatic vegetation, spawning gravels, or food sources. Steele (1977) conducted fishery studies in the Alder Creek drainage and found significantly higher sediment levels in areas adjacent to geothermal operation, as compared to undeveloped areas. Trout populations in areas of high sediment levels were found to be both smaller and in poorer condition than those in nondeveloped areas of Alder Creek. This impact should be insignificant if the mitigation measures identified to control erosion are followed.

Release of toxic material such as steam condensate, reinjection fluids, or drilling wastes into streams can cause loss of fish and aquatic organisms. Accidental spills of these materials causing varying impacts have been recorded on several occasions in the geothermal development area. The extent of their impacts will depend on the amount and kind of material released, the stream into which it is released, and the volume and flow of water present in the stream. Proposed berms built around the power plant and condensate pond should reduce the potential for a damaging spill.

Staff does not expect the project to have a significant impact on the rare peregrine falcon or the protected golden eagle and ringtail. The peregrine falcon and the golden eagle are not common in the project area, and project

activities are not likely to disrupt hunting that may infrequently occur there. The ringtail, which is known to inhabit chaparral areas, should not be significantly affected if present on the site, since the small amount of chaparral habitat (approximately 10 acres) that will be lost is insignificant in view of the extensive chaparral stands remaining in the project area (approximately 150 acres within the leasehold).

Staff does not consider impacts to recreational species from the project to be significant. Deer habitat loss due to power plant construction should not have a significant impact on the deer population because of the large areas of similar vegetation which will remain undisturbed. The noise associated with construction may temporarily reduce deer usage of adjacent habitat; however, operation of the power plant should have no adverse effects. Approximately six acres of western gray squirrel, mourning dove and quail habitat will be lost due to power plant construction. DWR, however, proposes to improve wildlife habitats in the area which, together with the creation of "edge" will help compensate for the habitat lost. Hunting will be prohibited in developed areas of the leasehold.

Direct impacts to riparian habitat, a spring, and other areas of surface waters have resulted from steamfield development and may increase due to the power plant construction and operation. The north embankment of the power plant foundation pad will end at the edge of a wet meadow-grassland community, creating a potential for sediment deposition on the wet meadow. A road on the north side of the Coleman well pad has already seriously impacted a spring and threatens the wet meadow community which is located between the two developed well pads. These impacts can be reduced to insignificant levels with appropriate mitigation measures.

A riparian corridor is located close to the power plant site on the west and south. Cooling tower drift may cause indirect impacts to the vegetation of this corridor. The exact nature of these impacts are not well known at this time. PG&E is now at various stages in the process of planning and carrying out drift studies (which will be completed in 1985) in different vegetation communities at several of their power plant sites to determine the impacts of drift. The results of their studies should be useful to the entire Geysers KGRA development.

Chaparral, which covers 40 percent of the leasehold, is a fire adapted vegetation type. Fires started by natural events have always been an integral and essential part of the chaparral's successional cycle. Nevertheless, the potential for wildfire is increased due to greater activity in the project vicinity. A wildfire can cause severe temporary damage to the wildlife and vegetation of the area. However, the high probability of early detection, the presence of many firebreaks (roads, steamline transmission corridors, and other cleared areas), easier access throughout the area (many new roads) and the availability of trucks to transport water should minimize this potential threat.

With the appropriate mitigation, most of the wildlife impacts identified for the DWR Bottle Rock project should be insignificant. However, it is not possible to

completely offset the loss of the yellow pine forest due to construction of the power plant. In addition, full development of The Geysers KGRA is likely to result in a significant cumulative effect on the fish and wildlife of the region. Combined habitat losses, increased human activity and disturbance, increased soil erosion and sediment deposition, decreased air quality, accumulated toxic substances from cooling tower or steam wells, improved access, and greater potential for accidental spills will result in a loss of numbers and quality of wildlife and fisheries. Most of these impacts cannot be quantified or evaluated at this time because of incomplete data on the long term nature of the impacts. However, it is certain that the accumulation of many insignificant impacts over a long period of time and over the entire Geysers KGRA will result in significant biological effects unless proper planning and mitigation are agreed to and implemented by all groups involved.

Mitigation Measures

Development of the proposed project could adversely affect wildlife, fisheries and vegetation. The extent of these impacts will depend on the implementation of effective mitigation measures. Specific biological resource mitigation has been identified in the exploratory well EIR (Neilson, 1975), the Bottle Rock NOI (DWR, 1978), the steamfield EIR (Neilson, 1979) and the Bottle Rock AFC (DWR, 1979). It does not appear that all of the measures identified in the steamfield EIR and exploratory well EIR have been implemented. These measures and those associated with the pipelines, transmission lines, and the power plant should be carefully monitored. The following composite mitigation measures have been proposed in the exploratory well EIR, the steamfield EIR, the NOI and the AFC, and staff recommends that they be implemented as part of the project:

- Limit clearing, grading or other construction activities to the smallest area necessary in order to minimize disturbance of vegetation and wildlife habitat (Neilson, 1975, 1979; DWR, 1978).

- Design access roads to make best use of existing roads and trails, thereby further reducing new disturbance (Neilson 1975, 1979).

- Avoid construction of roads and pads on unstable soils and landslides (Neilson 1979; DWR, 1978).

- Provide an adequate buffer zone around riparian zones, areas of critical concern, and natural drainage channels to protect them from sedimentation arising from nearby construction activities (Neilson, 1975, 1979).

- Hydromulch or otherwise protect exposed soils from erosion (Neilson 1975, 1979; DWR, 1978, 1979).

- Revegetation of exposed soils should be done using native vegetation of high wildlife value whenever feasible (Neilson, 1975, 1979; DWR 1978, 1979).

- Construct and maintain sediment retention basins at appropriate sites (Neilson, 1979; DWR 1978, 1979).

Provide necessary drainage control on all areas to prevent erosion (Neilson 1975, 1979; DWR 1978).

- Build berms at the power plant site, the reinjection pad, the cooling tower basin and the stretford unit to contain accidental discharges or spills (Neilson 1979; DWR 1978, 1979).

- Provide 50 nesting boxes each for western gray squirrels and songbirds and 50 nesting cones for mourning doves to offset the loss of yellow pine forest habitat due to power plant and road construction (Neilson 1978; DWR, 1979).

- Use brush piles to provide cover for quail, ground-feeding songbirds, and small mammals (Neilson 1979; DWR 1979).

- Use prescribed burning of mature chaparral in patches of about five acres on a rotating basis in order to help maintain maximum forage production and nutritional value. Reseed these areas with mixtures of forbs and grasses appropriate to specific soil and microclimate conditions. These measures should be continued on a regular basis throughout the life of the project (Neilson, 1979; DWR 1979).

- Construct two quail guzzlers in chaparral habitat to provide water through the dry season for birds and other wildlife (Neilson, 1979; DWR, 1979).

- Carry out studies to monitor songbirds, western gray squirrels, and mourning dove nest structure usage and population levels (Neilson, 1979; DWR, 1979).

- Monitor deer use of the managed chaparral areas (Neilson, 1979; DWR, 1979).

- Monitor small mammal usage of the managed chaparral areas (Neilson 1979; DWR, 1979).

In addition to these measures, staff recommends:

- The integrity of the springs in the meadow between the Coleman and Franciscan well pads should be fully protected. The impacts already incurred should be repaired and/or the second road to the pad should be removed. The exact method of construction and location of transmission towers and corridor is not known at this time; however, CEC staff expects this information soon. When staff receives the information it will review the adequacy of the proposed mitigation measures.

- In order to identify and mitigate any impacts that may occur from cooling tower drift, DWR should undertake or participate in a biological monitoring program. This program should identify immediate and cumulative direct and indirect impacts to vegetation or wildlife resulting from boron or heavy metal deposition. The specifics of this program have not yet been formulated but it will be reviewed by the CDFG and CEC staff for adequacy prior to the power plant certification.

- o In the case that new information becomes available during the life of the project indicating significant adverse impacts are taking place as a result of this project, the staff of the CEC will work in cooperation with DWR and CDFG in determining if mitigation is required, and if so, in developing and implementing the measures.

- o The St. Helena Fawn Lily (Erythronium helenae) community should be protected from adverse impact resulting from transmission line construction. This community should be identified by a competent botanist and marked in order to alert the contractor of its location.

- o Precautions should be taken in the area south of the proposed power plant site where lomatium (Lomatium repostum) grows, in order to avoid adverse impact to the community during construction and operation of the plant. This community should be identified by a competent botanist and marked in order to alert the contractor of its location.

- o Further development may take place in the leasehold after site certification. The third well pad along with an access road and steam transmission line may be constructed. The CEC staff should be included in review of any specific proposals for future development on the Francisco leasehold, prior to that development.

The Department of Water Resources submitted a conceptual mitigation plan in the AFC filing, which will be adequate to compensate for Biological Resource losses if implemented correctly. This conceptual mitigation plan was developed cooperatively by the California Department of Fish and Game and the DWR. A more detailed mitigation and implementation plan has been requested of DWR and after reception it will be reviewed for adequacy by the CEC staff prior to certification of the power plant.

HEALTH AND SAFETY

PUBLIC HEALTH

The potential for public health impacts from the Bottle Rock power plant depends on the ambient air concentrations of pollutants to which the population would be exposed, duration of exposure, and toxicity of the pollutants (See Appendix B). These ambient air concentrations consist of existing levels plus the increment added by the proposed project. The Bottle Rock power plant will emit and increase existing concentrations of hydrogen sulfide, radon-222, ammonia, total suspended particulates, mercury, arsenic, and boron. In addition, Bottle Rock power plant emissions may increase levels of sulfur dioxide and sulfates.

Standards

Table 14 lists ambient air quality standards for regulated pollutants, and Table 15 lists values for assessing potential public health impacts from unregulated pollutants in ambient air.

For certain geothermal contaminants, there are both occupational exposure and ambient air quality standards. Occupational standards are intended to protect generally healthy workers exposed to certain pollutants for limited times (e.g., work hours), often under controlled conditions. Ambient air quality standards are generally intended to protect a more diverse population containing potentially sensitive individuals (e.g., the very young and old, the acutely or chronically ill, etc.) from longer term exposure. Both types of standards are based on concern for human health, but they often provide different levels of protection. Typically, ambient air quality standards are more stringent than necessary for application in working environments, while occupational exposure standards may only provide a rough guide for evaluating the significance of ambient air quality impacts for the general public. An appropriate ambient air quality standard for a given pollutant may be several orders of magnitude lower (more restrictive) than an occupational exposure standard for the same pollutant.

Since ambient air quality standards are based at least in part on public health protection, CEC staff believes that compliance with the standards should be adequate protection of Public Health. The absence of an ambient air standard to protect public health from a given pollutant, however, does not necessarily mean that the pollutant poses no threat to human health. Rather, such absence may reflect more a lack of sufficiently reliable data upon which to base a legal standard, or the considerable time required by the rulemaking procedures to establish standards, than a lack of need or concern. For example, there is no adopted ambient air quality standard for arsenic. Yet arsenic and certain arsenic compounds are known toxicants and carcinogens.

The 1977 Amendments to the Clean Air Act direct the Federal EPA to determine the health risk posed by certain unregulated pollutants, including arsenic, and if a potential danger to public health exists, establish criteria and regulations for their control. To date, the EPA has not adopted regulations or standards for many potentially harmful power plant emissions. In the interim, the Commission should be concerned about emissions from thermal power plants such as arsenic and other unregulated pollutants, which are generally known to be or suspected of being harmful to human health.

TABLE 14

Ambient Air Quality Standards
Regulated Pollutants

Pollutant	Averaging Time	California Standard	Primary Federal Standard
Carbon Monoxide	12 hour	10 ppm ($11\ mg/m^3$)	—
	8 hour	—	9 ppm ($10\ mg/m^3$)
	1 hour	40 ppm ($46\ mg/m^3$)	35 ppm ($40\ mg/m^3$)
Hydrogen Sulfide	1 hour	0.03 ppm ($42\ \mu g/m^3$)	—
Non-Methane Hydrocarbons	3 hour (6–9 a.m.)	—	$160\ \mu g/m^3$ (0.24 ppm)
Lead	30 day	$1.5\ \mu g/m^3$	$1.5\ \mu g/m^3$ (quarterly average)
Nitrogen Dioxide	Annual Average	—	0.05 ppm ($100\ \mu g/m^3$)
	1 hour	0.25 ppm ($470\ \mu g/m^3$)	—
Oxidant (Ozone)	1 hour	0.10 ppm ($200\ \mu g/m^3$)	0.12 ppm ($240\ \mu g/m^3$)
Sulfur Dioxide	Annual Average	—	0.03 ppm ($80\ \mu g/m^3$)
	24 hour	0.05 ppm ($131\ \mu g/m^3$)*	0.14 ppm ($365\ \mu g/m^3$)
	1 hour	0.5 ppm ($1310\ \mu g/m^3$)	—
Suspended Particulate Matter	Annual Geometric Mean	$60\ \mu g/m^3$	$75\ \mu g/m^3$
	24 hour	$100\ \mu g/m^3$	$260\ \mu g/m^3$
Sulfates	24 hour	$25\ \mu g/m^3$	—
Radon-222	Annual Average	3 pCi/l**	—

*When standards for total suspended particulates of oxidant are being exceeded.
**Above natural background, at point of release to the environment.

TABLE 15

Values for Assessing Potential Public Health Impacts
From Non-Regulated Pollutants in Ambient Air

Pollutant	Type of Value	Source	Concentration	Averaging Time
Ammonia	California Occupational Standard	Cal/OSHA	25 ppm	8 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.06 ppm (43 ug/m^3)	annual average*
	Foreign Ambient Air Quality Standards	Russia & East European Countries	0.14 - 0.71 ppm	24 hours
Arsenic	Suggested Occupational Standard	NIOSH	2.0 ug/m^3	15 minutes
	Suggested Threshold Limit Value	ACGIH	50 ug/m^3	8 hours
	Presumed Safe Level	MTR - 6401	5.9 ug/m^3	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.005 ug/m^3	annual average*
Boron	Presumed Safe Level	MTR - 6401	50 ug/m^3	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	7.4 ug/m^3	annual average*
	California Occupational Standard	Cal/OSHA	10 mg/m^3 boron oxide	8 hours
Mercury	Presumed Safe Level	MTR - 6401	0.8 ug/m^3	24 hours
	Suggested Ambient Level Goal (based on toxicity)	EPA-600/7-77-136	0.1 ug/m^3	annual average*
	Suggested Ambient Level Goal (based on carcinogenic potential)	EPA-600/7-77-136	0.01 ug/m^3	annual average*
	California Occupational Standard	Cal/OSHA	50 ug/m^3	8 hours
Vanadium	Presumed Safe Level	MTR - 6401	6.8 ug/m^3	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	1.2 ug/m^3	annual average*
	Suggested Threshold Limit Value	ACGIH	0.5 mg/m^3 (dust) 0.05 mg/m^3 (fume)	8 hours
	Calif. Occupational Standard	Cal/OSHA	0.5 mg/m^3 (dust) 0.1 mg/m^3 (mist)	8 hours
ADA (anthraquinone disulfonic acid)	Suggested Ambient Level Goal	To be published by Oct 1979**	260 ug/m^3	annual average*
Hydrogen Peroxide	Suggested Threshold Limit Value	ACGIH	1 ppm	8 hours
	Calif. Occupational Standard		1 ppm	8 hours
Iron	Suggested Threshold Limit Value	ACGIH	10.0 mg/m^3 (iron oxide fumes) 1.0 mg/m^3 (iron salts) 0.08 mg/m^3 (iron pentacarbonyl)	8 hours
	Calif. Occupational Standard	Cal/OSHA	10.0 mg/m^3	8 hours

*Although an averaging time for Suggested Ambient Level Goals is not stated within the document, EPA-600/7-77-136 the authors have indicated that these goals are most applicable to annual average concentrations.

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Abbreviations:
- Cal/OSHA California Occupational Safety and Health Administration
- NIOSH National Institute for Occupational Safety and Health
- ACGIH American Conference of Governmental and Industrial Hygienists

EPA-600/7-77-136 Multimedia Environmental Goals for Environmental Assessment, J. V. Cleland and G. L. Kingsbury, U.S. EPA, Nov. 1977.

MTR-6401 Proposed Safe Ambient Air Quality Levels for Selected Potentially Hazardous Pollutants, G. L. Wilcox, The MITRE Corporation, May 1973.

For those pollutants which are not subject to adopted ambient air quality standards, several agencies and research groups have suggested what they consider to be safe levels or maximum permissible ambient air concentrations of certain pollutants. Methodologies and criteria for determining these levels vary, often resulting in quite different values. Neither CEC nor other state or federal agencies have adopted any of these suggested levels as standards.

Staff analysis therefore presents the range of those values suggested by agencies and research groups as a guide for assessing the potential for public health impacts.

Most available air quality data for The Geysers area are expressed in terms of maximum hourly average pollutant concentrations. In order to make comparisons with suggested safe annual average concentrations, CEC staff has assumed, as a worst case, that annual average pollutant concentrations are one-tenth the maximum hourly averages. This assumption is based on historical H_2S data for The Geysers area (SRI, 1978). The data showed that, depending upon the location, maximum hourly average H_2S concentrations ranged from 11, to greater than 48 times the annual average H_2S concentrations in 1976 and 1977. It is assumed that the relationship between maximum hourly average and annual average concentrations are similar for other geothermal pollutants.

Air Quality Status

The public health analyses and conclusions contained in this document are based on the results of the air quality analyses conducted by DWR. At this time the Lake County Air Pollution Control Officer (LCAPCO) has not acknowledged the acceptability of the DWR's air quality analyses. Additional air quality information has been requested of DWR by the LCAPCO and CEC staff. Additional data submittals and air quality analysis by the LCAPCO could substantially alter these public health analyses and conclusions.

Hydrogen Sulfide H_2S - DWR has supplied an analysis of the air quality impact of Bottle Rock hydrogen sulfide emissions (DWR, 1979). This analysis indicates that Bottle Rock H_2S emissions of 13.2 pounds per hour would contribute a maximum of 10 parts per billion (ppb) H_2S to background levels. This contribution from Bottle Rock power plant alone is below the state ambient air quality standard of 0.03 parts per million (ppm) H_2S.

The acceptability of the DWR's air quality analyses for normal power plant operation and for steam staking conditions has not been acknowledged by the Lake County Air Pollution Control Officer (LCAPCO). (For more information, see Air Quality Impacts Section.)

Based on results of the Cobb Valley Tracer Study, steam stacking conditions at Bottle Rock may result in numerous violations of the ambient air quality standard for H_2S. CEC staff estimates that stacking 360 pounds of H_2S per hour during certain meteorological conditions may result in ambient H_2S concentrations at Pine Grove in excess of 1.4 ppm above background levels (see Air Quality Impacts Section). DWR believes that the tracer study test which leads to this estimated maximum ambient value was incorrectly conducted and therefore, the test result is invalid. DWR has indicated that no more than 0.75 ppb

ambient H_2S would result per pound H_2S emitted. Based on DWR's interpretation of the tracer study results, a maximum ambient concentration of 0.27 ppm H_2S would result from stacking 360 lb/hr H_2S. Staff anticipates resolution of this issue during the AFC process.

As a mitigation measure, McCulloch's control valves will be capable of reducing steam flow by 50 percent within 30 minutes of an unscheduled outage. A reduction of 50 percent would reduce emissions to 180 pounds of H_2S per hour, resulting in an estimated maximum ambient H_2S concentration of 0.7 ppm above background levels. Based on DWR's assumptions this value would be 0.135 ppm H_2S.

To further control H_2S emissions during stacking DWR has indicated that a 96 percent efficient chemical abatement system will be used beginning during the second hour of steam stacking. To date no test data has been presented by DWR to demonstrate the capability of the chemical abatement system to achieve the levels of control required by the Energy Commission (see Air Quality Mitigation Section).

Maximum estimated ambient hydrogen sulfide concentrations resulting from steam stacking during an unscheduled outage at the Bottle Rock power plant are as follows:

	Assumed H_2S Abatement	Maximum Contribution to Ambient H_2S Concentrations	
		Based On Tracer Study	Based on DWR Assumptions
First half hour	0%	1.4 ppm	0.27 ppm
Second half hour	50%	0.7 ppm	0.135 ppm
Second hour	83%	0.238 ppm*	0.046 ppm
	96%	0.056 ppm*	0.0108 ppm

*Assuming abatement achievable incoming steam H_2S component estimated at 350 ppm.

Maximum ambient hydrogen sulfide concentrations resulting from unscheduled outage at Bottle Rock power plant are much greater than 0.03 ppm, the state ambient air quality standard. The residents of Pine Grove and other nearby populated areas may be adversely impacted by the odor and possibly by the toxic effects of hydrogen sulfide.

Hydrogen sulfide gas has a characteristic odor of rotten eggs which can be detected at low concentrations. The odor threshold varies with individual sensitivity; thresholds have been reported as high as 0.14 ppm and as low as 0.00047 (Walton and Simmons, 1978).

Based on this information, it could be expected that the odor of H_2S would be noticeable to some people at H_2S levels below the state standards, and to almost all individuals exposed to 0.14 ppm H_2S or greater. Hydrogen sulfide concentrations of 0.14 ppm could be equaled or exceeded during at least the first half of an unscheduled outage. Local agencies might receive an increased number of odor complaints.

Hydrogen sulfide in concentrations above the state occupational standard of 10 ppm (8 hour average) can cause irritation of the eyes and respiratory tract, damage to the lungs and loss of consciousness. At levels below 10 ppm H_2S may induce decreased corneal reflex, nausea, insomnia, headaches, loss of sleep, and other symptoms (Table B-1) (Walton and Simmons 1978).

There have been relatively few studies of adverse health effects from exposure to H_2S at low concentrations (less than 0.1 ppm) such as those measured in populated areas around The Geysers KGRA. Because of the lack of studies and questions concerning the validity of results from some of those studies, there is controversy as to the potential for adverse effects from H_2S at low concentrations.

Some experts do not believe that exposure to concentrations below one ppm adversely affects human health (Simmons, 1979). The State of Montana has proposed an H_2S standard based on reported health effects at 0.3 ppm (Montana 1979). The lowest concentrations accepted by other experts as inducing adverse health effects is 0.08 ppm (Illinois Institute for Environmental Quality, 1974), almost three times greater than the California ambient air quality standard for H_2S. Nausea, fatigue, loss of appetite, dizziness, blurred vision and increased incidence of mental depression have been reported to result from chronic exposure to this concentration (ibid). There have been studies which report adverse health effects at levels below 0.08 ppm, the validity of these low level studies, however, has been questioned (LBL, 1977; Walton and Simmons, 1978). There is reason to believe exposure to H_2S may be more harmful to certain groups of individuals than to the general population. These H_2S sensitive group include infants, individuals with anemia, eye or respiratory problems, schizoid or paranoid tendencies and those who have recently consumed alcohol (Illinois Institute for Environmental Quality, 1974; Walton and Simmons, 1978).

