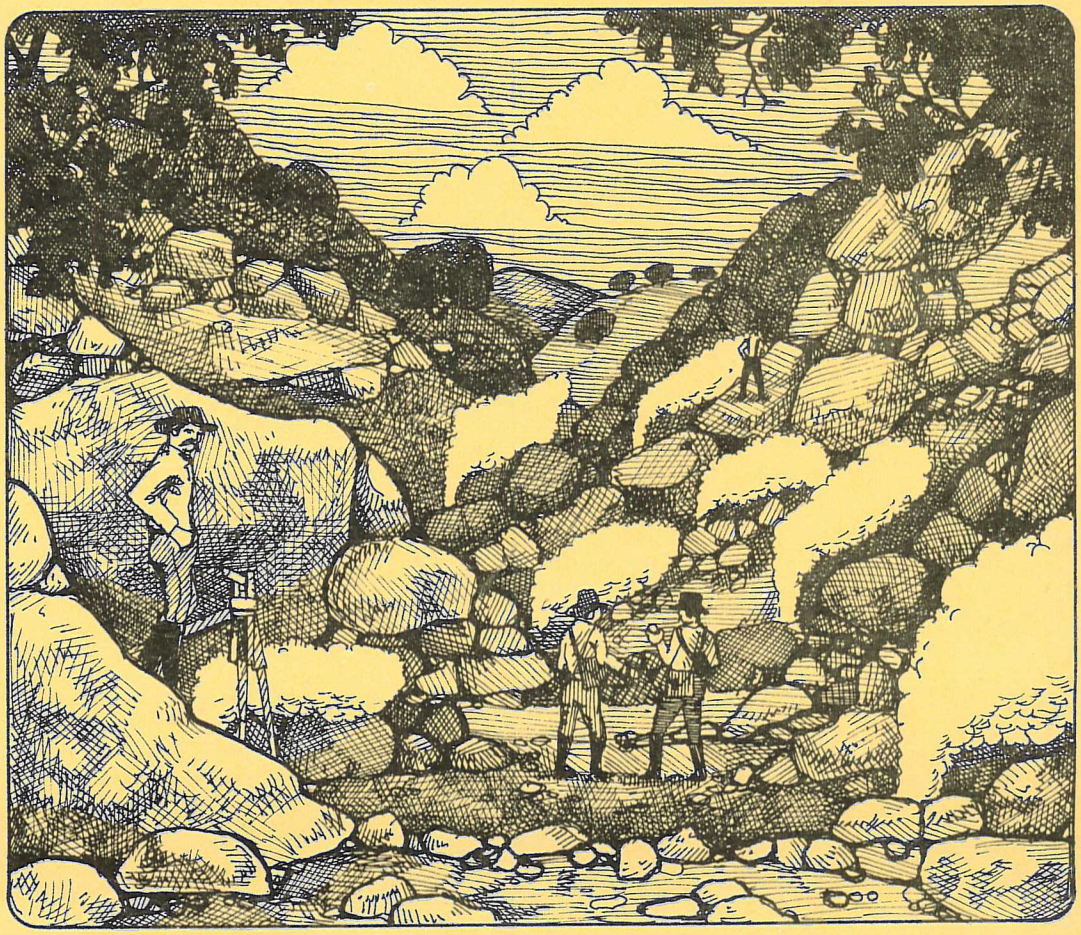
STATE OF CALIFORNIA

REPORT OF THE STATE GEOTHERMAL RESOURCES TASK FORCE

Priscilla C. Grew, Chairperson

June 1978



State of California

REPORT OF THE STATE GEOTHERMAL RESOURCES TASK FORCE

Priscilla C. Grew, Chairperson

June 1978

Report prepared by
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Judith Warburg
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June 30, 1978

TO: ALL INTERESTED PERSONS

SUBJECT: State Geothermal Resources Task Force Report

Assembly Bill 3590 (Chapter 958, Statutes 1976) created a State Geothermal Resources Task Force to study all aspects of the development of the geothermal resources of the state, to respond to questions relating to such development that are set forth in AB 3590, and to report its findings to the Governor and the Legislature.