Maximum concentrations of hydrogen sulfide in populated areas resulting from at least the first hour of an unscheduled outage of the Bottle Rock power plant are within the range of concentrations attributed by some experts with causing adverse health effects. These effects include nausea, insomnia, shortness of breath and headaches (see Table B-1).

The potential for adverse health effects from exposure to air pollutants is dependent upon duration of exposure as well as pollutant concentrations. In those studies which reported adverse health effects associated with low levels of hydrogen sulfide, subjects were exposed to fluctuating H_2S concentrations for at least three days. The adverse health effects reported in these studies may not necessarily result from exposures of shorter duration.

Mitigation Measures

Mitigation measures to reduce the impact of Bottle Rock power plant emissions on ambient air quality are described in the Air Quality Mitigation Section of this EIR. These measures consist of: (1) reducing steam flow by 50 percent within 30 minutes of an unscheduled outage, and (2) further controlling H_2S by a chemical abatement system beginning the second hour of stacking. These two measures were considered in the Public Health impacts section. Although ambient hydrogen sulfide concentrations will be reduced as a result of the measures, the

levels resulting from the first hour of an unscheduled outage may still be well above the state ambient air quality standard, and the residents of Pine Grove and nearby populated areas may potentially be impacted by the odor and toxic effects of hydrogen sulfide. (Due to the low odor threshold, the odor of H_2S may be noticeable to some individuals at concentrations below the state H_2S standard.)

The ambient H_2S concentrations resulting from the second hour of an unscheduled outage at Bottle Rock depends upon the degree of efficiency of the chemical abatement system. To date no test data has been presented by DWR to demonstrate the capability of this system to achieve the levels of control required by the Energy Commission (see Air Quality Mitigation Section). If the abatement efficiency is 96 percent or greater, the contribution of Bottle Rock emissions to ambient H_2S levels based on DWR's assumptions would be below the state H_2S standard, and below the range of levels reported to adversely impact health.

Total Suspended Particulates, Sulfur Dioxide, Carbon Monoxide, Nitrogen Dioxide, Oxidant, Lead and Nonmethane Hydrocarbons - The LCAPCO has not determined at this time if the Bottle Rock power plant will prevent the attainment, interfere with the maintenance, or cause a violation of the ambient air quality standards for these pollutants.

CEC staff believes that if the ambient air quality standards are not violated, the public should be sufficiently protected from adverse health impacts associated with inhalation of these pollutants.

Radon-222 - Due to steam source similarities, Bottle Rock power plant ^{222}Rn emissions probably will not differ substantially from those monitored at PG&E Units 1 through 11. Results of monitoring programs for Units 1-11 indicate that ^{222}Rn emissions meet applicable standards. Bottle Rock power plant ^{222}Rn emissions, therefore, probably will not be in excess of applicable standards, and probably will not adversely impact public health.

Ammonia - If the steam supply for the Bottle Rock power plant contains 194 parts per million (ppm) ammonia, (the average concentration measures in steam from 61 wells at The Geysers) the maximum contribution to ambient air ammonia concentrations in populated areas would be 0.291 $\mu g/m^3$ (one-hour average), based on DWR's interpretation of the tracer study results. This analysis assumes all ammonia entering the plant would be emitted to the atmosphere through the cooling tower and dispersed as a gas.

The incremental increase in emissions from the Bottle Rock power plant over the maximum ambient ammonia concentration defined by limited historical data (see Public Health Setting) would result in a maximum hourly average concentration of approximately 0.554 ppm. Assuming as a worst case that the annual average concentration is one-tenth the maximum hourly average concentration, the corresponding annual average ammonia concentrations would be 0.0554 ppm, which is slightly less than the most stringent suggested safe level of 0.06 ppm (annual average).

Based on analysis of available data, staff concludes that ammonia emissions from the Bottle Rock project would not increase background ammonia concentrations

above suggested safe levels, and public health should not be adversely impacted.

Arsenic - If the steam supply for Bottle Rock contains 0.019 ppm arsenic, the average concentration measured in steam from 61 wells at The Geysers, the maximum contribution to ambient air arsenic concentrations in populated areas would be approximately 0.02 $\mu g/m^3$ (one-hour average) based on DWR's interpretation of the tracer study results. This analysis assumes that all arsenic entering the plant is emitted to the atmosphere through the cooling tower and disperses as a gas according to results of the tracer study. The incremental increase in emissions from the proposed project, over the maximum background arsenic concentrations defined by limited historical data, would result in a maximum hourly average concentration of approximately 0.064 $\mu g/m^3$.

Assuming as a worst case that the annual average concentration is one-tenth the maximum hourly average concentration, the corresponding maximum annual average arsenic concentration would be 0.0064 $\mu g/m^3$. This estimated maximum concentration is slightly above the most stringent suggested safe level, the Multimedia Environmental Goal of 0.005 $\mu g/m^3$ arsenic in air. However, it falls well below other suggested safe levels (see Table 15).

Studies of arsenic flow through existing geothermal power plants at The Geysers KGRA indicates that most of the incoming arsenic is reinjected with excess condensate, and only a small percent is released to the atmosphere (Rosen, 1978). Therefore, the assumption that all incoming arsenic is released to the atmosphere would be incorrect and the actual annual average arsenic concentration would be below 0.0064 $\mu g/m^3$.

Based on analysis of available data, staff concludes that arsenic emissions from the Bottle Rock project might possibly increase background arsenic concentrations slightly above the most stringent suggested safe levels, but below other suggested safe levels. This does not necessarily mean that the public will be adversely impacted; however, it does indicate a need for periodic steam analysis and evaluation of background arsenic concentrations in ambient air (see Mitigation Section).

Mercury - If the steam supply for the Bottle Rock power plant contains 0.005 ppm mercury, the average concentration measured in steam from 61 wells at The Geysers KGRA, the maximum contribution to ambient air mercury concentrations in populated areas would be 0.0053 $\mu g/m^3$ (one-hour average) based on DWR's interpretation of the tracer study results.

The maximum hourly average concentration, based on Bottle Rock's contribution and limited historical data (see Public Health Setting) is 0.4053 $\mu g/m^3$. Assuming as a worst case that the annual average concentration is one-tenth the maximum hourly average concentration, the corresponding maximum annual average mercury concentration would be 0.04053 $\mu g/m^3$. This estimated maximum concentration is less than the most stringent safe level of 0.1 $\mu g/m^3$ based on toxic effects of mercury suggested by EPA-600/7-77-136.

One suggested safe level, the Multimedia Environmental Goal for organic mercury compounds in ambient air, is 0.01 $\mu g/m^3$, based on the carcinogenic potential of mercury compounds. Analysis of mercury in cooling tower exhaust indicates that mercury at The Geysers is primarily inorganic mercury (Robertson, 1977).

CEC staff believes that the suggested level for mercury based on toxicity is probably more applicable than the suggested level based on carcinogenic potential when comparing project emissions to ambient mercury concentrations at The Geysers KGRA.

Based on analysis of available data, staff concludes that mercury emissions from the Bottle Rock project would not increase background mercury concentrations above appropriate suggested safe levels, and public health should not be adversely impacted.

Boron - If the steam supply for the Bottle Rock power plant contains 16 ppm boron, (the average concentration measured in steam from 61 wells at The Geysers), the maximum contribution to ambient air boron concentrations in populated areas would be approximately 16.8 $\mu g/m^3$ (one-hour average). This analysis assumes that all boron entering the plant is emitted to the atmosphere through the cooling tower and disperses as a gas according to DWR's interpretation of the tracer study results.

Assuming as a worse case that the annual average concentration is one-tenth the maximum hourly average concentration, the corresponding maximum annual average boron concentration would be 1.68 $\mu g/m^3$. This value is below the most stringent suggested safe level for boron in air. There is no available data indicating existing ambient air boron concentrations in the vicinity of The Geysers KGRA.

Based on analysis of available data, staff concludes that Bottle Rock power plant boron emissions should not adversely impact public health.

Emissions from Hydrogen Sulfide Abatement System

DWR has proposed to abate hydrogen sulfide emissions from the proposed project with a surface condenser, a Stretford System, and a secondary condensate treatment system of hydrogen peroxide and iron catalyst. The Stretford System chemically treats noncondensible gases; the hydrogen peroxide/iron catalyst system injects chemicals into steam condensate. A portion of these introduced chemicals will be released to the atmosphere at the Stretford System cooling tower or at power plant cooling towers. Furthermore, H_2S abatement processes may result in the formation of other compounds, such as sulfates, which can also be emitted.

Hydrogen sulfide abatement systems are not expected to reduce emission rates of any pollutant besides H_2S.

Table 16 lists DWR's estimated Stretford system cooling tower emissions.

TABLE 16

STRETFORD SYSTEM COOLING TOWER EMISSIONS

H_2O	75%	4.5 lb/hr
ADA	0.1%	0.006 lb/hr
Vanasol	0.3%	0.018 lb/hr
$NaHCO_3$ Na_2SO_4 $Na_2S_2O_3$	24.6%	1.5 lb/hr

SOURCE: DWR, 1979.

Table 17 below presents maximum resultant ambient concentrations if these emissions disperse in air in a manner similar to DWR's estimates for H_2S. Since these emissions will be from the Stretford System cooling tower, instead of the power plant cooling tower, application of the tracer study to these emissions does not produce accurate estimates. However, in light of the very small resultant ambient concentrations, as compared to standards and suggested safe levels, it appears that public health should not be adversely impacted by The Bottle Rock Power Plant Stretford System air emissions.

TABLE 17

Estimated Maximum Ambient Air Concentrations
Of Stretford System Emissions

Anthraquinone Disulfonic Acid	0.0063 g/m^3
Vanadium	0.0189 g/m^3
Sodium Bicarbonate Sodium Sulfate Sodium Thiosulfate	1.575 g/m^3

SOURCE: CEC Staff Analysis.

Cumulative Impacts

Future development at The Geysers will increase the total quantity of pollutants emitted into the atmosphere and may increase ambient pollutant concentrations locally and possibly regionally. The Bottle Rock power plant will contribute to the cumulative impacts of total geothermal development.

Hydrogen Sulfide - Further development of geothermal resources at The Geysers will increase the quantity of hydrogen sulfide emitted into the atmosphere, resulting in an increase in ambient H_2S concentrations in nearby population areas. However, the Northern Sonoma County Air Pollution Control District has adopted regulations for retrofit H_2S abatement at existing units, which will reduce H_2S emissions at The Geysers KGRA.

Assuming the California ambient air quality standard for H_2S is not violated, the public should not be exposed to H_2S concentrations of 0.03 or greater. However, existing hydrogen sulfide concentrations in populated areas near The Geysers KGRA have occasionally been measured found to be in violation of the standard with only 12 units on line. Unless compliance with the standard is enforced, even greater and more frequent violations could result from future development. Although it is not known at this time if adverse health effects result from exposure to low levels of H_2S, it can be inferred that increasing H_2S concentrations will increase the possiblity of adverse health impacts (i.e., nausea, dizziness, headaches, suffocation). (Appendix B, Table B-1).

Radon-222 - Further development of geothermal resources at The Geysers will increase the quantity of radon-222 and its daughter products released into the atmosphere, resulting in a slight increase in ambient radionuclide concentrations in nearby populated areas. High concentrations of radon-222 are known to cause cancer and genetic abnormalities. However, if Bottle Rock and future facilities are in compliance with the California Department of Health Services (DOHS) radon-222 effluent standards, the public should not be exposed to greater than 3 picocuries/liters (3 pCi/l) of ^{222}Rn above natural background radiation. DWR will be required to monitor radon-222 concentrations in incoming steam, as specified by DOHS, to ensure compliance with state ^{222}Rn standards.

Ammonia - Operation of Bottle Rock and future power plant units at The Geysers KGRA will increase the quantity of ammonia concentrations in nearby populated areas. At this time it is not possible to estimate the resultant ambient concentrations; therefore, it is not possible to determine if public health will be adversely affected by cumulative emissions. High ammonia concentration may cause eye, respiratory, and skin irritations. The potential for adverse health impacts must be assessed for each facility proposed in the future in relation to the existing and planned facilities.

Trace Elements - Operation of Bottle Rock and future power plant units at The Geysers KGRA will increase the quantity of trace elements released into the atmosphere, resulting in a slight increase in ambient trace element concentrations in nearby populated areas. At this time, it is not possible to quantify either the trace element emissions from future power plants, or the resultant ambient concentrations. Mercury in cooling tower exhaust from Bottle Rock and future units at The Geysers KGRA may result in a slight increase in already elevated concentrations in biota (such as fish) in waters in this area. Due to the complexity of the accumulation process, it is not possible to determine the extent to which these emissions might increase environmental and biotic mercury levels. High concentrations of mercury can cause nervous system disorders and birth defects.

Mitigation Measures

Mitigation of health effects or the potential for adverse health effects from inhalation of geothermal pollutants could be achieved by reducing emissions of those pollutants, where possible. (Methods of H_2S abatement are discussed in the "Air Quality" Impact Section.) There are no known feasible technologies for abating emissions of radon-222, ammonia or trace elements from geothermal power plants, although H_2S abatement systems, particularly upstream treatment, may scrub pollutants other than H_2S to some degree.

Monitoring Programs - Staff recommends that DWR be required to conduct monitoring programs for geothermal pollutants. Monitoring alone would not mitigate any potential public health impacts; rather it would assist in determining the impact of the Bottle Rock power plant and geothermal development in general, on ambient pollutant concentrations, and ultimately on public health. Staff of the California Energy Commission (CEC) recommends that DWR be required to conduct or participate in the following monitoring programs:

- Monitoring emissions and ambient concentrations of H_2S should be conducted to ensure continued compliance with applicable regulations and standards to assist in the protection of public health.

- DWR has agreed to monitor concentrations of radon-222 in incoming steam quarterly to ensure continued compliance with state standards (DWR, 1979b).

- CEC staff recommends that DWR be required to measure concentrations of ammonia, mercury, arsenic and boron in incoming steam quarterly. If concentrations are sufficient to result in significant ambient concentrations of these pollutants, DWR should conduct an ambient monitoring program.

- CEC staff recommends that DWR be required to evaluate baseline ambient air concentrations of mercury, arsenic and ammonia in populated areas near Bottle Rock power plant.

These programs are described in detail in Appendix C.

Occupational Health

Geothermal power plants can pose risks to workers' health and safety. These risks are primarily related to toxic and potentially carcinogenic chemical compounds associated with geothermal steam and hydrogen sulfide abatement systems to which workers may be exposed. Such exposures may occur during routine operation, accident or upset conditions, repair and maintenance activities, and process or system modification activities.

Workers may come into contact with many of the potentially toxic and potentially carcinogenic substances (e.g., hydrogen sulfide, ammonia, radon-222, trace elements, and chemicals associated with hydrogen sulfide abatement systems) in geothermal steam, waste streams and during handling of chemicals used in abatement systems or as a result of leaking equipment. Adverse effects of such exposures could include dermatitis, acute chemical poisoning, chronic illnesses and, potentially, cancers after some induction latency period.

General Industry Safety Order 3203 (Subchapter 7 of Chapter 4, California Administrative Code, Title 8) requires employers to have an accident prevention program to reduce or prevent occupational injuries and illnesses, and to conduct periodic inspections to correct unsafe conditions. Employers must comply with California Administrative Code, Title 8, Chapter 4, Group 16 (Articles 107-112) which refers to control of hazardous substances. The California Division of Occupational Safety and Health (DOSH) enforces compliance with state occupational safety and health standards. DOSH must inspect the plant if there is a complaint from an employee. If worker conditions are found to be in violation of an occupational standard, DOSH will determine what corrective actions must be taken. There is generally no means for ensuring that an employer has an adequate accident prevention program until DOSH receives a worker complaint regarding worker health or safety.

CEC staff recommends that DWR be required to request the assistance of the Cal/OSHA Consultation Service in evaluating if the program proposed for the Bottle Rock project is adequate to protect worker health and safety. A letter of concurrence from the Cal/OSHA Consultation Service should be submitted by DWR to the Commission not later than 150 days prior to commencement of operation of the proposed project. The Cal/OSHA Consultation Service has agreed to review the accident prevention program proposed for the Bottle Rock project.

If DWR is unable to obtain the approval of the Cal/OSHA Consultation Service, it should request the Commission to convene a hearing to mediate any disputes regarding development of an adequate accident prevention program. If requested by DWR, the Commission should convene a hearing within thirty days of the receipt of the request, and should issue its decision on the disputed issues within forty-five days of commencement of the hearing.

DWR has agreed to have the Cal/OSHA Consultation Service make recommendations regarding the adequacy of its worker health and safety program (DWR, 1979b).

SAFETY

During the construction and operation of the Bottle Rock project, the health and safety of workers may be affected by:

- o Geothermal emissions from the steam field and the power plant.
- o Potentially damaging noise levels.
- o Potentially toxic chemicals used in the operation and maintenance of the facility.
- o Accidental injury due to structural failure.

Workers will be exposed to possibly hazardous geothermal emissions from steam wells and cooling towers. Worker exposure to airborne pollutants is regulated by California Occupational Safety and Health Administration (Cal/OSHA) occupational health standards (California Administrative Code Title 8). The principal emissions which may affect workers are hydrogen sulfide (H_2S), ammonia (NH_3) and radon-222 (^{222}Rn). The effects of these emissions on human health are described in Appendix B. Due to the low concentrations of trace elements in steam, workers should not be exposed to trace elements in excess of the Cal/OSHA standards.

Exposure to certain levels of noise may have a variety of effects on workers from irritability to actual hearing loss due to prolonged exposure to high noise levels. Workers will be exposed to noise levels in excess of 90 dBA from construction activities such as movement of heavy equipment and excavation blasting. Also, noise levels will exceed 90 dBA during unmuffled steam stacking and normal turbine operation.

Anthraquinone disulfonic acid (ADA) and vanasol (containing vanadium) are used in the operation of the Stretford process (DWR, 1979). Exposure to ADA, when it comes in contact with heated vapor, and vanadium dust can cause mild respiratory tract irritation. There are no current standards for exposure to ADA which is commonly used in the dye industry, and worker exposure limits to vanadium are recommended by American Conference of Government Industrial Hygienists (ACGIH) at 0.5 mg. vanadium dust (V_2O_5) per cubic meter of air (Patty, 1963).

DWR will install a secondary abatement process at Bottle Rock if additional abatement is necessary to comply with H_2S emission standards. Of the secondary abatement systems under consideration, the system which uses a hydrogen peroxide (H_2O_2)/catalyst process appears to be the most feasible at this time (DWR, 1979).

H_2O_2 is a strong oxidizing agent and care must be taken to avoid contamination of the H_2O_2 solution. If contamination occurs, the heat involved in the decomposition process can lead to rupture of the storage vessel even if pressure is vented through safety release valves.

Several types of geologic phenomena could affect the stability of project structures (e.g., buildings, well pads) which, in turn, could have an adverse impact on worker safety. These phenomena are discussed in the Geology Impact Section.

Mitigation Measures

Hydrogen sulfide detection equipment will be used at Bottle Rock (DWR, 1979) and DWR will comply with the Cal/OSHA H_2S standard. Ammonia emissions will be typically less than 12 ppm (DWR, 1979) and will comply with the Cal/OSHA standard of 25 ppm (8-hour time weighted average).

Where noise levels are greater than 90 dBA, DWR will ensure that employees abide by Cal/OSHA regulations for hearing conservation through administrative controls (limiting exposure) and/or the use of noise inhibitors such as hearing protectors (DWR, 1979).

ADA and vanasol, transported to the site as dry powders, are stored in steel drums in a separate chemical storage building adjacent to the Stretford facility. H_2O_2 will be stored on-site in high purity aluminum alloy tanks. Safety precautions for the handling of these corrosive or toxic chemicals are required of DWR workers. DWR's Division of Operations and Maintenance has issued a publication, Safety Rules, outlining safety procedures and instructions for the benefit of their employees and the general public. Bottle Rock employees will be required to wear proper clothing including gloves, aprons, and eye and face shields during the handling of hazardous chemicals. Proper observance of DWR's safety rules should prevent workers from being adversely affected by ADA, vanasol, or H_2O_2.

Holding tanks containing toxic, flammable or hazardous substances or chemicals will be anchored to prevent overturning or sliding during seismic events.

NOISE

The generally accepted criterion for determining the existence of a noise impact is audibility. To determine audibility, the background or ambient noise levels, the noise source projected noise levels and the total content of the noise must be examined. If a source's projected noise level is greater than or equal to the ambient level, it would probably be audible.

The noise standards which are applicable to this project are as follows:

Lake County - Lake County has adopted a noise element to its General Plan. It is the intent of the noise element to limit the ambient outside noise levels at residential receptors to 55 dBA L_{dn}. Adherence to the standards set forth in the noise element is accomplished by setting forth conditions on permits granted by the county on projects or activities which may produce noise. For the purposes of determining a violation of a permit, a source standard is established. For example, at PG&E Unit 13, this source standard value was 75 dBA (L_{eq}) at 200 ft. (61 m). Excluded from this standard are construction activities, such as movement of heavy equipment. Well drilling and production testing are not exempt. Lake County is currently considering a draft noise control ordinance. The standards which this draft ordinance propose, and which could be applicable to this project, are 55 dBA for daytime hours (7:00 a.m. to 10:00 p.m.) and 45 dBA for nighttime hours (10:00 p.m. to 7:00 a.m.) for residences and open space.

State - The applicable state regulations are the Cal-OSHA noise exposure regulations 8 CAC Article 105, General Industrial Safety Orders, and §23130 of the California Vehicle Code which establishes standards for licensed motor vehicles.

Federal - The Occupational Safety and Health Act of 1970 sets forth basically the same regulations as CAl-OSHA. The Environmental Protection Agency (EPA) has identified an L_{dn} of 55 dBA as providing reasonable protection against community annoyance and activity interference due to noise (EPA, 1971).

Construction

During construction, the highest levels of noise will be attributable to large earth-moving equipment and blasting (the noise level for construction activities can range between 75 and 95 dBA at 50 ft. (15 m)). The noise would most likely be discernible outdoors at the nearest receptors (Figure P) whenever the noise levels exceed 85 dBA. Construction activities which cause noise emissions of greater than 85 dBA are temporary and would occur during daylight hours whenever possible. The staff believes that these occurrences will be infrequent, and if they are limited to daylight hours, should not significantly disturb local residents. Construction noise is exempt under the Lake County use permits.

Operation

The plant will be designed and operated in a manner similar to existing geothermal units in The Geysers KGRA. Table 18 indicates the sound levels from typical Geysers generating units. DWR has indicated that they will utilize noise mitigation measures similiar to those that PG&E utilizes on their existing units.

TABLE 18

A-WEIGHTED SOUND LEVELS, dBA,
FROM TYPICAL GEYSERS GENERATING UNITS
IN NORMAL OPERATION AT FULL LOAD

	Noise Source Description	Distance Feet	Sound Level, dBA (Ref. 20 micropascals)
1.	Cooling Tower	5/10	81/85
2.	Outside Turbine/Generator Building	25	70/75
3.	Steam Jet Ejector (SJE)	3/10	88/93
4.	Around Turbine/Generator Unit Inside Building	3/5	92/94
5.	Random Locations on Turbine/ Generator Floor	-	90/94
6.	At Plant Fence Line, Distance From Noise Producing Surfaces	20/70	67/83
7.	Total Unit Noise	500/700	60/65

1-6 Measured values reported in Bush, R.C. 1976. An Overview of PGandE's Audible Noise Measurement Program at the Geysers.

7 Sound levels measured near Unit 11 (9/14/75, 10/5/75, 8/25/76). Source: P. Leitner, unpublished data.

(Source: DWR, 1978)

The nearest sensitive receptors are about 2,000 ft. (606 m) from the plant site. DWR indicated that the actual measured noise levels from PGandE Units 7 and 8, over flat open terrain, were 58 dBA at 500 ft. (152 m) and 37 dBA at 2,000 ft. (606 m) (DWR, 1978b). Those measurements indicated that the noise level dropped approximately 40 dBA between 50 ft. (15 m) and 2,000 ft. (606 m) due to distance atmospheric absorption and ground effects. This data is supported by a semi-empirical noise attenuation curve which is contained in "Plant and Equipment Noise Treatment," (Bush, 1977). This curve has been utilized by the Energy Commission staff in the PGandE Geysers Unit 16 and 17 and NCPA #2 proceedings to estimate noise attenuation. The curve shows that the average or mean expected attenuation between 50 ft. (15 m) and 2,000 ft. (606 m) is 40 dBA.

DWR has also provided data on noise emission levels from PGandE Geysers Unit 15 (55 MW). The noise level at 500 ft. (152 m) from that facility is approximately 55 dBA. DWR plans to design the proposed plant so that the noise emission level will not exceed 60 dBA at 500 ft. (152 m) or 80 dBA at 50 ft. (15 m) (DWR, 1978). DWR proposes that Bottle Rock will use similar mitigation measures as the Unit 15 plant, then it could be expected that emission levels will not exceed 55 dBA at 500 ft. (152 m) rather than 60 dBA at the same distance.

The estimated projected noise levels to the nearest receptors A & B (see Noise Setting section of this EIR) is 35 dBA-40dBA. Based on the above estimates, the noise from the operation of the facility may be audible occasionally at the nearest receptors; however, the noise emission level would comply with all applicable regulations, standards and recommendations. Noise from operation of the facility would not be audible at receptors which are farther in distance than receptors A & B.

Tonal Noise Recommendations - The typical frequency spectrum data for geothermal units in The Geysers KGRA is provided in the Noise Section of the NOI, pages 18-24. The turbine/generator, main transformer and cooling towers will produce low frequency tonalities. A listener would not perceive distinct tones but would rather hear a low level hum. When the ambient noise level in the vicinity of the receptors A and B is lower than 37 dBA, the hum sound may be audible outdoors. The ambient noise levels in the vicinity of receptors A and B are as low as 36 dBA at times. However, the noise levels in the vicinity of those receptors generally is greater than 37 dBA. Under these circumstances, the hum sound would be barely audible and could not be considered an adverse impact. The hum sound would not be audible or barely audible at receptors which are farther away from the plant than receptors A and B.

Cal-OSHA Requirements

Some areas inside the turbine building will have sound levels greater than 90 dBA. DWR states that it will ensure its employees abide by the current provisions of Cal-OSHA for hearing conservation through administrative controls (e.g., limiting exposure) and/or the use of hearing protectors (DWR, 1978). If these measures are implemented, the plant should adequately meet the hearing conservation requirements of Cal-OSHA.

Steam Field Development

When an unscheduled or scheduled power plant outage occurs, it may be necessary to vent all or a portion of steam field production directly to the atmosphere.

TABLE 19

NOISE LEVELS DUE TO GEOTHERMAL DEVELOPMENT
AND OPERATION ACTIVITIES

Activity	Maximum Noise Levels at (50 ft) 15.2 m in dBA	Projected Noise Levels at (0.6 mi) 1000m in dBA
Construction of roads and drill pads	90[c]	45-55
Construction of steam pipelines	90[c]	45-55
Mud drilling	85[a]	40-50
Air drilling (cyclonic muffler)	88[a]	45-55
Air drilling in steam (cyclonic muffler)	90[a]	45-55
Well clean-out (cyclonic muffler)	90[a]	45-55
Production testing (cyclonic muffler portable test muffler)	90[a] 100[a]	45-55 55-65
Shut-in well venting	75[a]	40
Normal field operations	40-70[a]	40
Steam venting at generating unit (rock-filled muffler)	70[b]	40
Starting steam transmission through pipelines (unmuffled well venting)	120[c]	75-85
Changing wellhead master valves (unmuffled well venting)	110[c]	65-75

[a]Based upon measurements by P. Leitner.

[b]Based upon measurements by PG&E and Union Oil.

[c]Estimated from noise measurements.

Source: Nielson, 1977.

Steam venting will normally occur if the forced outage is not expected to last more than three or four days. Mufflers of various designs have been installed by steam suppliers near each of the existing Geysers Power Plant units to control the noise which accompanies large-scale steam venting. Weighted sound levels of 101-103 dBA were measured at 75 feet (23 m) from the steam exit.

Since 1976, commercial mufflers have been replaced by rock mufflers at several of the operating Geysers units. These large rock-filled pits are extremely effective in noise abatement. Sound levels at approximately 50 feet (15 m) range from 70 to 85 dBA at full vent (Witescarver, 1978). Based on a 40 dBA attenuation, the projected noise level utilizing a rock muffler would meet the applicable standards and would result in an acceptable impact. If 40 dBA attenuation were assumed, the projected noise level utilizing a commercial muffler would not meet those standards for the residential receptors as identified in the NOI.

Staff recommends that DWR ensure that the steam supplier utilize rock mufflers because of the potential problems with meeting appropriate noise standards with commercial mufflers and to minimize the noise impacts. Since the noise emission level of the rock muffler would just meet the draft Lake County Noise Ordinance, the Applicant should ensure that the muffler is located to take maximum advantage of natural barriers and site topography.

Noise measurement data is generally lacking for steam field development in the KGRA. The location of all of the steam supply wells that will serve the plant during its lifetime are not known. However, because of the location of the facility, it can be assumed that some wells are within 0.6 miles (.96 km) of a receptor.

The complete list of noise levels from development and steam supply activities for the PG&E Geysers Unit 17 steam field are set forth in the Environmental Impact Report for Union Oil, Unit 17 (December, 1977) (Table 19) and Union Oil's Simplified Noise Model, Unit 17 Geothermal Development Area (March 1973). These noise levels are applicable to the Bottle Rock project. In summary, the projected noise levels at the 0.6 mile (.96 km) range are between 40 and 46 dBA. Some exceptions are: production testing with portable test mufflers (55 dBA), steam transmission line start up via unmuffled well venting (75 dBa), and well-head master valve changes (65 dBA). Unmuffled noise during steam stacking will be approximately 120 dBA at 50 feet (15 m) (DWR, 1978), and muffled stacking noise will be approximately 70 dbA at 50 feet (15 m) (Nielson, 1977). Production testing, unmuffled well venting, and well-head master valve changes are significiant noise sources; however, these activities occur infrequently and can be conducted during daylight hours.

Combined Effects

Combined noise levels from well development and steam field operation generally exceed the levels for plant construction and operation. Cumulative activities will not increase the impact on receptors.

The steam field development of PGandE Geysers Unit 17 and DWR Bottle Rock could have effects, depending upon the development schedule of these two steam fields.

Noise Mitigations Measures

DWR has defined the following mitigation measures which it proposes to control noise emission (DWR, 1978).

The analysis of potential project noise impacts has been based upon the assumption that equipment and operating procedures will be essentially the same as those used for existing Geysers Power Plant units and the following mitigation measures are essentially the same.

1. The steam jet ejector, located on the outside of the turbine/generator building, will have lagging installed on its exterior surface. The lagging will consist of mineral wool and an impervious membrane (aluminum and/or lead jacket).

2. Combined thermal and sound insulation will be installed on the exterior surfaces of the steam turbine to reduce the noise inside the turbine building.

3. The concrete walls and wooden roof of the turbine building will provide an effective barrier to noise propagation to the outside from the electro-mechanical equipment within the building.

4. An enclosed and acoustically insulated office space will be installed within the turbine/generator building.

5. Steam drain lines will be routed back to the condenser so that steam will not be vented to the atmosphere during plant startups.

6. During outage conditions, steam will be vented through a rock-filled muffler installed and operated by the steam supplier. Use of a rock-filled muffler would mitigate the most serious noise impact potential of the project.

7. Equipment suppliers will be encouraged to supply mechanical equipment that produces a sound level no greater than 80 dBA at three to five feet (.9 to 1.5 m) from the boundaries of the device.

8. All project employees and contractors will be required to comply with the current provisions of Cal-OSHA for hearing conservation.

Staff believes that these mitigations are adequate to minimize environmental impacts and no other mitigations are necessary.

TABLE 20

NOISE GLOSSARY

Decibels A-weighted dBA	Sound pressure level weighted in accordance with the "A" scale. A-weighted scale expresses the relative intensity of sounds, similar to the response of the human ear. One dBA represents the faintest audible sound; 50 to 60 dBA represents normal conversation at three to five feet (.9 to 1.5 m).
L_{eq}	Energy equivalent A-weighted sound level over a given time interval.
L_x	X-percent sound level, the A-weighted sound level equaled or exceeded x percent of the time. (e.g., L_{90}, L_{10}, etc.)
L_{dn}	Day-night average sound level - the 24 hour A-weighted equivalent sound level, with a 10 decibel penalty applied to nighttime levels.
CNEL	Community Noise Equivalent Level - A weighted measure of the cumulative noise exposure produced by a series of distinct noise events during three periods of the day. A 10 decibel penalty is applied to the nighttime levels, and a 5 decibel penalty is applied to the evening levels.
"Barely audible"	A term that refers to a noise level that would require a conscious effort to be heard.
Significant noise source	A term that refers to a noise level that would be annoying to the normal person and could cause interference with sleep and conversation.

ENERGY AND MATERIAL RESOURCES

Energy Resources

The impact of the proposed Bottle Rock Power Plant upon the geothermal steam reservoirs is potentially significant. Assuring efficient use of the steam resource would lessen any effect associated with depletion of that resource.

Magma, the heat source, superheats the fractured rock which, in turn, heats water, creating a reservoir of steam beneath the earth's surface - somewhat analogous to a steam boiler. The water recharge rate in The Geysers dry steam field is not known. Reports of pressure readings indicate that there has been a marked pressure loss at shallow zones, and a recognizable pressure loss in the deep zones.

Declining reservoir pressure suggests that water recharge of those steam reservoirs, if any, is at a rate less than the rate of steam production. It is not known if all the many rock fractures which comprise the steam reservoir are interconnected or to what extent. However, if the water recharge rate is less than the steam depletion rate, the pressure in the "boiler" will eventually drop below that required to drive the turbines in the power plants.

DWR predicts at least a 30-year steam supply for Bottle Rock based on proprietary reservoir pressure and production data and proposed geothermal power plant growth in The Geysers KGRA (DWR, 1978). However, the unknown rate of water recharge, the unknown volume of water in the reservoirs sustaining the steam supply, and the unavailability of "proprietary" data on steam pressure decline preclude staff verification of the reliability of the steam supply.

Material Resources

Materials employed for the construction and operation of the power plant, steam wells, and transmission lines would include concrete, steel, aluminum, wood, materials for insulators and insulation, the plant, etc. Energy consumed for construction and operation will include fuels such as diesel and gasoline and electrical energy for lighting and other purposes. The amounts of materials consumed by the proposed Bottle Rock project are minimal.

Mitigation Measures

Every effort must be exercised to maintain maximum productivity of the steam reservoir. These efforts should include analysis of well and reservoir production data, production monitoring and appropriate reservoir engineering.

During power plant shutdowns, venting geothermal steam directly to the atmosphere should be minimized through the use of automatic control valves on individual steam lines and/or cross-over interconnections between other geothermal facilites.

To conserve the steam resource, as well as minimize direct steam emissions to the atmosphere, DWR should consider the possibility of installing two 27 MW turbine generators. (27 MW turbines are currently used in PG&E's Units 3 and 4.) If one unit must be shut down for maintenance or forced outage, the other

unit could continue to operate. This should minimize the need for steam stacking since the incoming steam can be partially throttled back and the rest used to keep one unit in operation.

CULTURAL RESOURCES

PALEONTOLOGY

Potential impacts to paleontological resources within the study area arise as a result of construction of the power plant and related facilities, including cooling towers, power transmission lines, support roads, steam wells and pipelines, administrative offices, service centers, switching stations, and sulfur waste disposal facilities. Excavation is the primary activity that would impact paleontological resources.

Mitigation Measures

Localities of Significance B are specific places where it is known that identifiable radiolaria are present in the cherts. Excavation should be avoided in these areas. If it becomes necessary to disturb these localities, staff recommends that chert samples be collected, and sent to Professor Pessagno of the Sonoma State Geology Department for positive identification and evaluation.

Areas identified as of Significance C (i.e., chert) should be field checked during excavation in areas where construction is proposed. No fossils were discovered within these areas during field study, but some fossiliferous rocks may be discovered during excavation.

Areas identified as Significance D are Franciscan melange units which commonly contain fossiliferous cherts or sedimentary breccia. Outcrops of fossil-bearing chert within the melange have been studied and assigned Significance B. Therefore, if deep excavation [(i.e., greater than 13.2 ft. [4 m)] is required in an area of Significance D, a field check by a geologist should be made after excavation to determine if any fossil-bearing chert has been uncovered.

ETHNOGRAPHY AND ETHNOHISTORY

No ethnographic or ethnohistoric sites of socio-cultural significance were found to be present within the Francisco Unit Leasehold; therefore, no adverse impacts are anticipated.

ARCHAEOLOGY

The five prehistoric and one historic archaeological sites discovered within the Francisco Leasehold could be affected either directly or indirectly if geothermal development were to take place in their vicinity. Direct impacts would result from construction of drill pads, roads, pipe lines, service areas, and similar structures. Indirect impacts would result from changes in drainage patterns and possibly from casual artifact collecting prompted by an increased population in the area.

Mitigation Measures

Staff recommends that all of the archaeological sites identified within the leasehold be avoided and protected from the adverse effects of geothermal development. Specific recommendations follow.

CA-LAK-605 - Since the main road passing through High Valley cuts through the surface of this site, any significant improvement or modification of this road could have an adverse effect. Since the site is currently under consideration for nomination to the National Register of Historic Places, special care should be taken to avoid damage to the site. If no reasonable alternative can be found to a project which would affect the site, staff recommends that DWR and an archaeologist who is knowledgeable about the region consult and develop explicit plans for impact mitigation. Scientific investigation of the site should be considered as an impact mitigation measure. In all cases, for this site and the following, all results should be sent to the CEC and the State Historic Preservation Office.

CA-LAK-607 - This site is situated so that a significant change in drainage patterns could adversely affect the site through erosion. The observed surface material suggested that the major significance of the site is in its being accurately recorded in its biophysical context. If geothermal development were to effect the site, CEC staff recommends that DWR consult with an archaeologist who is knowledgeable about the region and that a program be initiated to (1) ensure that no significant subsurface materials are present; (2) to guarantee that representative archaeological materials are collected from the site; and (3) ensure that collected materials are analyzed and reported.

CA-LAK-608 - This site appears to be primarily a surface feature, i.e., no subsurface artifacts or features exist, any modification of its area would constitute a severe adverse impact because of the fragile nature of the site. If an impact were to occur as a result of development, staff recommends that the same mitigation measures recommended for CA-LAK-605 be initiated. Scientific investigation of the site should be considered as an impact mitigation measure.

CA-LAK-609 - Since this site is a relatively shallow surface phenomenon, it would be highly susceptible to any geothermal resources development in its vicinity. The 1978 observations suggested that construction of a dirt road had damaged the site since its initial discovery in 1975. Further damage should be avoided. If an impact is unavoidable, the mitigation measures recommended for CA-LAK-605 should be initiated.

CA-LAK-620 - This site, too, would be subject to an adverse impact if geothermal resources development occurred in its vicinity. The 1978 observations suggested that, since its discovery in 1975, the site had been affected, along with CA-LAK-609, by construction of a dirt road. Further damage should be avoided. If impact is unavoidable, a consultation process as described for CA-LAK-605 should be initiated, culminating in specific mitigation procedures taking into account the suspected antiquity of the site.

CA-LAK-974 - The historic site complex within the Francisco Unit Leasehold has been documented with respect to its origin, uses, and history (Peri et al, 1978). The site was found to represent land use, economic, and settlement patterns of the first quarter of the twentieth century in Lake County. Although the one remaining building of the site complex does not retain sufficient structural integrity to convey the character of that time period, the site complex as a whole does retain archaeological integrity and has potential for revealing additional information regarding domestic life during its period of use.

Staff therefore, recommends that the complex be avoided by activities associated with geothermal development. If any part of the complex were to be unavoidably affected by development, additional study is recommended. Such study should include test excavation of the foundation and building areas. DWR should consult with an archaeologist who is knowledgeable about the region before undertaking such a study.

SOCIOECONOMICS

The recent incursion of geothermal development into southwestern Lake County may significantly affect the population in this area. Each new development will increase the demand for labor, which raises concerns about the ability of this sparsely populated region to adequately absorb new residents without adversely affecting such things as the quality of public services or the supply of housing.

Construction of the Bottle Rock power plant will take an estimated 43 months and will employ approximately 80 workers at the peak construction period (DWR, 1978). The average monthly employment during construction will be about 40 workers. Development of the steamfield will require approximately 15 employees for a period of about 25 months (DWR, 1978). Operation and maintenance of the completed project will require about 16 full-time employees. Because of previous and on-going geothermal construction activity in the Geysers KGRA, a labor pool of geothermal workers has developed, most of whom reside in Sonoma County (Vollentine, 1977). Figure S indicates that the number of workers on prior geothermal projects reached a high of approximately 340 in 1978; however, this refers only to the labor required for the power plant, excluding the steamfield.

In addition, as many as nine well-drilling companies have routinely worked the Geysers KGRA, and many of the crew members have become permanent or semi-permanent residents of Lake and Sonoma Counties. As of October 1978, four drilling companies were operating in the Geysers KGRA (Gemmis, 1978). The labor requirements for the Bottle Rock project could, for the most part, be drawn from this resident labor force without significantly increasing the population of southwestern Lake County. The Bottle Rock project, in and of itself, would therefore not adversely affect the socioeconomic infrastructure of this area.

The employment impacts of the Bottle Rock project must also be examined in a cumulative fashion with other concurrent and proposed geothermal projects. Construction activities for the Bottle Rock project, including steamfield and power plant, are scheduled to occur between March 1980 and October 1983 (DWR, 1978). During this time, however, construction activities on PG&E's Units 16, 17 and 18, NCPA's Units 1 and 2, DWR's South Geysers project and SMUD's Geothermal Unit 1 are also scheduled to occur. As shown in Figure S, the cumulative demand for labor of these planned facilities (exclusive of steam field workers) is approximately 550, which is an increase of about 250 over the previous peak which occurred in 1978. By using the following assumptions, it is possible to derive and estimate the number of people that might move into Lake County due to this increased employment demand:

1) All of the approximately 300 workers that were employed during the 1978 peak construction period still reside in the four-county area (Lake, Sonoma, Napa and Mendocino) and are available for employment on geothermal projects. This assumption focuses the analysis on the impacts of the 250 new workers that will be required and avoids unsupportable speculation regarding recent changes in the existing labor force.

Source:

CEC analysis and forecast of construction worker requirements of DWR "Bottle Rock", NCPA Units 1 and 2. DWR South Geysers and SMUD geothermal construction worker requirements were adopted assuming: i) the schedule for NCPA 2 applies; and ii) construction is begun on both units during the first quarter of 1982.

Figure S: **ESTIMATED CONSTRUCTION PERSONNEL**

2) Of the additional 250 workers that will be needed, 40 percent, or about 100 workers not currently associated with geothermal activities, but with the necessary skills to work on a geothermal project, will already reside in the four-county area and will be willing to commute to a given project site. Being existing residents, their employment will not represent a population increase. The 40 percent figure, which was obtained from a study entitled Construction Worker Profile (Mountain West Research, Inc., 1975), was derived from a survey of energy projects. The survey revealed that on the average 39.9 percent of the construction workforce from each of the projects were local residents Staff considers this to be a reasonable estimate, as evidenced by the number of unemployment claims shown below for the mining and construction trades for the four county area (DWR, 1978).

Lake	Sonoma	Napa	Mendocino
46	331	343	276

While these figures are certainly subject to change, they do indicate that there is a significant amount of idle labor in the area that have the necessary construction skills needed for a geothermal project.

3) Of the remaining 150 additional workers, two-thirds will reside in Sonoma County and one-third in Lake County. This is smaller than the 3:1 ratio identified by PG&E in the Notice of Intention for their Unit 18 (PG&E, 1979). Staff considers the conservative ratio more appropriate in reflecting the directional development into Lake County.

The assumption that only a small percentage of the needed labor force will reside in Lake County is reasonable for several reasons. First, despite the indications that there has been some but as yet undetermined, inmigration of geothermal workers into southwestern Lake County, the limited infrastructure of the area may, in the long run, act as a constraint on the number of new residents. With a limited number of housing units available for occupancy, both single and multifamily, and with the increase in summer residents in Lake County, the number of available units is severely constrained. In addition, there may be a greater incentive for some workers to reside in a more urban area as found in Sonoma County because of greater employment and social opportunities. Second, although each new geothermal project represents a further expansion into Lake County, away from the developed Geysers power plants in Sonoma County, the distance is typically only a couple of miles. Thus, commuting is a very strong likelihood for those workers not residing in the immediate project area, as these short distances represent an insignificant addition to commute time. The Bottle Rock power plant site is located approximately five miles (8 km) north of PG&E's Unit 13, which is expected to be completed by early 1980 and only two miles (3.2 km) northeast of PG&E's Unit 11. These short increments of distance by themselves do not appear to be a large enough incentive for workers to choose to live in Lake County as opposed to Sonoma County, particularly those who already reside in Sonoma County or elsewhere.