Pursuant to the provisions of AB 3590, we transmitted the Executive Summary and Recommendations of the Task Force on December 29, 1977. This document summarized the contents of the full report and included all of the Task Force's recommendations regarding geothermal resources and development in California.

We hereby transmit the complete State Geothermal Resources Task Force Report containing information compiled during the period of the Task Force's existence from January 1, to December 31, 1977.

Huey D. Johnson
Secretary for Resources
The Resources Agency

Deni Greene
Director
Office of Planning & Research

STATE OF CALIFORNIA — RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
DIVISION OF OIL AND GAS

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June 30, 1978

The Honorable Huey D. Johnson
Secretary for Resources
The Resources Agency

The Honorable Deni Greene
Director
Office of Planning & Research

I hereby transmit to you the State Geothermal Resources Task Force Report, prepared pursuant to the provisions of Assembly Bill 3590 (Chapter 958, Statute 1976).

The Executive Summary and Recommendations of the Report, published December 29, 1977, contained all the recommendations of the Task Force. The full Report provides additional background information compiled by the Task Force.

Sincerely,

Priscilla C. Grew

Priscilla C. Grew
Director

STATE GEOTHERMAL RESOURCES TASK FORCE

(Membership as of December 1977)

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PREFACE

The State Geothermal Resources Task Force was created by Assembly Bill 3590 (Kapiloff) of the 1976 Legislative Session (Chapter 958 Statutes of 1976). The Legislature required the Task Force to study geothermal development in California and prepare this report of its findings for transmittal to the Governor and the Legislature by the Secretary for Resources and the Director of the Office of Planning and Research.

By law, the Task Force consisted of the following representatives: two members of the Assembly; two members of the Senate; three members of the public; and one member each from the Resources Agency, the State Lands Commission, the Division of Oil and Gas and the Division of Mines and Geology of the Department of Conservation, the Energy Resources Conservation and Development Commission, the Office of Planning and Research, the Public Utilities Commission, the Department of Water Resources, the Department of Fish and Game, the State Water Resources Control Board, the Air Resources Board, and the Solid Waste Management Board. Representatives of the Department of Parks and Recreation, Office of Historic Preservation, the Native American Heritage Commission, and the Assembly Office of Research also participated in the Task Force's study. Priscilla C. Grew, Director of the Department of Conservation, chaired the Task Force.

The Legislature required the Task Force to consider a series of questions related to four issues:

1. Resources Assessment and Conversion Technology

   What is the extent, nature and location of geothermal resources? What is the state of existing technology for converting geothermal energy into electric power?

2. Environmental Considerations

   What are the environmental constraints on geothermal development and how can development occur with the least possible harm to the environment?

3. Regulatory Issues

What are the best methods of planning for geothermal development?
What methods should the state or its agencies require for developing geothermal resources?
Is geothermal development occurring in an expeditious manner?
What laws should be amended to encourage expeditious development?
Should the Public Utilities Commission require utilities to use geothermal resources for generating electric power?

4. Economics of Geothermal Development

What economic issues are involved in geothermal exploration and development?
What are the best methods of attracting capital for geothermal development?

In order to respond to these questions and develop its recommendations, the Task Force held 8 days of public hearings in Sacramento, San Francisco, and San Diego at which 1,700 pages of testimony were received from 85 witnesses (see Appendix III). During 1977, the Task Force assembled for 26 days of meetings which were attended by representatives of industry, various interest groups, federal agencies, and members of the public (see Appendix II). The Task Force also studied geothermal sites in the field, spending 2 days each in The Geysers area and in the Imperial Valley. A draft report was circulated during November 1977; comments were received by correspondence and at a public forum in Sacramento. An executive Summary of this report, containing all the Task Force's recommendations, was issued in December 1977.

Underlined statements in the report are recommendations that the Task Force adopted by majority vote. Dissenting opinions are included in Appendix I. It should be kept in mind that most aspects of geothermal energy development are closely interrelated, and that the order of problems and recommendations in the report is not a listing according to priority.

By law the State Geothermal Resources Task Force was disbanded on December 31, 1977. Readers of this report who wish to comment on the text are invited to submit their comments to Dr. Priscilla C. Grew, Chairperson, Geothermal Resources Board, 1416 Ninth Street, Sacramento, California 95814.