4) Based on data in the Construction Worker Profile study, 50 percent of the workers moving into Lake County bring families with them, each average family consisting of a spouse and 1.5 children.

Using these assumptions, cumulative development will result in approximately 113 new residents moving into Lake County, of which approximately 38 will be children. This represents about a four percent increase in the local population and less than one-half percent increase county-wide.

The proposed Bottle Rock project will also generate property tax revenues to Lake County. However, since the Bottle Rock power plant will be owned by a public entity, the California Department of Water Resources, it will be technically exempt from property taxation. The remaining leasehold and all steam field improvements will be taxable. Estimates of annual property tax revenues provided by the State Board of Equalization (Bell, 1978) and the Lake County Tax Assessor's Office (Terhaar, 1979) range from $180,000 to $260,000, respectively.

Staff concludes that neither the impacts of the Bottle Rock project nor the cumulative impacts of other proposed geothermal projects in the area will significantly affect the local population.

Mitigation Measures

No mitigation measures are required.

LAND USE

Geothermal development in the Francisco Leasehold is compatible with the requirements of the Land Use Element of the Lake County General Plan, as well as, the Lake County Zoning Code. It is unclear, however, how the deficiencies identified by the Office of Planning and Research and the State Attorney General's Office will affect the use of the Lake County General Plan as a valid planning document.

The proposed Bottle Rock project is also in compliance with the requirements in the Conditions, Procedures, and Performance Standards For Geothermal Regulation. It is also unclear how any amendments to these geothermal regulations or the adoption of an entirely new set of standards will affect the proposed project's compliance with such regulations.

The proposed project will effectively commit the land within the Francisco Leasehold to geothermal development for approximately 30 years and may affect recreational activity within the area of the leasehold.

While there are no residences located within the leasehold, recreational activities such as hunting and hiking have occurred.

Although the extent to which hunting and hiking have occurred in previous years is not known, it has presumably been limited because of the private ownership of the lands within the leasehold. Therefore, a further reduction or elimination of these activities from the leasehold due to geothermal development is expected to be a minor impact.

Most of the recreational and residential activity occurs in the small communities several miles to the east of the leasehold along Highways 29 and 175, although there are scattered residences in the area immediately adjacent to the eastern boundaries of the leasehold. The nearest residence is about .4 miles (.6 km) east of the power plant site. Construction of the power plant and steam field developments will introduce a facility with an industrial appearance and character into a relatively undeveloped area valued for its scenic quality. The visual presence of the plant could adversely affect the value of residential property within view of the facilities. (The visual impacts and mitigation measures are discussed in the Aesthetics Section.)

The communities to the east of the leasehold, although not in direct view of the plant, could be affected by the operation of the proposed facilities. Hydrogen sulfide emissions, which can have a very bad odor as well as possible deleterious health effects in certain concentrations, could possibly reduce the recreational value of the few small, nearby resorts, as well as the economic value of some residential and commercial property. of particular importance is a residential area between one and one-half and two miles (2.4-3.2 km) east of the power plant site. This area contains approximately 750 subdivided parcels, of which only a small fraction (about 15 percent) have been developed. Emissions from the DWR plant could decrease the desirability of this area, affecting the sales of both the developed and vacant lots. Although the exact monetary cost of these types of impacts cannot be determined, the potential for

this problem is evident by the number of complaints that have been received by local authorities, particularly in Cobb Valley, with regard to the hydrogen sulfide odor and the drilling noise from geothermal development sites (Reynolds, 1979).

Mitigation Measures

Other sections of this report relating to the issues of noise and air quality have identified specific mitigation measures. If DWR adheres to the proposed mitigation measures, the land use compatibility impacts identified above would also be minimized.

AESTHETICS

Bottle Rock's primary visual impact will be the introduction of an industrial facility into an almost undeveloped area, thereby degrading the scenic quality which, in part, is one of the main overall attributes of this region.

The view to the south and west of the power plant site is obscured by a ridge. An intervening ridgeline to the east of Bottle Rock Road may block the view of the proposed facilities from the communities along Highways 175 and 29 south of Pine Grove. However, the power plant structure, cooling towers, and associated facilities will be visible from the east. Also visible will be the access roads, steam field improvements such as wells and steam pipelines, and the engineered cuts into the hillside to facilitate placement of the proposed structures. Immediately affected will be the scattered residences located in the area just east of the Francisco Leasehold. It is not clear at this time how many of these residences will have a view of the proposed facilities or the extent to which those that do will be affected. The fact that the proposed facilities are visible at such a close proximity could have an adverse effect on the property values of these residences. Quantification of these monetary impacts is not possible, however. The proposed facilities will also be visible from Bottle Rock Road which runs through a small valley at the base of the ridge. This visual encroachment by the proposed facilities may represent a significant violation of the objectives of the Scenic Highway Element of the General Plan.

In addition to the impacts caused by the physical structures, a significant visual disturbance could be created by the presence of the cooling tower plume. This feature may, in fact, pose the most significant effect as it cannot be mitigated and it can be seen from a much greater distance.

Mitigation Measures

In accordance with the requirements of the Conditions, Procedures, and Performance Standards For Geothermal Regulation, DWR shall submit to the CEC a landscape plan outlining the measures that will be undertaken to mitigate the visual impacts. These mitigation measures should consider the visual impacts as they relate to the adjacent residents, as well as, the scenic quality along Bottle Rock Road. Such a plan will be reviewed and approved by both the Lake County Planning Commission and the CEC.

PUBLIC SERVICES

Administrative Services

The Lake County Air Pollution Control District (APCD), in addition to receiving state funds, requires fees for issuance of its permits. The fee associated with the Authority to Construct and Determination of Compliance is initially $3,000 and $1,000 annually (Reynolds, 1979). The two permits are currently issued under the same fee schedule. The cost to the APCD to monitor a geothermal project has been estimated at $2330 (Gennis, 1978).

The county is also solicited by the CEC for review of documents and participation in its regulatory proceedings. Active involvement by the county could be expensive, but all costs are reimbursable through the CEC.

Protective Services

Police and fire protection services may be required at sometime during the projected 30-year lifetime of the project. Staff anticipates that the demand for these services will be minimal. Present services should be adequate to serve most of the needs of the proposed project.

Utilities

Electrical power for construction will be supplied by PG&E. After start-up, the proposed power plant will provide its own electrical power. No significant impact on local supplies of electricity is anticipated. No financial costs will be incurred by the county for water or sewer services.

Education

An increase in enrollment in the Konocti and Lakeport school districts, located in southwestern Lake County, could adversely affect the provision of public educational services in that area. However, staff does not anticipate a significant increase in the local population as a result of the Bottle Rock project. Therefore, this project, by itself, will not significantly affect the four local school districts. In addition, the cumulative effect on the school districts of all the planned geothermal projects in the area should not have a significant effect, as staff has estimated that enrollment will increase by an estimated 38-40 children. This may be considered a high estimate as some of these children may not be of school age.

Road Maintenance

Increased use of Bottle Rock Road by heavy vehicles that will be used to develop the geothermal leaseholds in the area, will accelerate road deterioration. Lake County has proposed an extensive reconstruction project but as yet has not determined who will pay nor what DWR's share shall be.

Mitigation Measures

No mitigation measures are proposed by staff at this time pending the outcome of the negotiations between Lake County and DWR regarding compensation payments by DWR. Staff expects that a resolution should be reached before the Final EIR is certified.

TRANSPORTATION

During the peak construction and drilling phase of the project, approximately 60 workers will be traveling to and from the project area (Nielson, 1978). This number will decrease once the power plant is operational due to low manpower requirements.

Given the size and location of the work force employed in The Geysers KGRA, the additional traffic that may be created by this project should not create a need to improve the two county roads (Geysers Road from Sonoma County and Hwy. 175 - Bottle Rock Road from Lake County) that serve the development area.

The increasing number of geothermal power plants in The Geysers KGRA is resulting in increased heavy equipment traffic associated with construction and operation activities. This traffic may result in accelerated deterioration of the Lake and Sonoma County roads which serve the geothermal development area. The Bottle Rock project may add to the overall road deterioration. The extent or significance of the road deterioration resulting from the Bottle Rock project alone cannot be accurately assessed. However, a cumulative effect in the form of accelerated deterioration of roadways may result from geothermal power plant development in The Geysers KGRA.

Mitigation Measures

Roads within the leasehold will be maintained by McCulloch, the steam field developer. County roads are maintained by the counties (Lake and/or Sonoma). If the county determines that the roads within their jurisdiction are being abused by heavy truck and construction equipment (load limits are set by the County Road Commission), DWR will be requested by the county to participate in maintenance costs (Lake County, 1979).

UNAVOIDABLE ADVERSE IMPACTS

This section presents a summary of any adverse impacts which result from the construction or operation of the Bottle Rock project that cannot be completely mitigated. The detailed analysis for this summary can be found in the preceding Environmental Impacts and Mitigation Measures section.

Air Quality and Public Health

The power plant will emit varying amounts of H_2S, particulates, radon-222, mercury, arsenic, ammonia, and boron, and will increase existing concentrations of these elements in the atmosphere in The Geysers KGRA. There will be no "significant" adverse impacts on air quality and public health if DWR complies with all current and future air quality and public health standards; however, in the event of a plant shut-down, where geothermal steam is vented to the atmosphere, there could be a significant unavoidable adverse impact on air quality and public health.

Water Resources

There will be some loss of watershed and diversion of natural runoff from the construction of roads and pads. Siltation and sedimentation will be increased by the erosion of the numerous access roads and steam well pads required during the lifetime of this project.

Biological Resources

Yellow pine forest and mixed evergreen forest will be lost due to the construction of the power plant, access roads, and steam lines. The high wildlife value of these habitats make their loss impossible to completely mitigate. Eventual revegetation of these forests to a mature stage will require approximately 100 years if the power plant is removed after decommissioning.

Road fill from an access road to the Coleman well pad has begun to cause siltation impacts to a spring and wet meadow of high wildlife value. Also, a native prairie grassland area has been significantly affected by deposition of earth removed from the Francisco well pad.

Soils

There will be an incremental increase in soil erosion and sedimentation due to the increase in the length of access roads. Small amounts of trace elements, e.g., boron and ammonia, from cooling tower drift will be deposited in the soil.

Cultural Resources

Archaeological resources will be affected as a result of the construction of the steam pipeline and power plant access roads.

Land Use and Aesthetics

The appearance of the land will change from a natural environment to an industrial complex. Approximately 16 acres of land will be converted to power

plant site, well pads, and access roads. An additional 1.1 miles (.6 km) will be used for transmission corridor.

Steam plumes will be visible from off-site.

Emissions of H_2S may produce a nuisance odor.

Energy Resources

There may be a depletion of the steam resource if steam reservoirs cannot be effectively recharged. Consequences of consumption of the geothermal resource are as yet undetermined.

Noise

Noise levels at the closest residences will increase due to the construction and operation of the power plant and related facilities.

PROJECT ALTERNATIVES

There are a wide variety of potential alternatives to the Bottle Rock power plant. These alternatives assume that the basic need and purpose of the project is to supply 55 MW of electricity to the system by 1983. The alternatives are: no project, location alternatives; facility alternatives; size alternatives; design alternatives; generation alternatives; transmission line alternatives; and alternative uses of geothermal steam.

The information sources used for this section of the report include the Bottle Rock NOI, information obtained during NOI regulatory proceedings, the Commission's Electricity Forecasting and Planning Report (1977), and the draft introduction to the 1979 Biennial Report of the California Energy Commission.

No Project Alternative

If the Bottle Rock facility does not begin operation by 1983, there could be a substantial increase in the cost of operating the State Water Project. To not operate the facility would 1) probably result in increased energy costs to DWR customers because DWR would have to purchase additional power from other utilities; 2) run contrary to national and state energy policies; and, 3) deter DWR from developing a diverse power generating capability.

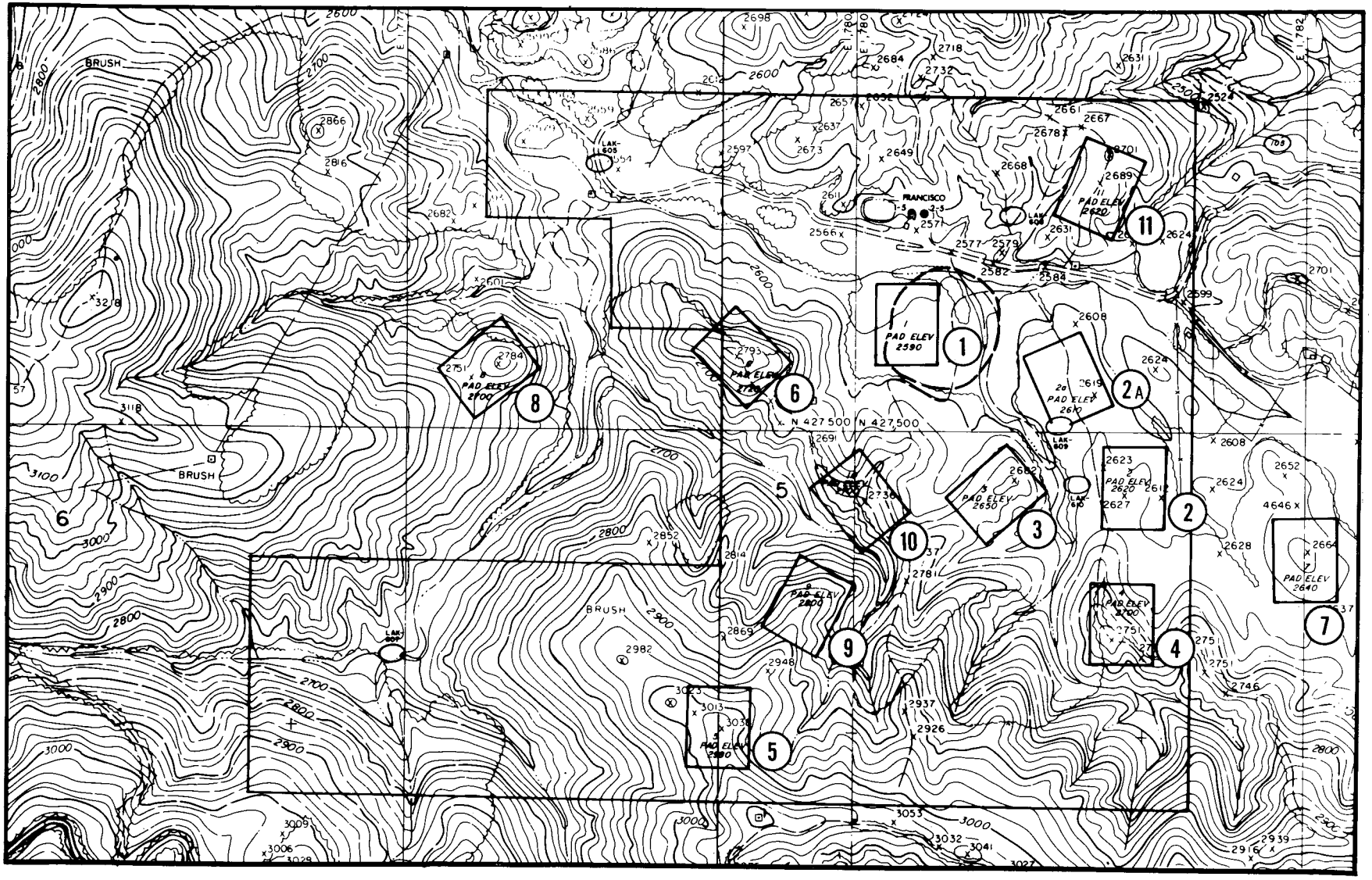
Location Alternatives

The location of geothermal power plants is limited to areas of proven geothermal resources, within a designated leasehold, and to specific areas within that leasehold in regard to topographic and geologic features. The power plant must be located close to the steam wells because it is generally considered that it is inefficient to transport steam for more than one mile because of temperature and pressure loss.

DWR initially considered over eleven plant sites for the proposed project within the Francisco leasehold. Geological, visual, archaeological, historical, environmental, and economic factors were considered by DWR before arriving at a decision on the proposed site. The site locations are shown in Figure T. The principal characteristics of the sites examined and subsequently eliminated by DWR are described in Appendix D.

Facility Alternatives

The primary determinant for consideration of alternative facilities at this stage in the Energy Commission licensing process is the time required for planning, design, licensing, and construction in relation to the date when the electricity is required to be on-line. Because of long construction lead times, coal-fired, nuclear, and hydroelectric generating plants are not feasible alternatives to Bottle Rock. New sources of energy such as fuel cells, solar, tidal energy, magnetohydrodynamics, and wind power have limited application and will not be commercially available within the necessary time frame. Oil fired combined-cycle units, repowered existing generating plants, and cogeneration are all possible alternatives because the lead time required from planning to operation varies only slightly from time required for a geothermal project. However, with only a few exceptions, using fuel oil for new generation facilities is contrary to the Federal Power Plant and Industrial Fuel Use Act.



Source: DWR, 1978
Modified by California Energy Commission, Oct. 1979

Figure T: **ALTERNATIVE POWER PLANT SITES**

Size Alternatives

DWR believes that a 55 MW plant is the optimal size based on the quality of the Bottle Rock steam field. Earlier plants constructed by PG&E such as Units 5 and 6 and Units 7 and 8 are a combination of 53 MW each for a total plant capacity of 106 MW. PG&E unit 15 is an operating 55 MW power plant. Geysers 16, 17, and 18 are three other recent proposals by PG&E; these plants will be 110 MW each. PG&E unit 13 is the largest plant in The Geysers KGRA with a capacity of 135 MW.

Design Alternatives

The components of a geothermal generating facility which allow some flexibility of design are cooling systems, hydrogen sulfide secondary abatement systems, and size and number of turbine generators.

Cooling System - The cooling system for the Bottle Rock power plant will use a surface condenser and a multi-cell forced draft wet type cooling tower. The turbine exhaust steam will be condensed and used to replace water lost in the cooling tower due to drift and evaporation which occurs as part of the cooling process. According to DWR, some alternatives to this cooling method and the reasons they were discounted are as follows (DWR, 1978):

1. An air-cooled condenser requires an extremely large surface area which would not be viable at The Geysers KGRA. In addition, the efficiency would drop because the size limitations would produce a higher condenser pressure by this cooling mechanism;

2. A direct-contact condenser, employed by PG&E's Units 1 through 12 mixes the steam from the turbine exhaust directly with the cooling water to condense the exhaust steam. The mixture is then pumped by the condensate pump to the cooling tower. The cooled water is collected at the basin in the tower, and is then pumped to the condenser. Though more economical, this cooling method increases abatement requirements by concentrating a larger portion of the hydrogen sulfide in the circulating water;

3. A closed-cycle cooling system circulates the cooling water within a closed loop, and uses surface condensers and dry cooling towers as heat exchangers prevents the direct contact of the cooling water with the turbine exhaust steam and the atmosphere in the cooling tower. This system would require the reinjection of greater amounts of condensate than a wet cooling tower system since losses due to evaporation and drift in the tower would be eliminated. The non-condensable gases in the steam would still have to be removed from the condenser and treated to comply with air quality standards. A positive aspect of this type of system is the elimination of air pollution emissions at the cooling tower, but the physical size and cost increase make this an undesirable alternative.

4. Other alternative cooling methods include: 1) no cooling, (with the turbine exhausted directly to atmosphere) which is a less efficient

thermodynamic use of steam as well as the exceedence of the air pollution emission standards; 2) once-through cooling, which is not practical because a large water supply is not available in the area; 3) a natural draft tower which would not be suitable for this power plant because of size, and cost; and 4) combination wet and natural draft tower would be more feasible and would reduce evaporation losses; however, the costs and size would still be too large.

Alternative H_2S Secondary Abatement Systems - DWR originally proposed to use the Stretford H_2S abatement system which was expected to remove at least 98 percent of all the H_2S contained in the exhaust geothermal steam. Tests of the Stretford system at PG&E's Unit 15 indicate that only a 67 percent efficiency rate has been achieved.

Therefore, additional H_2S abatement will be necessary if the amount of H_2S dissolved in the water formed by the surface condenser produces cooling tower emissions in excess of applicable standards. Secondary H_2S abatement will be applied to the condensate flow, between the surface condenser and the cooling tower.

The Metal Catalyst System - Hydrogen sulfide dissolved in water, in the presence of air and at normal temperatures, is unstable and undergoes oxidation to form free sulfur. This reaction is ordinarily slow but can be accelerated by use of appropriate catalysts such as dissolved ferric ions. In the process the ferric ion is regenerated, so that more hydrogen sulfide is oxidized. The iron concentration in the cooling water is maintained at 30 ppm by weight or higher. The condenser off-gas is released in the cooling water, so that its hydrogen sulfide content is also oxidized. The major problems associated with the iron catalyst system are corrosion of metal parts in contact with the cooling water and rapid accumulation of sludge.

A metal catalyst, supplemented either with hydrogen peroxide or with caustic soda is being used continuously at PG&E Units 3 and 6 and Unit 11. This system will also be used at other PG&E Units only during H_2S episodic alert days.

PG&E reports that they have achieved 90 percent abatement in their existing direct condenser units by use of high concentrations of iron catalyst. However, systems using this form of abatement experienced serious operational problems which caused reduced reliability due to sludge formation and induced corrosion.

Hydrogen Peroxide Oxidation - The FMC Corporation of Philadelphia has found that hydrogen peroxide (H_2O_2) can remove essentially all the H_2S in the steam after it has been condensed. This process can occur in less than 15 seconds if 1 ppm (by weight) of iron is present to catalyze the reaction. This iron concentration is so low that it does not cause corrosion and sludging problems.

The amount of H_2O_2 required depends upon the products of the reaction and the pH. It may be economical to employ pH control to keep the H_2S out of the condensate in the first place and not use H_2O_2 at all. The amount of H_2O_2 required for the reaction may also prove to be several times the amount estimated. The exact procedures and chemistry of the hydrogen peroxide secondary abatement system will not be known until the results of full scale tests at PGandE's Unit 15 are available in late 1979 or early 1980.

This system which has been chosen as the preferred secondary abatement method, if necessary, for Bottle Rock and other proposed power plants that are presently at various stages of the Commission's regulatory process; they are: PGandE Units 16, 17, and 18; and NCPA No. 1 and No. 2.

Sulfur Dioxide pH Control - Injection of sulfur dioxide (SO_2) into the condensate to control the pH of the condensate and to displace the H_2S dissolved in the condensate is an attractive method for reducing the amount of H_2S in the condensate, because sulfur obtained from the Stretford process could be burned to provide a readily available source of SO_2.