INTRODUCTION

The State Geothermal Resources Task Force has investigated the status of geothermal resources and development in California and in this report offers recommendations for overcoming obstacles facing increased utilization of this significant natural resource. For the most part, these recommendations are short-term solutions to immediate problems and would not radically change the roles of governmental agencies currently regulating geothermal development.

The Task Force concludes that geothermal operations have been hindered by the lack of a statewide policy on geothermal development. This has resulted in instances where industry has been forced to comply with conflicting governmental policies toward geothermal energy development and environmental protection. The Task Force therefore recommends legislation establishing a statewide policy to encourage geothermal development consistent with environmental quality standards.

In addition to geothermal resources suitable for the production of electrical power, California has extensive undeveloped hot water reservoirs suitable for direct thermal applications. The Energy Resources Conservation and Development Commission and the U.S. Geological Survey have concluded that these resources, if developed, could make a significant contribution to satisfying California's energy needs. The Task Force therefore recommends establishing a statewide policy to encourage the use of non-electric hot water geothermal resources for commercial and non-commercial uses where the development is consistent with environmental quality concerns.

GEOTHERMAL RESOURCES ASSESSMENT AND CONVERSION TECHNOLOGY

Geothermal development is often mentioned as a potential alternative source of electrical power. The 1977 Biennial Report of the California Energy Resources Conservation and Development Commission (hereafter, Energy Commission) states that utility companies in California had the capacity to produce 36,269 megawatts of electricity (MWe) in 1975. Peak demand that year was 28,894 MWe. Powerplants operating on geothermal resources had a total capacity of 502 MWe, representing 1.4 percent of the state's installed generating capacity in the same year. In comparison, the remainder of the installed capacity consisted of 2,287 MWe in coal-fired plants; 8,737 MWe in hydroelectric plants; 1,379 MWe in nuclear plants; 21,361 MWe in oil-fired plants; and 1,054 MWe as pumped storage.

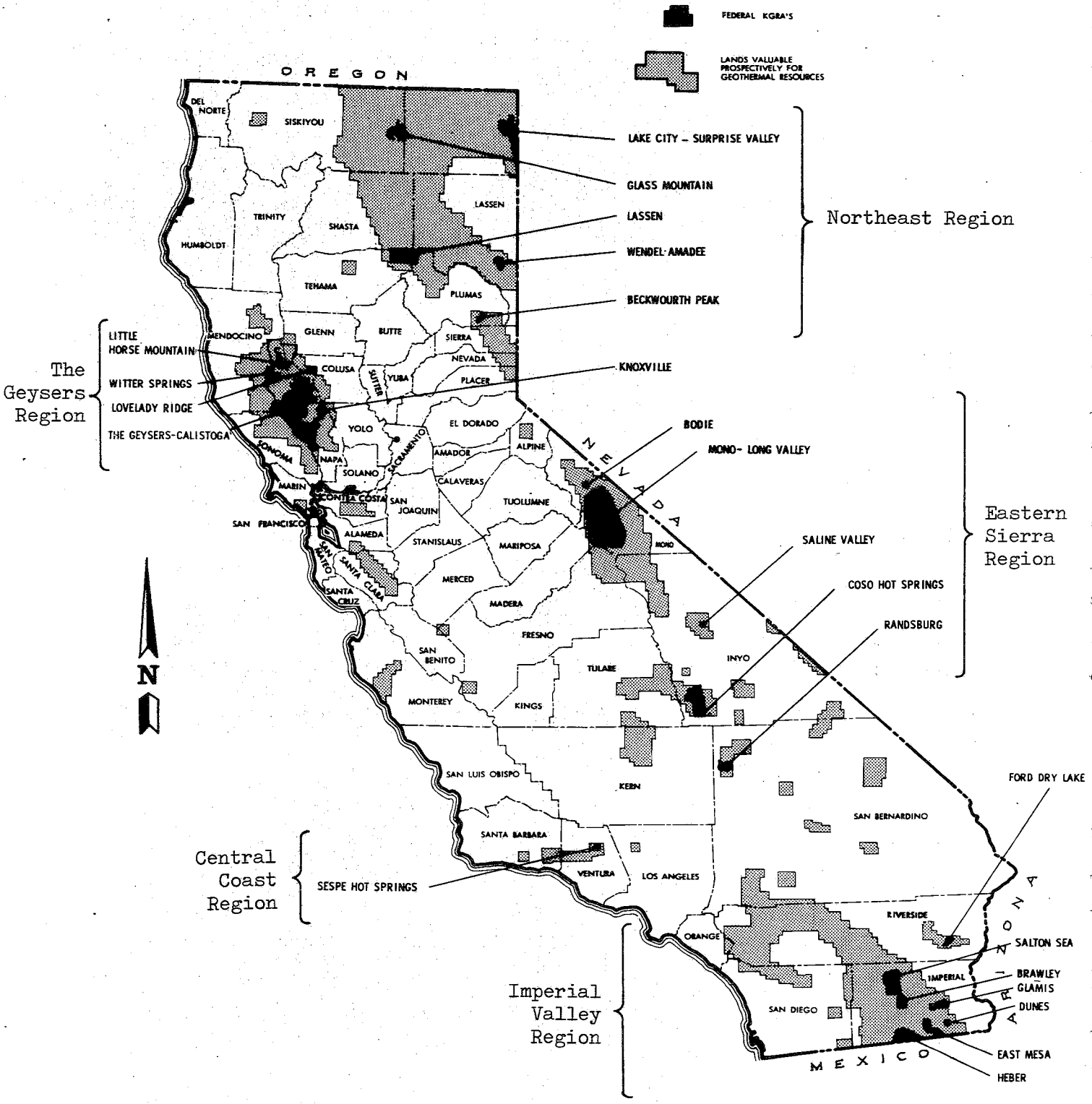
According to the 1977 Biennial Report, the Energy Commission's demand forecast for 1995 is 60,746 MWe. The utilities, however, estimate their capacity projections to be 84,880 MWe for 1995 and predict that geothermal capacity will be 3,458 MWe, or 4.1 percent of total installed capacity. In comparison, the utilities estimate capacity for 1995 as 8,656 MWe from coal, 3,526 MWe from combined cycle, 6,068 MWe from gas turbines; 9,070 MWe from hydroelectric plants; 30,827 MWe from nuclear plants; 17,448 MWe from oil- and gas-fired plants; 5,323 MWe from pumped storage, and 504 MWe from solar, wind, and fuel cell sources.

California is richly endowed with geothermal resources. The U.S. Geological Survey (USGS) estimated in 1975 that the State contains 72 percent of the nation's electrical generating potential from geothermal energy. These resources are widely distributed in California. Figure 1 shows 5 regions containing the 23 Known Geothermal Resources Areas (KGRAs) so far identified by the USGS. Exploration and development is progressing in many of these areas, with the greatest development presently occurring at The Geysers in Sonoma County, where natural steam is directly converted into electricity.

Commercial uses of geothermal resources are generally divided into electric and non-electric applications. Conversion of geothermal resources to electricity depends on the temperature of the resources and their

FIGURE I

LOCATIONS OF CALIFORNIA KNOWN GEOTHERMAL RESOURCE AREAS (KGRA'S)



SOURCE: Jet Propulsion Laboratory, Geothermal Energy Resources In California: Status Report, for ERCDC (June 1976), pp. 1-3, Fig. 1.

composition. Currently, only two types of geothermal resources, vapor-dominated (dry steam) and liquid-dominated (hot water) systems with temperatures above 150°C are considered economically feasible for electrical generation in California.

Depending on the source, estimates of the state's electrical geothermal potential range from 12,000 to 19,000 MWe for a 30-year period. Identified electrical energy potential is present in 9 of the 23 KGRAs: Mono-Long Valley, Coso Hot Springs, Salton Sea, Lake City-Surprise Valley, The Geysers-Calistoga, Heber, East Mesa, Brawley, and Lassen.