Significant development and prototype testing remain to be done on this system before it can be adapted for commercial use. However, if the Stretford process does not provide the necessary H_2S abatement, the use of sulfur dioxide pH control should be considered and evaluated as a secondary H_2S abatement method.

Other H_2S abatement systems which have been or could be used are discussed below. Most have proved ineffective or have been displaced by the Stretford and surface condenser/partitioning process.

Steam Converters - An old geothermal industry process, the steam converter was the only effective way of reducing the high gas content of the steam. However, the process seriously degrades the quality of the steam and nearly double the mass of steam that is required to produce the same amount of power as unconverted steam.

Preplant Oxidation - PG&E has briefly experimented with the injection of oxygen (O_2) into the incoming geothermal steam, upstream of the turbine units. The results were not encouraging since injection of twice the amount of O_2 theoretically required for full oxidation only caused an H_2S reduction of 5 percent. Upstream injection of H_2O_2 has also been tried but with poor results.

Upstream Absorption Scrubbers - Upstream absorption of H_2S with a copper sulfate solution has been investigated by the EIC Corporation.[2] Although a field trial by PGandE at Geysers Unit 7 removed 90 percent of the H_2S, considerable development and testing remain to be completed before this process can be adopted for commercial use.

The Burner-Scrubber System - This system mixes the condenser off-gases with air and burns them. The system was used on PG&E's Unit 4 but was discontinued because it was unable to reduce H_2S emissions by more than one-half of that required and because the off-gases are only marginally flammable.

The Deuterium Process - The Deuterium Corporation has installed and tested a liquid absorption type of scrubber to remove H_2S from a portion of the incoming steam at PGandE's Unit 7. Details of the process are considered proprietary information, but early test results indicated 90 percent or better H_2S abatement. There were problems associated with regeneration of scrubber solutions which have yet to be resolved.

The Deuterium process has been developed to produce "heavy" water (deuterium) and requires copious amounts of process steam, electrical power and hydrogen sulfide. Therefore, the process would be a secondary geothermal industry rather than an abatement system.

Turbine Generator Size - As an alternative to using one 55 MW turbine generator, two 27 1/2 MW generators could be used. Bechtel National, Inc. prepared a report for DWR, Geothermal Power Plant Studies, which included a comparison of the twin turbine generators and a single turbine generator. Bechtel's report concluded:

> "For a power plant which is expected to be base loaded and, therefore, operating close to its full capacity, a twin unit system will have only one conclusive advantage, i.e., reducing the rate of H_2S emitted to the atmosphere during stacking due to a forced outage of one of the twin units. The comparatively high cost of installing and maintaining the twin unit system does not appear to justify this single advantage." (Bechtel, 1978).

Alternative Means of Accomplishing Project Objectives

Energy Conservation - The need section in the Project Description chapter of this report discusses the Energy Commission's adopted forecast for energy and peak demand. These figures incorporate some conservation measures. New and expanded conservation measures, over and above those included in the adopted forecast, will be implemented by DWR, thereby reducing electrical demand in the state water project. Geothermal generation has been identified by the Energy Commission as a preferred technology and is cost effective in comparison to other alternative generation technologies. Conservation is an alternative that would be more applicable to other, less preferred and less cost-effective forms of electrical generation.

Purchased Power - DWR currently purchases a portion of its electrical energy from suppliers such as Pacific Gas and Electric Company, Southern California Edison, Los Angeles Department of Water and Power, and San Diego Gas and Electric Company. Contracts with these suppliers will terminate on April 1, 1983. Therefore, DWR will need additional energy to replace energy sources no longer available. To continue to use purchased power, DWR would have to successfully negotiate new contracts with individual suppliers; in addition, the energy purchases are becoming increasingly expensive. (DWR, 1979b)

Alternative Transmission Facilities

Transmission Structures - Any number of designs for towers, insulators and conductors are presently available. DWR proposes to use single circuit, steel lattice towers and nonspecular conductors which will blend into the background landscape and minimize visual impacts. An alternative design consisting of large-diameter, steel pole-type towers would provide a more substantial structure which is more visible against the brush and tree-covered hillsides.

An underground, low pressure, oil-filled, self-contained cable could be utilized as an alternative for the overhead transmission line. Underground transmission would require extensive clearing, grading and trenching and would significantly

increase the estimated cost of the project. Undergrounding the proposed transmission line would reduce the visual impact and physical obstruction but the greatly increased installation costs and the possible effects of erosion or slope failures on cable reliability make this an undesirable alternative.

Transmission Routes - Currently PG&E owns the only transmission facilities in The Geysers KGRA. DWR proposes to tie into the PG&E transmission system at Geysers Unit 17.

To determine the best route from the Bottle Rock site to Geysers 17, DWR evaluated various routes from an engineering, economic, and environmental standpoint. DWR identified and evaluated three potential routes from Bottle Rock to Unit 17 and one route from Bottle Rock to Unit 11. DWR chose the route shown on figure G because it required the least amount of transmission and access roads already exist along portions of this route. CEC staff are concerned that the proposed interconnection point and transmission facilities do not adequately consider the overall transmission needs of the area. An adequate transmission plan should be developed to consider transmission needs (with regard to adaquacy of capacity, transmission losses, reliability and costs), for DWR as well as future power plants.

Alternative Uses of Geothermal Steam

In addition to its use for electrical generation, geothermal steam can be used for a variety of domestic and industrial processes, the most common being a source of direct-heat for buildings or for industrial drying. Typically these processes depend on a resource with a 100° to 150°C temperature range. The steam resource at The Geysers KGRA is approximately 250°C. Direct heat uses of geothermal energy can substitute for electricity, natural gas, and fuel oil, typically needed for water heating, space heating and cooling, food processing, refrigeration, and process-heat applications.

The potential for these direct-heat uses is drastically reduced because the heat must be used close to the steam source, usually a mile away at the most. Further, site-specific zoning, lack of adequate data, economics, and lack of abatement technologies have limited the use of geothermal energy.

Organisms, particularly those in aquatic environments, can absorb, concentrate and transform trace elements. Mercury may be transformed to more hazardous forms (such as methyl mercury), and accumulate in various links in food chains, particularly in higher trophic levels, Fish can contain high mercury levels since they take up mercury compounds both through consumption of food and through their gills (Britt, 1976). Ingestion of mercury in contaminated food or water can result in adverse health effects such as headaches, blurred vision, loss of muscular coordination and death (Waldbott, 1973). To protect public health from hazards of mercury ingestion, the Federal Food and Drug Administration recommends 1.0 ppm mercury in fish as a safe level for human consumption.

High concentrations of mercury have been measured in fish at Clear Lake, not far from The Geysers (Week, 1978). Although the mercury content in most fish tested was below the recommended safe level of 1.0 ppm in edible fish, a small number of the fish sampled exceeded this value. Such high levels are

believed to be caused by sources other than mercury emissions from The Geysers power plants, yet it can be inferred that this area may carry a significant burden of background mercury already, and any addition to the environment would increase this burden.

Emissions from PG&E Unit 16 and associated wells will contain arsenic, possibly in the form of suspenced particulates, arsenic trioxide vapor, or arsine (Unit 17 NOI). Chronic exposure to arsenic trioxide may cause irritation to nose and throat, hair loss, tremors, anemia and cancer of the skin, lung or liver (Britt, 1976).

PG&E Unit 16 will also emit boron in cooling tower exhaust. Boron and boron compounds can be toxic to humans when present in relatively high concentrations. No significant damage to human health has been induced by inhalation of boron compounds, despite the large number of persons who are occupationally exposed to them (Waldbott, 1973).

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed Bottle Rock project will provide short-term (30 or more years) benefits by providing electricity for the State Water Project (SWP). The project will allow DWR to diversify its electrical generation resource base and avoid the use of nonrenewable petroleum fuels. DWR's energy forecast indicates an energy deficiency for the SWP through the year 1998. Previously, DWR has relied on hydroelectric development and energy purchases from suppliers, e.g., Pacific Gas and Electric Company. Energy purchases are becoming increasingly expensive, and the availability of hydroelectric power is decreasing; DWR must turn to other sources of energy (DWR, 1978). The project also provides short-term employment to individuals and payroll effects from workers will be felt in Lake County.

While the proposed project by itself has few unmitigable adverse impacts, it represents, in combination with other geothermal development, cumulative and long-term (greater than the life of the project) impacts. These cumulative impacts are related to the modification of The Geysers KGRA from a relatively undisturbed environment to an industrial development.

Major land transformations will occur as a result of clearing and leveling well pad areas, power plant sites, roads, and pipeline corridors. Erosion and sedimentation may increase over the entire KGRA, affecting streams and wildlife habitat. The erosion rates of soils formed on Franciscan Formation are among the highest known in the world, as much as 60 inches (150 cm) of soil per 100 years. In addition, the potential exists for increased landslide activity to occur as the Mayacmas Mountains are believed to be "landslide prone" (Neilson, 1977).

Removal of plant cover throughout the KGRA will decrease wildlife habitat.

Further, access to the industrial areas must, by necessity, be restricted from recreational uses in order for geothermal developers to maintain a certain amount of security for installations and to protect citizen safety.

Industrial installations will become a long-term feature of the landscape, thereby affecting the aesthetic quality of the area. Cooling tower plumes will be visible from off-site. It may not be economically feasible or practical to restore the land to its original state at the end of usefulness of its steam resource, considering the potential full development of the KGRA (Neilson, 1977).

Because the KGRA is located in the upper reaches of the watershed, vegetation removal and alteration of natural run-off patterns may diminish watershed values (Neilson, 1977).

Certain amounts of pollutants (from steam stacking and cooling tower emissions) will continue to be released into the environment on an incremental basis as more wells are drilled and power plants are constructed. These incremental increases may affect the soils, water quality, air quality, and may degrade habitat (Neilson, 1977).

An equal long-term and cumulative concern is the impact on the geothermal resource. It is unclear whether geothermal steam is renewable, and if so, what period of time is required for the resource to be renewed. The reliablity or lifetime of the steam supply (geothermal resource) for the primary purpose of electrical generation or any secondary uses remains undetermined.

The project is proposed by DWR at this time because it will assist in meeting the SWP's forecasted energy requirements of 1998 and will decrease DWR's dependence on increasingly expensive purchased power.

Construction and operation of Bottle Rock, by itself, should not create any significant adverse environmental impacts as long as all applicable laws, regulations and standards are complied with, and the mitigation measures proposed in this EIR are fully and effectively implemented.

The policy of the Energy Commission is to encourage and expedite the processing of geothermal power plants. However, during the NOI/AFC proceedings, the Energy Commission must carefully evaluate the environmental effects of the project in order to balance the need for energy against the protection of the environment and the maintenance of public health and safety.

GROWTH INDUCEMENT

The construction and operation of the proposed geothermal facilities will not directly induce a noticeable increase in the area's growth rate. This is due to the small labor force required to construct and operate the facility and the fact that much of the needed labor will probably be drawn from a resident labor force. This resident labor pool has developed as a result of previous geothermal projects in the area, primarily at the PG&E Geysers Power Plant in Sonoma County.

If potential impacts of this proposed project are sufficiently mitigated, then approval and construction of the Bottle Rock power plant may make it easier to approve future geothermal projects in the area. Further development of the geothermal resource, beyond the Bottle Rock project, would increase the demand for labor, leading to a potential increase in the local population. However, staff has assessed the cumulative impacts on the local population that could occur from all planned projects in the area (including PG&E's Units 16, 17, and 18, NCPA's Units 1 and 2, SMUD's Geothermal Unit 1 and DWR's Bottle Rock and South Geyser's projects) and has determined that the effects will not be significant (see Socioeconomic impacts section). Therefore, the cumulative effect will not lead to substantial growth in the area.

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ORGANIZATIONS CONSULTED

Federal Agencies

United States Geological Survey
Burea of Land Management
Department of Energy
Federal Aviation Administration
Federal Communications Commission
United States Fish and Wildlife Service

State Agencies

Historic Preservation Office
California Department of Industrial Relations
California Division of Mines and Geology
Native American Heritage Commission
California Division of Oil and Gas
Department of Parks and Recreation
California Public Utilites Commission
California Air Resources Board
Department of Fish and Game, Sacramento
Department of Fish and Game, Regional III, Yountville
California Department of Health Services, Hazardous Material Management Section
California Department of Health Services, Environmental Health Services Branch
Solid Waste Management Board
Office of Planning and Research
Division of Aeronautics
State Water Resources Control Board
California Regional Water Quality Control Board, Central Valley Region
Attorney General's Office, Public Resources Section
State Board of Equalization

Local Agencies

Air Pollution Control Office, Lake County
Air Pollution Control Office, Sonoma County, RWQCB, Central Valley Region
Lake County Planning Department
Sonoma County Planning Department

GLOSSARY

A-WEIGHTING - Weighting system that approximates the auditory response of the human ear, which discriminates against low and high frequencies.

AEROSOL - A colloid system of solid or liquid particles dispersed in a gas.

ALPHA ENERGY - Energy from the positively charged alpha particle emitted by certain radioactive materials. It is unable to penetrate the epidermis of skin, but when inhaled or ingested is considered dangerous.

AMBIENT TEMPERATURE - Natural temperature of the environment at a given time.

ANTIFORM - Anticlinal type structure in which the stratigraphic sequence is not known.

ARCHAEOLOGY - Site, artifacts, or other remains dating from prehistory. With respect to the Western Hemisphere, this includes the American Indian era.

BERM - A ledge or shelf, typically one that guides drainage at the top or bottom of a slope.

BLEED - Small amount of steam vented to atmosphere when well is shut in.

BLOOIE LINE - A pipe used to carry fluids and cuttings from the well to a muffler/separator during air drilling operations.

BLOWOUT - An uncontrolled eruption of a steam well.

CAPACITY - The ability of a power plant or generating unit to produce a certain level of power, usually expressed in kilowatts or megawatts.

CARCINOGENIC - Those agents which can cause cancer.

CHRONIC - Of long duration; continuing.

CI/ML (CURIES PER MILLILITER) - A measure of concentration of radioactivity in a substance.

CI/ML (CURIES PER MILLILITER) - A measure of concentration of radioactivity in a substance.

CLASS I DISPOSAL SITE - Those for which protection against a vertical or lateral continuity of leachate and any water source is naturally provided by geologic conditions. A Class I site must have natural barriers to prevent verticle hydraulic continuity with usable water. It may have manmade barriers to prevent lateral hydraulic continuity with useable water.

CLASS II-1 DISPOSAL SITE - Those which have been modified to prevent a vertical or lateral hydraulic continuity of leachate and a water source.

CONDENSATE - The liquid which results from the condensation of geothermal steam.

CONSTITUENTS - The chemical components of a waste on a body of water.

COOLING TOWER - Structure in which heat is removed from hot condensate taken from the condenser.

CUT AND FILL - Construction term referring to earth removal at a site (cut) and disposition of the excess dirt (fill).

DECIBEL - One tenth of a Bel - a measure of sound pressure.

DECIBELS A-WEIGHTED (dBA) - Sound pressure levels weighted in accordance with "A" scale. A-weighted scale expresses the relative intensity of sounds, similar to the response of the human ear. 2 represents the faintest audible sound; 130-140 represents the average pain level.

DECIDUOUS - Vegetation that loses its leaves annually, generally in fall or winter.

DEW POINT - The temperature to which a given parcel of air must be cooled at constant pressure and constant water vapor content in order for saturation to occur.

DIELECTRIC - Nonconducting.

DRIFT - The gaseous and aqueous plume which comes out of the cooling tower and is dispersed by meteorological conditions or deposits on the surrounding environment.

DRY STEAM - Hot steam which contains no condensate.

EDGE - The division between two adjoining habitats.

EFFLUENT - Water or waste stream which flows out of a treatment facility.

ENTRAINMENT - The mixing of environmental air into a preexisting organized air current so that the environment air becomes part of the current.

EMISSION - Material passed into the atmosphere in a gas stream; may contain an air contaminant.

ETHNOGRAPHIC - Related to the branch of anthropology concerned with the classification and description of regional, chiefly primitive human cultures.

FAULT - A fracture or fracture zone in the earth's crust along which parallel slippage of adjacent earth material has occurred.

FAUNA - Animals of a specified region.

FEN - An area of low, flat, marshy land.

FLORA - Plants of a specified region.

FUMAROLES - A naturally occurring hole in geothermal areas from which hot steam and gases arise.

GEOTHERMAL STEAM - Steam created by the heat of the earth.

GEYSER - Spring that throws forth continuous or intermittent jets of heated water and steam.

GROUNDWATER - Water found underground in porous rock strata and soils.

HABITAT - The environment where a plant or animal lives.

HAZARDOUS WASTES - Wastes, or a combination of wastes, which may cause serious illness or pose a hazard to human health or the environment through the treatment, storage, or disposal of such waste.

IGNEOUS - Rock material formed by cooling and solidification of molten magma, either at the surface, such as volcanic rock, or at depth.

INSOLATION - Solar irradiation.

INVERSION - An atmospheric condition where a layer of cool air is trapped by a layer of warm air so that it cannot rise. Inversions restrict the dispersion of pollutants to horizontal rather than both horizontal and vertical directions. Inversions often, but not always, reduce the dilution of pollutants.

JURASSIC-CRETACEOUS - Relating to periods of the Mesozoic Era (75-180 million years ago). Also the system of strata deposited during those periods.

KILOWATT (KW) - 1000 watts.

KILOWATT-HOUR (KWH) - The basic unit of electric energy equal to one kilowatt (1,000 watts) or power supplied to or taken from an electric circuit steadily for one hour.

Lx - The statistical level of noise which is exceeded x percent of the time during the observation interval, dB. Three common statistical parameters are L_{10} (high level), L_{50} (median level) and L_{90} (low level).

Leq - Energy equivalent level or equivalent sound level is the steady noise level which in a stated period of time would contain the same noise energy as the time-varying noise during the same time period.

Lmax - Maximum A-weighted sound level for a given time or event.

Lmin - Minimum A-weighted sound level for a given time or event.

LEACHATE - Drainage from a waste or fluid resulting from the percolation of liquid through a waste substance.

LEASEHOLD - An area leased by a steam supplier for geothermal development.

MAGMA - Molten rock material within the earth, from which an ingeneous rock is formed by cooling.

MELANGE - Mixture of incongruous elements of soil and rock; in the Franciscan Formation refers to the presence of variable blocks of stable rock in a matrix of sheared and pulverized rock.

METAMORPHIC ROCK - Rock changed by combinations of pressure, heat and water solutions.

MICROGRAMS PER CUBIC METER (g/M^3) - A measure of concentration of a pollutant in air. A microgram is one millionth (10^{-6}) of a gram.

MILLIGRAMS PER CUBIC METER (mg/M^3) - A measure of concentration of a pollutant in air. A milligram in one thousandth (10^{-3}) of a gram.

MICROCLIMATE - The conditions of temperature, humidity, wind, etc., immediately surrounding an organism or in a particular habitat.

MORPHOLOGY - The form and structure of plants and animals.

MUFFLER - Device for sound attenuation through which steam is directed during periods of release, such as stacking, to the atmosphere.

MEGAWATT (MW) - 1,000 kilowatts, 1 million watts.

NATURAL BACKGROUND RADIATION - That radiation which is not man-made and originates from terrestrial (pertaining to the earth's crust) and cosmic (pertaining to outer space) sources.

NATURAL RECHARGE - An area of very permeable soil through which rainwater percolates to replenish groundwater aquirers.

PARTICULATES - Any material, except uncombined water, which exists in a finely divided form as a liquid or solid at standard conditions.

PATH TREATMENT - A reduction of noise at the receiver's position due to a physical change in the path of sound between source and receiver.

PICO CURIES - (pCi) - 10^{-12} Curie. A curie is a unit of radioactivity.

POLLUTION ROSE- A graphic description showing the effect of wind direction on average air pollutant concentrations.

RAPTOR - Bird of prey such as a hawk, owl, or eagle.

REINJECTION - Process of removing excess condensate from the cooling tower basin and injecting it into the steam reservoir through nonproducing wells.

RESERVE CAPACITY - Backup generating capacity used in the event other generating units are unavailable for service because of forced or scheduled outages or in the event of unforeseen conditions that can effect either the magnitude of the load or system capacity or both.

RIPARIAN - Associated with or adjacent to a permanent or seasonal water source.

RUNOFF - That portion of precipitation on the land that ultimately reaches streams; water from rain or melted snow that flows over the surface.

SCRUBBERS - Devices used to remove contaminants from a gas stream.

SEDIMENTATION - The settling out of solids in a liquid.

SEISMICITY - State of being caused by or subject to an earthquake or earth vibrations.

SERPENTINE - A rock or mineral consisting essentially of a hydrous magnesium silicate, usually having a dull green color and often found along fault zones and landslide areas.

SHEAR ZONE - A zone of crushed rock caused by tectonic forces often in relation to faulting.

SILTATION - To become filled or chocked up with earthen sediments (rock, soil etc.).

SILVICULTURE - The art or procedures of producing and tending a forest and forest trees.

STEAM STACKING - The condition where incoming steam is released to the atmosphere instead of entering the power plant. This condition occurs when the plant is not operational.

STEAM SUPPLIER - Geothermal development firm with which PG&E has contracted for the sale and purchase of geothermal steam.

STEAM SUPPLY AREA - Land area necessary to provide an adequate source of geothermal steam for a particular power plant unit.

STEAM RESERVOIR - A porous and permeable geological structure, underlain by a heat source and overlain by an impermeable caprock, containing steam.

STEAM SUPPLY FIELD - A geographical area overlying one or more steam reservoirs accessible by conventional drilling technology.

SUBSIDENCE - Settling or sinking of land, usually due to withdrawal of natural underground fluids by man.

SUMP - A pit or reservoir serving as a drain or receptacle for liquids.

TECTONIC - Relating to the folding or faulting of the earth's crust.

TERATOGENIC - Those agents which can cause development of abnormal structures in an embryo; development of a severely deformed fetus.

THOUSAND CIRCULAR MILLS (mcm) - A circular mill (cm) is a term used to define cross sectional areas, being a unit of area equal to the area of a circle 1 mil in diameter. A mil equals one-thousandth of an inch.

TOPOGRAPHY - Physical features of a district or region such as are represented on maps; the relief and contour of the land.

TRANSMISSION LINE - Structures and conductors that carry bulk supplies of electrical energy from power generating units for system needs. By definition, transmission voltage is 50 kV or above.

TROPHIC LEVELS - A means of categorizing organisms by their position in the food chain. Higher trophic levels are those animals which consume other animals.

TROPOPAUSE - Upper portion of the atmosphere, which extends outward about 7 to 10 miles from the earth's surface.

TURBINE - Rotating engine activated by the reaction or impulse or both of a current of fluid or gas.

VENTING - Releasing steam from a pipeline section through valves to the atmosphere.

WATERSHED - A topographically defined area drained by a river/stream or system of connecting river/streams such that all outflow is discharged through a single outlet.

WATER VAPOR - Water substance in vapor form; one of the most important constituents of the atmosphere.

WATT (W) - The amount of work available from an electric current of 1 ampere at a potential of 1 volt. 1,000 watts (1 kilowatt) is roughly the amount of energy required to raise the temperature of one pound of water one degree Fahrenheit per second.

APPENDIX A

IMPACT IDENTIFICATION MATRIX

This section identifies "potential" impacts associated with the (1) steam field; (2) power plant and related facilities; and (3) transmission lines of The Geysers 17 Geothermal Project.

The impacts are identified by environmental categories and were evaluated to determine their significance or insignificance. The sources of data employed for this determination are identified opposite the potential impact. Indications of significance are those of the author or, when indicated in the source column, the Data Source.

The California Environmental Quality Act (CEQA) and the State EIR Guidelines define significance in a very broad, general way. Section 21068 of CEQA states that a significant effect on the environment is a "substantial, or potentially substantial, adverse change in the environment". The State EIR Guidelines note that "an iron clad definition of significant effect is not possible because the significance of an activity may vary with the setting" (CAC 15008l(a)). Significance is a threshold concept. Any change in an environmental resource represents an impact. As the change becomes greater, it approaches the threshold of significance. The threshold is determined by the duration, timing, magnitude, historical trends, secondary consequences, and synergistic effects of the impact. In many cases, federal, state and local laws, regulations, standards and ordinances represent the maximum threshold of significance. That is, beyond the level defined by the standard, the impact is always considered significant. An impact may be considered significant before the level defined by the standard is reached as a result of timing, synergistic effects, regional or local importance and so on. The initial determination of significance is made by an expert in the environmental category in question. The final decision is made by the decision makers.

If the potential impact has not been discussed, does not contain sufficient data to make a determination of significance, or has conclusions by different data sources that substantially conflict, then the impact is classified as unresolved.

Impact Identification Matrix

EARTH RESOURCES

Project: Bottle Rock

By: Kent Murray

Date: August 20, 1979

Environmental Category Potential Impact	Significance	Source
POWER PLANT FACILITIES		
Hazards		
Seismic shaking/fault rupture	Insignificant - Good design and construction practices can prevent unacceptable damage.	NOI, pages 27-29.
Mass wasting or general slope instability	Insignificant - Normally a critical concern in power plant design for the Geysers area, however the Bottle Rock proposed site area appears to be free of unstable slopes.	NOI, pages 39-40.
Liquifaction	Insignificant - Liquifiable soils are not known to occur in the leasehold.	NOI, page 39.
Differential settlement	Insignificant - Low probability of causing facility damage using good construction and maintenance practices.	NOI, page 39.
Volcanism	Insignificant - Low probability of occurrence.	NOI, page 42.
Subsidence	Minor significance: Induced subsidence from withdrawal of subsurface fluids may result in a minor hazard to the facility.	NOI, page 41.

Impact Identification Matrix

Project: Bottle Rock

By: Kent Murray

EARTH RESOURCES

Date: August 20, 1979

Environmental Category

Potential Impact	Significance	Source
Impacts		
Unique geological features	Insignificant - There are no unique geological resources of historical, scientific or recreational interest within the boundaries of the Francisco leasehold.	NOI, page 44.
Mineral resources	There are no mineral resources on the Francisco leasehold.	NOI, page 45.
STEAM FIELD (wells, well pads, roads and pipelines)		
Hazards		
Fault rupture (sump pond fault)	Probably insignificant - It is believed that this fault is potentially active (has experienced movement within the last 2 million years but probably not within the last 11,000 years) and therefore has a low probability of movement.	Staff's findings and conclusions.
Seismic shaking	Probably insignificant - Wells, pipelines, and roads are generally insensitive to shaking. Pipelines and roads can usually be easily repaired. Good construction and maintenance practices will reduce hazard to all facilities.	NOI, page 33; NOI hearings.

Impact Identification Matrix

Project: Bottle Rock

By: Kent Murray

EARTH RESOURCES

Date: August 20, 1979

Environmental Category

Potential Impact	Significance	Source
Volcanic activity and subsidence	Insignificant - The probability of either of these phenomena damaging the facilities is remote.	NOI, page 41 and 42.
Slope instability	Insignificant - Generally in the Geysers area, this hazard is particularly acute, however at the Bottle Rock site there are no active or potentially active landslides or unstable slopes which could affect the wells, well pads, roads or even pipelines.	NOI, page 39-40.
TRANSMISSION LINES, CONSTRUCTION AND OPERATION (lines between roads)		
Hazards		
Slope instability/surface fault rupture/ differential settlement liquifaction	Significant - Only to the extent that the siting of towers must take into consideration such potential hazards. Easily mitigatable through avoidance or by good construction and maintenance procedures.	NOI, pages 23-25.
Seismic shaking/subsidence	Insignificant - Due to normal construction practices.	NOI, pages 23-25.
Impacts		
Commercial and noncommercial geologic resources	Insignificant - None known along transmission bus route.	NOI, pages 23-25.

Impact Identification Matrix

Project: DWR BOTTLEROCK

By: L. Dillon

Date: 9-28-79

WATER RESOURCES

Environmental Category

Potential Impact	Significance	Source
WELL FIELD		
Increases levels of suspended solids in surface waters due to increased erosion	Significant	Francisco Leasehold EIR
Discharge of geothermal fluids to surface waters	Significant	Francisco Leasehold EIR, F & G-RWQCB list of geothermal discharges.
Potential ground water pollution	Insignificant - There are no defined ground water basins in the upper drainages of the High Valley, Alder, and Kelsey stream systems.	NOI- Environmental Effects, Water Quality, page 6.
Alteration of ground water hydrology	Insignificant - Same reasons as listed above.	NOI, Environmental Effects - Water Quality, page 6.
Increased water pollution due to damage caused by environmental hazards	Significant - Increased sediment nutrient, and hydrolic loadings on the affected stream channels.	NOI, Hydrology, pages 6-9. Francisco Leasehold EIR.
Potential damage to well or pipeline facilities from flooding	Significant - Geothermal development and pipelines are on crests or mountain ridges and pipelines also follow roadways - above and removed from streams.	
Increased overland flow, storm runoff. Increased discharge from cleared areas. Increased channel erosion, stream water temperature, volume and velocity.	Significant -	

Impact Identification Matrix

Project: DWR Bottlerock

By: L. Dillon

WATER RESOURCES

Date: 9-28-79

Environmental Category

Potential Impact	Significance	Source
WELL FIELD (continued)		
Disruption of ground water movements by cuts for access roads or facility sites. Change in ground water and recharge areas due to impervious surfaces.	Significant - Size and distribution of the underground resources is a matter of conjecture.	Francisco Leasehold EIR.
Potential destruction from flooding, either natural or intensified by construction activities.	Insignificant for plants and well sites due to their elevated position. Significant for roads and moderately so for pipelines.	Staff judegement.
Potential deleterious effects of wastewater disposal on ground and surface waters.	Insignificant - Waste materials are required to be contained in lined sumps, of adequate size.	RWQCB WDR's. Francisco Leasehold EIR.
Degradation of water quality (surface and ground) from discharge of chemical effluents (demineralizer regeneration wastes biocide and blowdown from steam generators, heating boilers and closed cycle cooling systems) in receiving waters.	Insignificant - Because of berms, pumps, and condensate ponds. However, all systems and personnel are vulnerable to failure.	RWQCB inspections. Francisco Leasehold EIR.
Change in the temperature of receiving waters from thermal effluents.	Insignificant - Steam would not readily condensate in enough volume to flow to a stream with enough elevated temp. to impact the water's quality	Personal experience.

Impact Identification Matrix

Project: DWR Bottlerock

By: L. Dillon

WATER RESOURCES

Date: 9-28-79

Environmental Category

Potential Impact	Significance	Source
WELL FIELD (Continued)		
Modification of existing stream flows and infiltration patterns due to the location and construction of reservoirs, lakes, ditches, pipelines, towers, cooling ponds, etc. Includes stream channel relocation or diversions and altered site drainage characteristics.	Insignificant - Well pads far above streams, no other water bodies involved.	Personal experience. Francisco Leasehold EIR.
POWER PLANT		
Potential degradation of water quality related to:		
-Increased surface runoff increasing erosion potential, siltation, turbidity	Significant during construction and early operation.	NOI-Geotechnical - pages 43-44 AFC, V-101,102.
-Discarded or discharged construction materials, fuels, fluids	Insignificant - All construction will be done after the containment system is in.	
-Wastewater (construction, sanitary)	Insignificant - Very little generated	Personal experience.
-Dredging and spoil disposal	Significant-	
-Increased water temperatures due to increased turbidity	Possibly significant during construction, less during operation of plant	Francisco Leasehold EIR.
-Temperature increase due to removal of vegetation	Insignificant - Stream flows will be of such velocity that isolated warming areas should have no effects.	Personal experience.
-Disturbance of stream bed for road, pipeline, and cable crossing	Significant - Will require mitigation measures.	

Impact Identification Matrix

WATER RESOURCES

Project: DWR Bottlerock

By: L. Dillon

Date: 9-28-79

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (Continued)		
-Increased levels of suspended solids in surface waters due to increased erosion.	Significant during construction and prior to establishment of re-vegetation mitigation measures.	AFC pp. V-3, V-101-103.
Potential deleterious effects of wastewater disposal on ground and surface waters.	Significant -	AFC, V-3.
-Degradation of water quality (surface and ground) from discharge of chemical effluents (demineralizer regeneration wastes, biocide and blowdown from steam generators, heating boilers and closed cycle cooling systems) in receiving waters.	Significant - For geothermal. Precautions required by SWRCB.	Central Valley Regional Water Quality Control Board Personnel.
Degradation of ground water quality from spills and leakage of oils, toxic chemicals, liquid wastes, etc.	Insignificant - Limited ground water. Mitigation measures proposed.	Central Valley Regional Water Quality Control Board Personnel.
Degradation of ground water quality from liquid waste disposal on the facilities site.	Insignificant - Impermeable layer over plant site and strict operational criteria.	Conversations with R.W.Q.C.B. personnel.
Change in currents, flows, temperature, chemical constituents, etc. of the receiving waters from discharge of cooling waters, blowdown discharge, treated service water systems, or accidents.	Significant - No discharge, except accidentally, to receiving waters.	Fish and Game - RWQCB spill list.

Impact Identification Matrix

Project: DWR Bottlerock

By: L. Dillon

WATER RESOURCES

Date: 9-28-79

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Increased overland flow, storm runoff. Increased discharge from cleared areas (especially timbered areas). Increased flood potential and channel erosion. Increased stream water temperature, volume and velocity.	Significant - But minimal, due to elevated position of plant sites and limited areas denuded.	Staff judgement.
Disruption of ground water movements by cuts for access roads or facility sites. Change in ground water and recharge areas due to impervious surfaces (increased surface areas impervious to water infiltration) and site dewatering.	Insignificant - Due to elevated nature of plant sites, and limited extent of ground water (mainly in fractures in hard rock).	Staff judgement.
Potential destruction from flooding, either natural or intensified by construction activities.	Insignificant - Due to elevated position of plant site. Possibly significant for culverts, down shutes and road crossings.	AFC - Hydrology Section.
Impacts from consumptive use of water in generating plant operations.	Insignificant - Main water source, spent geothermal fluids.	AFC Section IV-14, IV-19.
Modification of existing stream flows and infiltration patterns due to the location and construction of reservoirs, lakes, ditches, pipelines, towers, cooling ponds, etc. Includes stream channel relocation or diversions and altered site drainage characteristics.	Insignificant - Construction of the proposed project will not modify the existing stream flows.	NOI - Hydrology Section.

Impact Identification Matrix

Project: DWR Bottlerock

By: L. Dillon

WATER RESOURCES

Date: 9-28-79

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Potential for flooding from reservoirs and ponds if dams or levees break.	Insignificant - There are no large bodies of water upstream of the proposed project.	NOI- Hydrology Section page 9-10 Chapter VII.
TRANSMISSION LINES		
Degradation of water quality, resulting from construction and/or operation of transmission line facilities.	Insignificant - Disturbance at footings for towers directed away from stream crossing. Brush clearance should cause only temporary problems.	
Alter existing flow patterns (water courses, overland flow, ground water recharge) by placement of tower pads and substation and switchyard facilities.	Insignificant - Very small surface area involved.	
Potential loss of tower, transmission lines or other facilities due to flooding.	Insignificant.	

Impact Identification Matrix

Project: Bottle Rock

By: D. Anderson

BIOLOGICAL RESOURCES

Date:

Environmental Category

Potential Impact	Significance	Source
WELL FIELD		
Vegetation damage and destruction	Insignificnat - Results of roads and other access corridors. Impact minimized with proper precautions.	NOI, page 7,8,10,11 Biological Resources AFC V-3, 106,108-110.
Potential loss of agricultural production	N/A - No agriculture on the lease-hold.	
Potential for harm to flora and fauna from liquid and gaseous effluents discharged during operation of geothermal facilities	Unresolved - Should be insignificant unless problems develop with venting and clearing well debris.	AFC V-3.
Loss of wildlife habitat or significant habitat components	Significant - Results of roads and access corridors. Erosion effects on aquatic organisms. Insignificant with proper mitigation.	NOI, pages 7,8,11 Biological Resources AFC I-3, 106,108-110.
Disturbance of wildlife by human activity and noise	Insignificant - The activity and noise will decrease after the drilling and construction are completed.	NOI, page 11 Biological Resources AFC V-106-108.
Hazards to fish and wildlife from sumps, disposal of drilling muds, releases of geothermal fluids, etc.	Significant - If spill contents enters stream or introduced into the food chain. Insignificant with proper mitigation.	NOI pages 8,9,10,14 Biological Resources AFC V-105 F & G letter of 11-20-78.

Impact Identification Matrix

Project: Bottle Rock

By: D. Anderson

BIOLOGICAL RESOURCES

Date: _____

Environmental Category

Potential Impact	Significance	Source
WELL FIELDS (continued)		
Creation of new habitat features and availability of new habitat areas after abandonment	Insignificant - Developed areas will be returned to a natural condition.	AFC p. IX-3 Fish and Game letter of 11-20-78.
Potential for loss of flora and fauna from fire	Insignificant - There is a potential for loss of wildlife and vegetation communities. If precautions are taken this potential impact should be minimized.	EIR for Union Oil Co., Unit # 17 Development Area, 1977.

Impact Identification Matrix

Project: Bottle Rock

By: D. Anderson

BIOLOGICAL RESOURCES

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT		
Loss of vegetation (negative or agricultural) and wildlife habitat (food cover, nesting locations, breeding ground, winter ranges, etc.), resulting from construction	Significant - Yellow pine and mixed evergreen forests have a high wildlife value. The surrounding area will be impacted through noise and human activity.	NOI pages 7,8,9 Biological Resources Fish & Game letter of 11-20-78 NOI page 35 Biological Resources (Neilson page 1) NOI pages 72,73 Biological Resources (Leitner p. 25) AFC p. V-106,108-110
Increase fire hazard caused by workmen and equipment resulting from construction	Insignificant - Provided precautions are taken. The development increases fire breaks and communication. It also provides a small source of water (at power plants), more exposure for earlier fire detection.	EIR for Union Oil Co. Unit # 17 Development area 1977.
Potential loss of flora and fauna related to the increased fire hazard caused by operation and maintenance of the facility	Insignificant - Plant site will be cleared of vegetation. Precautions should be taken to protect against fire.	EIR for Union Oil Co. Unit # 17 Development area 1977.
Potential for harm to flora and fauna from liquid and gaseous effluents discharged during operation of geothermal facilities	Unresolved - damage to vegetation is indicated from other operating Geothermal facilities. Wildlife may by impacted via direct vegetation loss and food chain transport.	NOI pages 9,10 Biological Resources NOI page 73 Biological Resources (Leitner page 25) AFC p V-106 Fish & Game letter of 11-20-79

Impact Identification Matrix

BIOLOGICAL RESOURCES

Project: Bottle Rock

By: D. Anderson

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Potential loss of agricultural production	N/A - No agricultural production on the power plant site.	
Change in species composition (both floral and faunal) due to habitat changes (e.g. degradation of water quality) resulting from construction	Insignificant - Erosion control proposed.	Fish & Game letter of 11-20-78.
Potential harm to vegetation and wildlife from the degradation of water quality from wastewater systems	Insignificant - Mitigation proposed to retain spills on-site erosion control proposed.	AFC p. V-105-106
Permanent loss of vegetation and wildlife habitat due to project facilities	Significant - Not only the power plant site but the surrounding area may be adversely impacted by increased human activity.	NOI pages 7,8,9,11 Biological Resources NOI page 43 Biological Resources (Neilson page 9)
Loss or displacement of wildlife supported by the habitat	Insignificant - Mitigation to increase the carrying capacity of the unaffected areas is proposed.	Fish & Game letter of 11-20-78 NOI pages 72,73,74 Biological Resources (Leitner pages 24,25,26)
Loss of rare, endangered, unique or unusual species of plants and wildlife, communities or habitats	Insignificant - Mitigation to avoid these losses is proposed.	AFC p V-1,3,106,107,108-110

Impact Identification Matrix

Project: Bottle Rock

By: D. Anderson

BIOLOGICAL RESOURCES

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Loss of wildlife from construction activities from lack of available habitat after displacement	Insignificant - Provided mitigation proposals to increase carrying capacity of habitats on the remainder of the leasehold are implemented prior to construction.	AFC p V-108-110
Direct loss of wildlife from construction activities: Loss of aquatic communities if a stream is relocated Loss of aquatic organisms (fresh water)	Insignificant - Provided mitigation proposals for construction of a sedimentation pond are implemented prior to power plant construction.	NOI pages 7,13,14 Biological Resources AFC pages V-102-103 Fish & Game letter of 11-20-78
Loss of rare, endangerd, unique or unusual species or habitat resulting from construction activities	Insignificant - No losses identified for the site.	NOI page 43 Biological Resources (Neilson page 9) NOI pages 66,67,71,72 Biological Resources pages 18,19) AFC page V-1, 116,117
Accumulation of harmful substances in some species due to uptake of pesticides, herbicides, construction chemicals, etc.	Unresolved - Both vegetation and wildlife could be significantly affected by cooling tower drift containing toxic materials. Herbicide and pesticide use may cause a potentially significant impact.	NOI pages 12,13 Biological Resources NOI pages 74,75 Biological Resources (Leitner pages 26,27) AFC page V-106 Fish & Game letter of 11-20-78

Impact Identification Matrix

BIOLOGICAL RESOURCES

Project: Bottle Rock

By: D. Anderson

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Change in wildlife species composition, species diversity and species number in vicinity of generating facility	Significant - Some species may be shy of humans, structures, noise or their cumulative effect. Insignificant - With proper mitigation implementation.	NOI page 11 Biological Resources AFC pages V-106,108 (Geysers Wildlife Study, 1977) AFC V-108-110
Deleterious effects on aquatic organisms and other wildlife from surface water contamination from cooling tower or pond drift or cooling pond leakage	Significant - The potential exists, although with the proper mitigation implementation, the probability should be insignificant.	NOI pages 9,10,11,12,13,14 Biological Resources NOI pages 73,74 Biological Resources (Leitner pages 25,26) AFC page V-106 Fish & Game letter of 11-20-78

Impact Identification Matrix

BIOLOGICAL RESOURCES

Project: Bottle Rock

By: D. Anderson

Date:

Environmental Category

Potential Impact	Significance	Source
TRANSMISSION LINES		
Increased human access (secondary impacts on and near transmission corridors such as increased hunting (increased loss of animal species and disturbance and destruction of habitat), increased recreation potential)	Insignificant - Not expected.	NOI pages 11,13 Biological Resources AFC pages V-107,108 (Geysers Wildlife Study, 1977) Fish and Game letter of 11-20-78
Disturbance, especially of sensitive species from human encroachment (sensitivity depends on species, time of year, life history stage, etc.)	Unresolved - More information required.	NOI page 11 Biological Resources AFC pages V-107-108 (Geysers Wildlife Study 1977) Fish and Game letter of 11-20-78
Restriction of migration routes and daily movement corridors	Unresolved - More information required. Insignificant with proper mitigation measures.	NOI page 9 Biological Resources
Collision mortalities, especially in waterfowl migration routes, between birds and towers, cables or other facilities	Insignificant - This is an area of low waterfowl usage.	NOI page 9 Biological Resources
Electrocution of large birds on towers and cables	Insignificant - Tower design eliminated this impact.	United States Department of Agriculture Rural Electrification Administration REA Bulleton 61-10

Impact Identification Matrix

Project: Bottle Rock

By: D. Anderson

BIOLOGICAL RESOURCES

Date: _____

Environmental Category

Potential Impact	Significance	Source
TRANSMISSION LINES (continued)		
Permanent loss of habitat under tower footings, paved access roads, switchyard and substation facilities. Loss of rare and endangered and unique or unusual species or habitat. Loss of wildlife species supported by habitat permanently lost (if adjacent areas unable to support displaced wildlife)	Unresolved - The exact route of the transmission lines are not known. If route is mitigated, the impact will probably be insignificant.	NOI page 38 Biological Resources AFC p. V-I, 106,107,108
Change in species composition and in food and cover value of transmission right-of-way	Unresolved - More information required. Should be insignificant if mitigation measures are implemented.	
Loss of vegetation and wildlife habitat through "clean" maintenance of access roads and facility sites	Unresolved - More information required.	
Loss of vegetation and supported wildlife by selective thinning of vegetation during maintenance activities	Unresolved - More information required as to methods of maintenance.	
Probable detrimental effects to flora and fauna from exposure to electric and magnetic fields in the vicinity of power lines	Insignificant - Type of vegetation and wildlife not known to be affected by 230 KV line.	"Biological Effects of High Voltage Electric Fields" Electric Power Research Institute EPRI 381-1 Final Report 1975.

Impact Identification Matrix

Project: Bottle Rock

By: D. Anderson

Date:

BIOLOGICAL RESOURCES

Environmental Category

Potential Impact	Significance	Source
TRANSMISSION LINES (continued)		
Potential damage to lines and towers from fire supported by vegetation beneath the lines	Insignificant - Towers will be of steel and the vegetation will be maintained at a safe height. minimum ground clearance is 30 feet as required by the California Public Utilities Commission.	NOI page VI 4.
Loss of electrical energy as the result of a fire (from whatever cause)	N/A	
Potential for loss of agricultural production	N/A - No agricultural production.	
Potential fire hazard to lands (vegetation, wildlife) from fires started by downed lines	Insignificant - Could be significant but probability of this potential impact appears low. Early detection through better communication and exposure to humans plus many fire breaks caused by increased roads in area should offset increased risk.	EIR for Union Oil Co. Unit # 17 Development Area, 1977.

Impact Identification Matrix

HEALTH/ SAFETY

Project: DWR Bottlerock

By: Nancy Post

Date:

Environmental Category

Potential Impact	Significance	Source
WELL FIELD (continued)		
Emissions may be caused by accident hazard during well operations	Worker health - Insignificant - Compliance with occupational health standards and requirements (Cal. Admin. Code Title 8 Chapter 4) should ensure adequate protection of worker health.	Cal. Admin. Code Title 8, Chapter 4.
Emissions may present a health hazard to workers or the public.	Public health - Unresolved - Emissions from the well field will contribute to ambient H_2S concentrations, which may occasionally violate the air quality standard for H_2S in the vicinity of the well field. The frequency and duration of violations are not known.	Draft EIR for McCulloch Corp. DWR Bottle Rock Power Plant Francisco Leasehold. July 1979.
Exposure to noise in excess of 90 dB(A) for 8 hours for workers or in excess of 55 dB (L_{dn}) to sensitive environmental receptors.		
POWER PLANT		
Emissions incurred during construction may present a health hazard to workers or the public.	Insignificant - Emissions from construction equipment, and dust are not expected to increase abmient pollutant concentrations in nearby communities to levels which would adversely impact public health. Compliance with occupational health standards and requirements should ensure adequate protection of worker health.	DWR Bottlerock Power Plant NOI. Cal. Admin. Code Title 8 Chapter 4.

Impact Identification Matrix

HEALTH/SAFETY

Project: DWR Bottlerock

By: Nancy Post

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Emissions from generating operation may present a health hazard to workers or the public.	See attachment.	
Emissions from heat dissipating system may present a health hazard to workers or the public.		
Possibility of accidents associated with transportation systems constructed as a direct adjunct to the power plant (examples: new supply road).	Insignificant - Primary ingress/egress is through existing California Highway System with some new road construction. If applicant complies with existing L.O.R.S. governing the use of these roads, no environmental impact can be prognosticated.	Staff position. CAL. DMV drivers hand book 1978 edition.
Exposure during operation of power plant to noise in excess of 90 dB(A) for 8 hours for worker or in excess of 55 dB (L_{dn}) to sensitive receptors.	Insignificant - Applicant muste comply with DOSH standards and staff will recommend compliance with local noise elements or ordinances.	

(Impact Identification Matrix - Health)

ATTACHMENT

Worker health - Insignificant - Compliance with the occupational health standards and requirements set forth in Cal. Admin. Code Title 8, Chapter 4, should ensure adequate protection of worker health.

Public health - Unresolved - Preliminary analysis of the Cobb Valley Tracer Study indicates that ambient hydrogen sulfide concentrations which may result from stacking of steam for the Bottle Rock power plant are far in excess of the state ambient air quality standard for hydrogen sulfide.

Emissions of other regulated pollutants and unregulated pollutants (mercury, arsenic, and ammonia) from the Bottle Rock power plant are not expected to result in ambient concentrations harmful to human health. However, monitoring programs may be warranted to determine emission rates and ambient concentrations of these pollutants.

Sources: Cal. Admin. Code Title 8, Chapter 4
Geysers Cobb Valley Air Quality Impact Study MRI 79
DWR Bottle Rock Powerplant AFC 1979

Impact Identification Matrix

Project: DWR Bottlerock

By: Nancy Post

HEALTH/SAFETY

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Possibility of security problems associated with general operations and maintenance of the plant.	Insignificant - There is potential for damage to the environment from sabotage of chemical holding tanks on site. This potential for damage is mitigated. Because o f the plants remote location and small capacity, a serious saboteur would probably attack more critical network points (switch yard, transmission lines) which do not have frequent visits by operations personnel. Also, the plant site will be bermed to contain any possible chemical spillage volume and clean-up would begin immediately.	Staff; page IV-26, NOI.
Possibility of accidents associated with construction of power plant facilities.	Insignificant - Minor environmental impact is expected from construction accidents. Applicants compliance with Cal. OSHA construction standards will mitigate the dangers of construction.	Staff position. Cal. Admin. Code Title 8, Chapter 4.
Possibility of accidents associated with use of explosives, heavy equipment operation.	Insignificant - Only minor impact is expected from use of explosives provided they are stored per 27 CFR 181 storage between use.	27 CFR 18.

Impact Identification Matrix

Project: DWR Bottlerock

By: Nancy Post

HEALTH/SAFETY

Date: _____

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (continued)		
Possibility of accidents associated with operation and maintenance of generation system equipment.	Unresolved – Use of potentially hazardous chemicals in hydrogen sulfide abatement systems at the Bottlerock power plant will increase transport of potentially hazardous materials on roads in The Geysers KGRA and surrounding areas. The possibility of impacts to the health and safety of workers and the public may increase due to the potential increase in traffic accidents and chemical spills.	
Exposure to noise during construction in excess of 90 dB(a) for 8 hours for workers or in excess of 66 dB (L_{dn}) to sensitive receptors.		

Impact Identification Matrix

Project: DWR Bottlerock

By: Nancy Post

HEALTH/SAFETY

Date:

Environmental Category

Potential Impact	Significance	Source
TRANSMISSION LINES		
Potential health hazard from exposure to electric fields and magnetic fields.	Insignificant - Members of the public are not chronically exposed and health hazards have not been demonstrated.	Numerous technical publications and several siting cases before this Commission.
Possibility of accidents associated with the electric transmission system.	Insignificant - See above. Compliance with safety standards and the staffs grounding criteria make hazards highly unlikely.	See Above.
Exposure to noise in excess of 90 dB(A) for 8 hours for workers, or in excess of 55 dB(L_{dn}) to sensitive receptors.	Insignificant - Applicant must comply with DOSH standards and staff will recommend compliance with local noise elements or ordinances.	See above.
Radio and TV interference (RI/TVI).	Insignificant - Noise is low level and there are few or no receptors. The applicant will be expected to comply withe staffs RI/TVI mitigation criteria and FCC part 15.25.	See above.
WELL FIELD		
Possibility of accidents associated with well drilling and steam or hot water extraction.	Insignificant - Applicants compliance with Cal. OSHA standards for industrial safety are reasonable precautions for the environment. See emission, this section.	Cal. Admin. Code Title 8, Chapter 4.

Impact Identification Matrix

Project: Bottle Rock

By: Loni Perry

ENERGY AND MATERIAL RESOURCES

Date:

Environmental Category

Potential Impact	Significance	Source
TRANSMISSION LINES		
Use of resources and energy associated with construction of electrical transmission system, including transformer stations, etc.	Unresolved	
Use of resources and energy associated with operation of transmission facilities transmission lines, transformer stations, switchyard, etc.	Unresolved	
Energy used in transmitting, transforming, switching and regulating electrical energy (transmission lines, terminal equipment (transformers, converters, switchgear) and control and metering systems)	Unresolved, however, T-line loses are very significant for economic and relative merit considerations	CEC Staff
POWER PLANT		
Use of resources and energy in the preparation of the site and construction of the various facilities including the generating plant	Unresolved - However, quantities believed to be minimal	
Depletion of the geothermal resource for power generation	Significant - Recharge rate for geothermal resource is unknown; however, reservoir pressures have declined.	

Impact Identification Matrix

ENERGY AND MATERIAL RESOURCES

Project: Bottle Rock

By: Loni Perry

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (Cont)		
Resource and energy uses associated with project facilities including the generating, service water, and waste heat dissipating systems (e.g., coolant pumps, cooling tower blowers) plus other internal uses	Unresolved - However believed to be minor based upon statistics from currently operating generating facilities	
Use of chemicals, materials, fuel and electricity for facilities operation and maintenance	Unresolved - Believed to be minimal.	
Energy and resources used in maintenance of turbines	Unresolved - However believed to be minor	
WELL FIELD		
Use of resources and energy associated with construction of well field and waste fluid disposal facilities, and with well field abandonment	Unresolved - But believed to be minimal	
Energy use associated with operation of well field and waste fluid disposal facilities	Unresolved, however due to nature of power source and gravity feed reinjection system the energy use would be minor	

Impact Identification Matrix

Project: Bottle Rock

By: Gary C. Heath

Date: 10-31-79

Environmental Category CULTURAL RESOURCES

Potential Impact	Significance	Source
WELL FIELD		
Disturbance or destruction of cultural resources due to exploration, drilling and construction related to development of geothermal resource.	Unknown	No documentation
Disturbance or destruction of paleontological resources resulting from construction.	None	NOI Cultural Resource Section (CRS) Page 2
Disturbance or destruction of historical resources.	Unknown	NOI CRS Pages 18-24
Destruction of valuable resources by ongoing power plant maintenance and operation and visitors.	Unknown	NOI CRS pages 18-24
Increased access and resulting disturbance of cultural or historical resources.	Unknown	NOI CRS Pages 18-24

Impact Identification Matrix

Project: Bottle Rock

By: Gary C. Heath

Date: 10/31/79

Environmental Category CULTURAL RESOURCES

Potential Impact	Significance	Source
POWER PLANT		
Possible disturbance or destruction of archaeological resources resulting from construction.	Likely	AFC Pages V-120 thru V-121
Disturbance or destruction of paleontological resources resulting from construction.	None	NOI CRS Page 2
Disturbance or destruction of historical resources.	None	NOI CRS Pages 18-24
Disturbance or destruction of educational, religious, scientific or other cultural resources.	None	NOI CRS Pages 2-18
Destruction of valuable resources by ongoing power plant maintenance and operation and visitors.	Unknown	NOI CRS Page 28
Increased access and resulting disturbance of cultural or historical resources	Unknown	NOI CRS Page 28

Impact Identification Matrix

Project: Bottle Rock

By: Gary C. Heath

Date: 10/31/79

Environmental Category CULTURAL RESOURCES

Potential Impact	Significance	Source
TRANSMISSION LINES Possible disturbance or destruction of archaeological, paleontological, historical, educational, religious, scientific or other cultural resources, resulting from construction and operation/maintenance activities.	Unknown	NOI CRS Pages 1-39. AFC Pages V-120 thru V-122

Impact Identification Matrix

HUMAN RESOURCES

Project: Bottle Rock

By: Mike Smith

Date: _____

Environmental Category

Potential Impact	Significance	Source
WELL FIELD		
Potential impacts on local/regional employment by workers employed within power plant project area for development of geothermal resource	Insignificant - Large resident labor force has been created in Geysers area to work geothermal resource	NOI
Secondary impacts of population increase service (indirect) employment, population increase, and demand for housing	insignificant - Little population increase due to geothermal development expected	NOI pg. 80, Vollentine, et al., pg. 59
POWER PLANT		
Project area will experience increased employment and income directly attributable to construction of power plant and related facilities (Primary employment)	Insignificant - Increased local employment not expected - local resident geothermal work forces.	NOI
Power plant construction will compete with other projects or existing sources of employment for workers	Insignificant - see above	NOI
Project area will experience increased employment and income directly attributable to operation and maintenance of power plant	Insignificant - Facilites will be operating by existing, roving operations crews	NOI

Impact Identification Matrix

Project: Bottle Rock

By: Mike Smith

HUMAN RESOURCES

Date:

Environmental Category

Potential Impact	Significance	Source
POWER PLANT (Continued)		
Project area population will increase due to increases in direct and indirect employment	Insignificant– Workforce to be drawn from resident geothermal workforce	NOI
Housing units will be required to accomodate construction worker households	Insignificant – will draw from existing resident geothermal workforce	NOI, pg. 80; Vollentine, et al., pg. 59
Operation and maintenance of power plant may result in new households in project area	Insignificant – see above	NOI, pg. 80; Vollentine, et. al., pg. 59
Presence of power plant may diminish employment in other sectors	Insignificant – see above	NOI, pg. 80; Vollentine, et al., pg. 59
TRANSMISSION LINES		
Population and housing effects due to construction of transmission lines	Insignificant – (Geysers 17 transmission line) land is wilderness; transmission line crew will erect line. Line is little over 1 mile long. Geysers – Lakeville 230 iv	NOI

Impact Identification Matrix

Project: Bottle Rock

By: Mike Smith

Date:

Environmental Category: ECONOMIC ACTIVITY

Potential Impact	Significance	Source
WELL FIELD		
Potential change in economic activity in primarily rural/agricultural/recreational areas	Unresolved - Some recreational activities may be displaced by wellfield activities.	Not really addressed
POWER PLANT		
Conformity with the CERCDC biennial forecast of electrical demand		
Impact of constructing project on national capital supplies		
Impact of proposed project on "average" residential, commercial and industrial rate schedule		
Change in basic econonomic activities of affected region	Insignificant - Region has in the past been explored and utilized for geothermal activities.	NOI
Impact of additional population on adequacy of commercial services	Insignificant - Little population expected to be added - workforce drawn from existing resident labor-force	NOI

Impact Identification Matrix

Project: Bottle Rock

By: Mike Smith

Date: _____

Environmental Category INSTITUTIONAL RESOURCES

Potential Impact	Significance	Source
POWER PLANT		
Adequacy of community services/facilities due to plant requirements, e.g., waste water, solid waste, police, fire	Insignificant - Plant will make very minor requirements upon community services (if any)	NOI
Adequacy of community services/facilities due to increased population (construction and operation work force). Services/facilities demanded could include: . Sewer . Water . Transportation . Police protection . Fire protection . Solid waste . General government . Schools . Medical care . Electrical and gas utilities . Parks and recreation . Flood control and drainage . Telephone and communications . Housing	Insignificant - Project is expected to utilize resident geothermal workforce	
Change in capital requirements, operating costs and revenues of local service providers	Significant - Will add to county tax revenue	

Impact Identification Matrix

Project: Bottle Rock

By: Mike Smith

Date: _____

Environmental Category INSTITUTIONAL RESOURCES

Potential Impact	Significance	Source
POWER PLANT (continued)		
Adequacy of local transportation systems to accommodate construction and operation	Significant - Project traffic may cause deterioration of Bottle Rock Road	
Potential depletion of municipal water supplies by heat dissipating system		
TRANSMISSION LINES		
Identify public utility lines requiring alteration	Insignificant - None so identified in area	NOI

Impact Identification Matrix

Project: Bottle Rock

By: Mike Smith

Date:

Environmental Category SOCIAL STRUCTURES

Potential Impact	Significance	Source
POWER PLANT		
Possible changes in community structure, lifestyle	Insignificant - Workforce is already present to a large degree in the resident populations of Lake and Sonoma Counties (primarily Sonoma)	Lake Co. Economy: Potential Socio-Economic Impacts of Geothermal Development Vollentine, Kunin, et al., 2/77 LBL-5944
WELL FIELD		
Change in land use due to exploration and extraction	Significant - Project borders on residential recreational area.	
Change in land use due to transportation needs	Insignificant -	
Change in land use due to fuel and waste disposal	Insignificant	
Compatibility with nearby existing and planned land uses, and/or land use designations including General Plan	Unresolved - Lands that well field is located on is undesignated by Lake Co. - this may be under litigation	Report on the Status of Development of Geothermal Energy Resource, Jet Prop. Lab. 6.76; Sec. 5, page

Impact Identification Matrix

Project: Bottle Rock

By: Mike Smith

Date: _____

Environmental Category LAND USE

Potential Impact	Significance	Source
POWER PLANT		
Consumption of land for generating plant and related facilities	Insignificant - Zoning takes the plant size into account	NOI
Compatibility with nearby existing and planned land uses and/or use designations including General Plan	Insignificant - Sonoma Co. has classified geothermal area as such	NOI

APPENDIX B
POTENTIAL HEALTH EFFECTS OF GEOTHERMAL POLLUTANTS

Geothermal steam contains contaminants which when inhaled or ingested in sufficient quantities can adversely impact human health. These include hydrogen sulfide (H_2S), radon-222 (^{222}Rn), ammonia (NH_3), particulate matter, and trace elements, such as mercury (Hg), arsenic (As), and boron (B). Abatement systems can also emit varying amounts of pollutants such as vanadium (V), anthraquinone disulfonic acid (ADA), hydrogen peroxide, iron (Fe) sodium carbonate ($NaHCO_3$) sodium sulfate (NA_2SO_4), and sodium thiosulfate ($NA_2S_2O_3$). Some of these pollutants can react in the ambient air to form secondary pollutants such as sulfur dioxide and sulfates.

The potential for adverse impacts to public health depends on: 1) the toxicity of the emitted contaminants, 2) the concentration or quantity to which the public is exposed, and 3) the duration of exposure. Exposure to these pollutants can occur from inhalation of air, or ingestion of contaminated drinking water or food. The following discussion addresses potential adverse human health impacts associated with these contaminants.

Hydrogen Sulfide

Hydrogen sulfide is a toxic gas which can be fatal to humans when inhaled in concentrations of 1000 parts per million (ppm) and above for several minutes (NIOSH 1977). Longer exposure to lower concentrations also can be fatal. In concentrations above the state occupational standard of 10 ppm (8 hour average) H_2S can cause irritation of the eyes and respiratory tract, damage to the lungs and loss of consciousness. Sulfide at levels below 10 ppm may induce decreased corneal reflex, nausea, insomnia, headaches, loss of sleep, and other symptoms (Table B-1) (Walton and Simmons 1978).

There have been relatively few studies of adverse health effects from exposure to H_2S at low concentrations (less than 0.1 ppm) such as those measured in populated areas around The Geysers KGRA. Because of the lack of studies and questions concerning the validity of results from some of those studies, there appears to be controversy as to the potential for adverse effects from H_2S at low concentrations.

Some experts do not believe that exposure to concentrations below 1 ppm adversely affects human health (Simmons, 1979). The State of Montana has proposed an H_2S standard based on reported health effects at 0.3 ppm (Montana 1979). The lowest concentrations accepted by other experts as inducing adverse health effects is 0.08 ppm (Illinois Institute for Environmental Quality, 1974), almost three times greater than the California ambient air quality standard for H_2S. Nausea, fatigue, loss of appetite, dizziness, blurred vision and increased incidence of mental depression have been reported to result from chronic exposure to this concentration (ibid).

There have been studies which report adverse health effects at levels below 0.08 ppm, the validity of these low level studies, however, has been questioned (LBL, 1977; Walton and Simmons, 1978). Yet, the possibility that these low levels can induce adverse health effects cannot be dismissed without further investigation.

TABLE B-1

HUMAN HEALTH EFFECTS OF HYDROGEN SULFIDE

ppm*	Health Effects	Reference
0.00047-0.0045	Odor threshold	Leonardos, 1969 Wilby, 1969
0.007-0.03	Slight odor	Gurinov, 1952
0.03	California ambient air quality standard for one-hour average (concentration based on the odor threshold)	ARB, 1970
0.04-0.13	Clear definite odor	Gurinov, 1952
0.08	Increased incidence of mental depression, dizziness and blurred vision	State of Illinois 1974
0.30	Increased incidence of nausea, insomnia, shortness of breath and headaches with chronic exposure	Indiana APCD, 196
0.7-7	Incidence of decreased corneal reflex with chronic exposure	State of Illinois 1974 Rubin, 1975
4.6	Readily apparent, offensive odor	Simson, 1971 Yant, 1930
10	Threshold limit value for 8-hour exposure at the work place	American Conference of Governmental Industrial Hygienists, 1977
10-50	Threshold for irritative action with prolonged exposure: eye irritation such as conjunctivitis and at the higher concentrations dry throat. Fatigue, loss of appetite and insomnia with chronic exposure	Ahlborg, 1951 Gurinov, 1952 NIH, 1941
20-30	Very strong, but not intolerable odor	State of Illinois 1971 Yant, 1930
70-150	Eye irritation after several hours of exposure; conjunctivitis, keratitis and photophobia. Threshold for olfactory paralysis occurring within minutes	Devege, 1956 Evans, 1967 Mitchell, 1925 AIHA, 1963
200-300	Serious local irritation to eyes and respiratory tract caused upon inhalation for one hour, with possible subsequent pulmonary edema. This is the maximum concentration which can be inhaled for one hour without serious consequences.	Mitchell, 1925 Haggard, 1925

Adapted from Walton, A.H. and W.S. Simmons, 1978

There is reason to believe exposure to H_2S may be more harmful to certain groups of individuals than to the general population. These H_2S sensitive group include infants, individuals with anemia, eye or respiratory problems, schizoid or paranoid tendencies and those who have recently consumed alcohol (Illinois Institute for Environmental Quality, 1974; Walton and Simmons, 1978).

Hydrogen sulfide gas has a characteristic odor of rotten eggs which can be detected at low concentrations. The odor threshold varies with individual sensitivity; thresholds have been reported as high as 0.14 ppm and as low as 0.00047 (Walton and Simmons, 1978). Different experimental techniques and difficulties in accurately preparing very dilute hydrogen sulfide concentrations may contribute to the wide discrepancy between reported thresholds. At high concentrations (70-150 ppm) hydrogen sulfide causes olfactory paralysis - loss of sense of smell (Walton and Simmons, 1978).

The California ambient air quality standard for H_2S is 0.03 ppm (1 hour average). Although public health protection was considered, this value was based on the average H_2S odor threshold obtained in a study conducted by the California Department of Public Health. In that study H_2S odor thresholds for 16 individuals were reported to range from 0.012 to 0.069 ppm; the average was 0.029 ppm H_2S (California Air Resources Board, 1970). A report prepared by Lawrence Berkeley Laboratories states that if the standard is to be based on known odor threshold, "then the standard should be lowered by a factor of 3 to 5 to the more recently accepted value for the odor perception threshold" (Case, 1977).

Radon-222

The noncondensable gas fraction of steam originating from natural fumaroles and developed geothermal wells contains the noble radioactive gas, radon-222 (^{222}Rn). When the steam is used to produce electrical energy, ^{222}Rn and its daughter products are found in the cooling tower sludge, in the steam condensate released to the atmosphere from the cooling tower, and at various locations with the workings of the plant itself (i.e., the steam exhaust ducts and condensers).

The primary health hazard associated with ^{222}Rn and its short-lived daughter products is inhalation and possible deposition in the lung. ^{222}Rn itself is usually inhaled and exhaled without disposition on lung tissue. However, the short-lived daughter products of ^{222}Rn (especially those which emit alpha particles), have a high probability for deposition. Deposition of an alpha-emitting substance on the lungs provides a greater potential for temporary or permanent tissue damage through the natural destructive action of the alpha energy.

Standards for radon-222 set by the Department of Health Services (DOHS) (Section 30355 of Title 17 of the California Administrative Code), are 100 pCi/l in air for a controlled area and 3 pCi/l in air for an uncontrolled radiation area at the point of release to the environment. These standards are for concentrations in the air above natural background radiation. A controlled radiation area is interpreted as being an occupational area and an uncontrolled area in interpreted as being any area to which the general public would have access.

Ammonia

Ammonia is primarily an irritant to eyes, mucous membranes, and the upper respiratory tract. The lowest concentration reported to cause irritation in humans via inhalation of 20 parts per million (ppm) (EPA, 1977), and barely noticeable eye irritation has been reported at 5 ppm (NIOSH, 1974). Exposure to low levels of ammonia has not been observed to cause permanent adverse health effects (EPA 1977). The odor threshold for ammonia has been reported to range between approximately 0.7 ppm and 50 ppm (NAS, 1977). Standards and suggested safe levels for exposure to ammonia are listed in Table B-2.

Trace Elements and Chemical Emissions

Geothermal steam contains trace elements, including mercury, arsenic and boron. Abatement systems emit vanadium, iron, $NaHCO_3$, Na_2SO_4, and $Na_2S_2O_3$. These substances could cause adverse public health impacts if present in sufficient concentrations. Suggested standards and safe levels for these pollutants in air are listed in Table B-2.

Mercury

Inhalation of mercury compounds can induce cough, fever, bronchitis and pulmonary edema. Chronic poisoning results from the accumulation of mercury in the brain, kidney and hair, and causes symptoms such as headaches, dizziness and fever. Children are especially susceptible to mercury poisoning (Britt, 1976). Certain mercury compounds have been shown to have potential to cause cancer or birth defects (EPA, 1977).

Organisms, particularly those in aquatic environments, can absorb, concentrate and transform trace elements. Mercury may be transformed to more hazardous forms (such as methyl mercury), and accumulate in various links in food chains, particularly in higher trophic levels. Fish can contain high mercury levels since they take up mercury compounds both through consumption of food and through their gills (Britt, 1976). Ingestion of mercury in contaminated food or water can result in adverse health effects such as headaches, blurred vision, loss of muscular coordination and death (Waldbott, 1973). To protect public health from hazards of mercury ingestion, the Federal Food and Drug Administration recommends 1.0 ppm mercury in fish as a safe level for human consumption.

High concentrations of mercury have been measured in fish at Clear Lake, not far from The Geysers KGRA (Week, 1978). Although the mercury content in most fish tested was below the recommended safe level of 1.0 ppm in edible fish, a small number of the fish sampled exceeded this value. Such high levels are believed to be caused by sources other than mercury emissions from geothermal power plants at The Geysers KGRA, yet it can be inferred that this area may carry a significant burden of background mercury already, and any addition to the environment would increase this burden.

Arsenic

Arsenic emitted from geothermal steam may be in varying forms such as suspended particulate, vapor or arsine. Acute exposure to arsenic (depending on concentration) may cause headaches, dizziness, numbness, chills and fever, nausea,

TABLE B-2

Values for Assessing Potential Public Health Impacts
From Non-Regulated Pollutants in Ambient Air

Pollutant	Type of Value	Source	Concentration	Averaging Time
Ammonia	California Occupational Standard	Cal/OSHA	25 ppm	8 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.06 ppm (43 ug/m^3)	annual average*
	Foreign Ambient Air Quality Standards	Russia & East European Countries	0.14 - 0.71 ppm	24 hours
Arsenic	Suggested Occupational Standard	NIOSH	2.0 ug/m^3	15 minutes
	Suggested Threshold Limit Value	ACGIH	50 ug/m^3	8 hours
	Presumed Safe Level	MTR - 6401	5.9 ug/m^3	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	0.005 ug/m^3	annual average*
Boron	Presumed Safe Level	MTR - 6401	50 ug/m^3	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	7.4 ug/m^3	annual average*
	California Occupational Standard	Cal/OSHA	10 mg/m^3 boron oxide	8 hours
Mercury	Presumed Safe Level	MTR - 6401	0.8 ug/m^3	24 hours
	Suggested Ambient Level Goal (based on toxicity)	EPA-600/7-77-136	0.1 ug/m^3	annual average*
	Suggested Ambient Level Goal (based on carcinogenic potential)	EPA-600/7-77-136	0.01 ug/m^3	annual average*
	California Occupational Standard	Cal/OSHA	50 ug/m^3	8 hours
Vanadium	Presumed Safe Level	MTR - 6401	6.8 ng/m^3	24 hours
	Suggested Ambient Level Goal	EPA-600/7-77-136	1.2 ng/m^3	annual average*
	Suggested Threshold Limit Value	ACGIH	0.5 mg/m^3 (dust) 0.05 mg/m^3 (fume)	8 hours
	Calif. Occupational Standard	Cal/OSHA	0.5 mg/m^3 (dust) 0.1 mg/m^3 (mist)	8 hours
ADA (anthraquinone disulfonic acid)	Suggested Ambient Level Goal	To be published by Oct 1979**	260 ng/m^3	annual average*
Hydrogen Peroxide	Suggested Threshold Limit Value	ACGIH	1 ppm	8 hours
	Calif. Occupational Standard		1 ppm	8 hours
Iron	Suggested Threshold Limit Value	ACGIH	10.0 mg/m^3 (iron oxide fumes) 1.0 mg/m^3 (iron salts) 0.08 mg/m^3 (iron pentacarbonyl)	8 hours
	Calif. Occupational Standard	Cal/OSHA	10.0 mg/m^3	8 hours

*Although an averaging time for Suggested Ambient Level Goals is not stated within the document, EPA-600/7-77-136 the authors have indicated that these goals are most applicable to annual average concentrations.

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Abbreviations: Cal/OSHA California Occupational Safety and Health Administration
NIOSH National Institute for Occupational Safety and Health
ACGIH American Conference of Governmental and Industrial Hygienists

EPA-600/7-77-136 Multimedia Environmental Goals for Environmental Assessment, W. F. Cleland and G. L. Kingsbury, U.S. EPA, Nov. 1977.

MTR-6401 Proposed Safe Ambient Air Quality Levels for Selected Potentially Hazardous Pollutants, J. L. Allen, The MITRE Corporation, May 1973.

vomiting, abdominal pain, pulmonary edema, jaundice, and leukocytosis. Chronic exposure may cause irritation to nose and throat, hair loss, tremors, anemia and cancer of the skin, lung, or liver (Britt and Hushon, 1976).

Boron

Compared with other atmospheric pollutants, the medical literature on boron and its compounds is sparce (Waldbott, 1973). Boron and most boron compounds are not highly toxic (Waldbott, 1973; Durocher, 1969), although boron hydrides have been rated as highly toxic (Durocher, 1969).

Chronic exposure to boron and boron compounds can result in reduced appetite, nausea, weight loss, increased risk of lung infection, central nervous system depression and kidney injury (Britt and Hushon, 1976).

Inhalation of boric acid and boron oxide in the form of dust can cause respiratory irritation, but is not likely to induce permanent damage (Waldbott, 1973).

Inhalation of boron hydrides (boranes) can result in severe central nervous system damage with symptoms including headache, dizziness, drowsiness, convulsions, fever, cough and pneumonia (Wilcox, 1973; Waldbott, 1973). Death or permanent damage may result (Durocher, 1969).

Vanadium

Excessive concentrations of vanadium can become toxic and result in conjunctivitis, skin irritation, chest pain, cough, asthma, pneumonia, nausea and vomiting, headache and tremor. Long range effects include hypertension, cardiovascular disease, kidney damage, anemia, emphysema and pulmonary fibrosis (Britt and Hushon, 1976). There is no evidence of teratogenicity, carcinogenicity, or mutagenicity due to vanadium. In fact, studies suggest that vanadium may be an essential element for some animals (at certain concentrations).

Occupational standards and recommended safe levels of exposure to vanadium has been given in Table B-2.

Anthraquinone Disulfonic Acid (ADA)

Stretford solution contains Anthraquinone 2:7 Disulfonic Acid (PGandE, 1979b), an organic aromatic compound most commonly used in the dye industry (Stern, 1977). Very little information is available which describes health effects from exposure to ADA.

Anthraquinone is reported to be a naturally occurring mutagenic compound, although the contribution to human cancer remains to be evaluated (Ames, 1979). It has low systemic toxicity to humans, but may cause skin irrigation sensitization (The Merck Index, 1968). Anthraquinone 1:5 Disulfonic Acid and Anthraquinone 1:8 Disulfonic Acid are suspected to have low toxicity (The Condensed Chemical Dictionary, 1972).

Hydrogen Peroxide

Exposure to hydrogen peroxide fumes has been traditionally an occupational worker concern rathern than a public health concern. Hydrogen peroxide in

nonflammable, but since it is an oxidizing agent, it helps to support combustion. Hydrogen peroxide, by itself, is not as toxic as it is when in combination with other pollutants such as ozone. Ozone (1 ppm) combined with hydrogen peroxide at concentrations above 1.5 ppm were lethal to some animals; whereas hydrogen peroxide by itself in a concentration of 200 ppm produced only a slightly toxic responses (Svirbely, J.L. et al, 1961).

Iron

Exposure to iron oxide fine particulates results in conjunctivitis, chronic bronchitis, pulmonary fibrosis and emphysema. Iron oxide can penetrate the walls of the lung bronchi and alveoli without damage to the mucous or ciliary barrier. In this way it can transport the carcinogen benzo(a)pyrene into the lungs (Waldbott, 1973). Ingestion of ferric sulfate causes vomiting, tachycardia, liver insufficiency, and capillary damage.

Occupational standards and recommended safe levels of exposure to iron and its compounds are given in Table B-2.

Sulfates

High concentrations of sulfates are associated with increased attack frequency in asthmatics, worsened symptoms in cardio-pulmonary patients, decreased ventilatory function in school children and symptoms of acute and chronic diseases in children and adults (Bachman, 1975).

Ambient and occupational standards associated with sulfate are given in Table B-3.

TABLE B-3

Ambient Air Quality Standards

Pollutant	Averaging Time	California Standard	Primary Federal Standard
Carbon Monoxide	12 hour	10 ppm ($11 mg/m^3$)	—
	8 hour	—	9 ppm ($10 mg/m^3$)
	1 hour	40 ppm ($46 mg/m^3$)	35 ppm ($40 mg/m^3$)
Hydrogen Sulfide	1 hour	0.03 ppm ($42 \mu g/m^3$)	—
Non-Methane Hydrocarbons	3 hour (6-9 a.m.)	—	160 $\mu g/m^3$ (0.24 ppm)
Lead	30 day	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$ (quarterly average)
Nitrogen Dioxide	Annual Average	—	0.05 ppm ($100 \mu g/m^3$)
	1 hour	0.25 ppm ($470 \mu g/m^3$)	—
Oxidant (Ozone)	1 hour	0.10 ppm ($200 \mu g/m^3$)	0.12 ppm ($240 \mu g/m^3$)
Sulfur Dioxide	Annual Average	—	0.03 ppm ($80 \mu g/m^3$)
	24 hour	0.05 ppm ($131 \mu g/m^3$)*	0.14 ppm ($365 \mu g/m^3$)
	1 hour	0.5 ppm ($1310 \mu g/m^3$)	—
-Suspended Particulate Matter	Annual Geometric Mean	60 $\mu g/m^3$	75 $\mu g/m^3$
	24 hour	100 $\mu g/m^3$	260 $\mu g/m^3$
Sulfates	24 hour	25 $\mu g/m^3$	—
Radon-222	Annual Average	3 pCi/l**	—

*When standards for total suspended particulates of oxidant are being exceeded.
**Above natural background, at point of release to the environment.

APPENDIX C

HEALTH RELATED MONITORING PROGRAMS

Conclusions presented in this document regarding the potential for public health impacts from operation of the Bottle Rock power plant are based on estimated steam composition, air quality impact analysis and DWR's interpretation of the tracer study results, and historical data regarding ambient pollutant concentrations in The Geysers KGRA. If actual conditions vary substantially from the information used in the analyses, the conclusions reached could be incorrect, and there could be a greater potential for adverse public health impacts. Furthermore, ongoing and future geothermal development will increase pollutant emissions at The Geysers KGRA during the operating lifetime of the Bottle Rock power plant. Although the increase in ambient pollutant concentrations resulting from one power plant unit may be small, the cumulative impact of future development at The Geysers KGRA may increase ambient pollutant concentrations above ambient air quality standards or suggested safe levels.

California Public Resources Code Section 25532 mandates the Energy Commission's responsibility to establish monitoring programs. CEC staff recommends that DWR be required to periodically measure concentrations of hydrogen sulfide, ammonia, mercury, arsenic and boron in the Bottle Rock power plant incoming steam. DWR has agreed to monitor randon-222 concentrations (DWR, 1979b). This information is necessary to verify estimated steam composition and to determine if concentrations of contaminants in Bottle Rock power plant steam vary substantially with time.

Hydrogen Sulfide

The details of an emissions monitoring program for H_2S will be approved by the Lake County Air Pollution Control Officer.

Ammonia, Mercury, Arsenic and Boron

CEC staff recommends that DWR be required to conduct quarterly monitoring of ammonia, mercury, arsenic and boron concentrations in incoming steam. DWR has not agreed to conduct such a program at this time. The following is a description of CEC staff's recommended program.

Monitoring should begin within 45 days of commencement of commercial operation, and reports should be provided to CEC within 30 days of sampling. The methods for sampling and analysis should be discussed with the Department of Health Services. At the end of one year of monitoring, DWR, CEC, and DOHS staff should evaluate the results of the monitoring program to determine future monitoring requirements, if any. Continuation of the quarterly steam analysis would depend on: a) the variation of the steam concentrations of each pollutant b) the rate of emission of each pollutant, and c) the development or status of ambient or emission regulations for each pollutant. If pollutant concentrations do not vary more than 20 percent, and rates of emission are low, monitoring would be terminated for specific pollutants unless new regulations have been adopted requiring monitoring. CEC staff recommends that DWR and staff shall agree upon significant rates of emissions for Bottle Rock not later than 120 days prior to commencement of commercial operation.

If new wells are added to supply steam for the Bottle Rock power plant, additional steam analyses may be required to guarantee that pollutant emissions do not change significantly (20 percent). DWR should inform CEC staff if a new well is supplying steam to the Bottle Rock power plant.

If Bottle Rock emissions are great enough to cause significant ambient pollutant concentrations, DWR should conduct an ambient monitoring program. Significant ambient concentrations would be 33 percent of any standard, or 50 percent of any standard when plant contribution is added to the existing background.

Since there are currently no ambient air quality standards for ammonia, arsenic, or mercury, not later than 120 days prior to commencement of Bottle Rock commercial operation, DWR and CEC staff should agree upon significant ambient concentrations for these pollutants. The Executive Director should inform the Commission as to the nature of these DWR/staff agreements. If DWR and staff are unable to reach agreement, the Staff shall request the Commission to convene a hearing for the purpose of resolving disputes.

Staff recommends that DWR be required to evaluate existing baseline concentrations of mercury, arsenic and ammonia in ambient air in populated areas downwind of the Bottle Rock power plant.

In the evaluation for mercury and arsenic the Applicant should:

a. Review previous ambient monitoring results;

b. Analyze several of the most recent hi-vol samples collected in The Geysers area;

c. Conduct vapor phase ambient monitoring at locations representative of population exposure. Final details should be agreed upon by Applicant and Staff. Monitoring will be conducted prior to commencement of the plant's operation.

In this evaluation for ammonia the Applicant should:

a. Review previous ambient monitoring results;

b. Extrapolate ambient ammonia concentrations using the emissions ratio of hydrogen sulfide and ammonia, and ambient H_2S data. Spot field measurements will be used to confirm this methodology not later than 120 days prior to commencement of the plants operation.

Radon-222

The Department of Health Services (DOHS) Radiologic Health Section (RHS) requires periodic monitoring of radon-222 (^{222}RN) concentrations in incoming steam of geothermal power plants to verify compliance with applicable standards and to provide input into an RHS multiple source modeling study investigating the cumulative impacts of ^{222}Rn in The Geysers KGRA. This monitoring requirement is based on California Health and Safety Code 25607.

> §§ 25607. Radiological monitoring. No person shall operate a nuclear reactor, nuclear fuel reprocessing plant, or other installation,

as defined by the department, which could, as a result of routine operations, accident, or negligence, significantly contaminate the environment with radioactive material, without first instituting and maintaining an adequate program of radiological monitoring. The proposed program shall be submitted to the department for review and acceptance as to its adequacy.

California Administrative Code Title 17, Section 30355 specifies concentration limits for radioactive effluents released to uncontrolled areas. The concentration limit for radon-222 is 3 pCi/l above natural background radiation at the point of release to the environment.

The Radiological Health Section has proposed the following minimal requirements for monitoring and reporting on radon-222 at The Geysers:

1. Each power production unit must be sampled such that the instantaneous radon-222 emission rate (Ci/sec) to the environment can be accurately determined.

2. Each unit must be sampled at least quarterly.

3. The sampling and analysis methods must be shown to be accurate by comparison to known standards supplied by an acceptable source (NBS or EPA). This "standard comparison" or "calibration" shall be run with each set of samples counted unless it is shown that the counting system is sufficiently stable that calibration is unnecessary for each run, then calibration shall be required at least once per year.

4. Notification levels (as specific activity determined in the effluent) are: 3pCi/l of Rn-222 warranting a written 30-day notice to RHS upon confirmation of that level in the original sample, and 6 pCi/l, Rn-222 warranting a notification to RHS within 24 hours of detecting that level of activity in a sample.

5. Approximately 10 percent of samples taken will be duplicated, with the duplicate sample sent to the Sanitation and Radiation Lab for cross-check analysis as a quality control on the utility's lab analyses.

6. Annual report shall be sent to the Department of Health Services, Radiologic Health Section. It shall discuss each point above, present all data in the calculation for emission rate, and include one sigma standard deviation associated with the counting error. The error in the sampling procedure and emission calculation shall be discussed.

   The report will also indicate the maximum dose due to emissions, calculated at the site boundary, and to the nearest resident, and the resultant population dose. (These dose calculations may follow a simplified methodology to be established by RHS in the near future).

APPENDIX D
LOCATION ALTERNATIVES

A prerequisite to site evaluation was the determination of the amount of land needed for the plant. Preliminary dimensions of the major components (turbine-generator building, cooling tower, switchyard, and H_2S abatement facility) were determined and arranged into several configurations. From this process a preliminary determination was made that a minimum area of 3-1/2 acres was necessary to support the plant.

Using a topographic map, eleven alternate power plant sites were selected for further investigation. In addition, Ecoview, in the EIR for exploratory wells on the Francisco Leasehold, suggested still another site which differs from DWR's eleven possible sites. This comprised a total of twelve sites from which DWR made its final selection. (See Figure T).

Using the following criteria, a list of pros and cons were developed for the 12 possible sites:

1. Adequate level area for the power plant facilities.
2. Plant pad site at an Elevation 2,700 feet or higher to get the steam stacks above the inversion layer.
3. Site accessibility.
4. Visibility of the site from scenic corridors or other key points.
5. Geologic suitability.
6. Economics of each site.
7. Aesthetics of scars made by excavation and fill.
8. Cultural and archaeological sites which may be damaged by construction.
9. Wildlife habitat that would be destroyed by construction. Seven sites were dropped from further consideration because they did not meet the criteria listed above. These sites were eliminated for the following reasons:

Site 1 - The site is in a meadow which is valuable for wildlife habitat. In addition, the area is boggy in the rainy season and, therefore, does not provide a good foundation. Furthermore, the pad would be below Elevation 2700 feet. The site is also in the middle of Historical Site LAK 974H.

Site 2 - The pad would be located too close to archaeological sites LAK 609 and LAK 610. (See Figure Q). In addition, the pad would be below Elevation 2700 feet.

Site 2a - Same reasons as Site 2.

Site 3 - Same reasons as Site 2.

Site 7 - The site is outside the boundaries of the leasehold and, therefore, additional land would have to be purchased. Also, the distance from the well pads would be too great. Finally, the pad site would be below Elevation 2,700 feet.

Site 8 - The site is outside the leasehold and therefore, additional land would have to be purchased.

Site 11 - The site was close to archaeological site LAK 608.

This left Sites 4, 5, 6, 9, and 10 for further analysis. Each of these sites was then evaluated to determine whether the site configuration would be appropriate after cuts and fills were made. Approximate quantities of the cuts and fills were calculated and an analysis of the necessary access roads was made. As a result, three more sites were eliminated for the following areas:

Site 6 - The site would require two pad levels to reduce excavation. In addition, access to the site would be difficult. Furthermore, due to the configuration that would be necessary to accommodate the facilities, the alignment of the cooling tower may not be the most desirable;

Site 9 - Same reasons as Site 6; and, 11

Site 10 - This site is too small and irregular in shape and would require a large fill area to accommodate the plant facilities.

The two remaining sites were then analyzed to determine which could best meet all mentioned conditions. In addition, a detailed visibility analysis was conducted by DWR's Division of Design and Construction using existing topographic maps and by visiting the site and surrounding area. It was decided that after the final site was chosen, a detailed geological, air quality, and meteorological evaluation would be done for that site.

Site 4 would have the pad at Elevation 2,700 feet, making road access easy because the road would be one-half mile long with gentle grades. In addition, this site is visible only when looking from the northeast portion of the leasehold. With the exception of the view from one residence, the site is not visible because it is wooded with oak and coniferous trees. Construction of the actual pad would require about six acres of wooded area to be cleared. Excavation required for the pad make the site visible from the Hoberg's area about three miles away. This will be mitigated by landscaping the site.

Site 5 would have required the pad to be located at Elevation 3000 feet, and the access road would be a one and one-half mile steep climb to the site. Due to the elevation and location, this site is highly visible. Before excavation, construction of the pad would require clearing of shrubbery which is primarily manzanita. Construction of the access roads would require excavation and embankments which would leave visible scars. In addition, other environmental damage such as excessive erosion may result.

Before the final criteria (air quality and meteorological tests) were conducted, DWR presented the County of Lake officials with the site selection process it had followed. DWR indicated to the officials that Site 4 was the initially

favored site because of: 1) economics; 2) aesthetics; and, 3) least amount of environmental damage. It was agreed that DWR would conduct the meteorological tests at both sites to determine which site was best from an air quality standpoint.

The monitoring program was performed by Environmental Systems and Service (ES&S). ES&S's study included monitoring wind speed, temperature, relative humidity, H_2S occurrence, and total suspended particulates, and conducting smoke and F.P. tracer studies. After 30 days of data were collected, compiled, and evaluated, DWR presented the data to the Lake County officials.

They concurred that results of the ES&S tests imply that the lower site (Site 4) is "slightly better in terms of expected air quality impact."

While air quality testing was being undertaken, geologic mapping of the leasehold and two sites was also being conducted. Analysis showed that only small dental blasting may be needed for the structural excavation of Site 4.

After thorough investigation and evaluation of all selection criteria, DWR determined that Site 4 was the best location for the power plant. Development of this site is the most economically feasible for DWR and will cause the least environmental damage to the area.