Although the experts disagree on the rapidity with which geothermal energy will be developed, there is general agreement on the potential size of its contribution to California's electrical capacity. The Status Report on Geothermal Resources in California, published by the Jet Propulsion Laboratory (JPL) in 1976, estimates that the State's geothermal reservoirs could produce 19,000 MWe for a 30-year period. The Chairman of the Energy Commission has stated that 20,000 MWe could be produced in California by the year 2000. Recent estimates by the staff of the Electric Power Research Institute are that 2,800 to 4,000 MWe could be developed in California by 1985. These estimates, however, assume that development of liquid-dominated resources in the Imperial Valley will not encounter serious delays.

With the exception of spas, which were developed in California in the 19th century, relatively little has been done to develop non-electric uses of the State's geothermal resources with temperatures less than 150°C. The USGS has identified 46 hot-water convection systems in California with subsurface temperatures ranging from 90°C to 150°C. Low-temperature resources are located in many areas of the state and could potentially be used for heating, food processing, and industrial purposes. Several governmental agencies are currently sponsoring projects to investigate such non-electric applications as crop drying, space heating, and aquaculture.

DESCRIPTIONS OF GEOTHERMAL REGIONS

A geothermal region is an area defined by the natural limits of the resource; it does not correspond to jurisdictional boundaries. For discussion purposes, this report identifies the counties in California's geothermal regions. The regions, all containing KGRAs established by the USGS, are: The Geysers Region; the Imperial Valley Region; the Eastern Sierra Region; the Northeast Region; and, the Central Coast Region (Figure 1).

The Geysers Region

The Geysers Region consists of Lake, Sonoma, Mendocino, Napa, and portions of Colusa and Yolo Counties, with most of the present geothermal exploration and development taking place in Sonoma and Lake Counties. The Geysers is a very unusual geothermal area. Unlike most geothermal systems which are dominated by hot water, the region contains large quantities of dry steam, which occurs where there is a minimal amount of water and large quantities of heat. At The Geysers, the ultimate heat source is believed to be a magma chamber which may also have been the source for the geologically young, silicic volcanic fields nearby.

The Geysers' main geothermal reservoirs are 900 to 2750 meters in depth and consist of faulted and fractured rocks including graywacke, a type of sandstone. Temperatures of the resource range from approximately 150°C to 250°C, allowing direct electrical generation using current technology.

The USGS estimated in 1975 that The Geysers Region has the potential to produce 1,590 MWe for 30 years; JPL has reported a 30-year potential of 1,722 MWe for the combined Geysers-Calistoga KGRA. Industry has projected a total generating capacity in The Geysers Region of 2,300 MWe by 1985.

Imperial Valley Region

The Imperial Valley Region includes 7 KGRAs in Imperial and Riverside Counties. The resource found in the Imperial Valley Region is liquid-dominated, in which a large quantity of water is under pressure sufficiently high to prevent boiling.

The Imperial Valley Region was partially formed by spreading of the earth's crust, associated volcanism, and extensive faulting. Crustal spreading is the geologic process that has formed the great oceanic ridges encircling the globe. Flow of material in the earth's mantle causes spreading or rifting of the overlying crust; this process can move large masses of sea floor or land away from the spreading zone.

Spreading on land can cause the near-surface rock formations to break apart and form large valleys such as the Salton Trough. During and after spreading in the Imperial region, unconsolidated layered sediments (mud, sand, and silt) were deposited in the Salton Trough during the formation of the Colorado River delta. These sedimentary deposits form both the impermeable caprock and the permeable reservoirs of the Imperial Valley geothermal systems. Abnormally high heat flow and magmatic intrusions associated with the crustal spreading are ultimately responsible for heating the subsurface layers of sedimentary rocks that contain the geothermal fluids.

Much of the geothermal fluid of the Imperial Valley Region contains large quantities of dissolved solids. These highly corrosive brines can damage the equipment used for conversion to electricity. Temperatures of the fluid vary from one geothermal area (known as an anomaly) to another and range from 135° to 350°C.

According to the 1976 JPL Status Report on Geothermal Resources in California, the Imperial Valley Region could produce approximately 4,579 MWe for a 30-year period.

Eastern Sierra Region

The Eastern Sierra Region, comprising Mono, Inyo, San Bernardino, and portions of Madera and Fresno Counties, has not been extensively explored. The major heat sources in the region are believed to be the result of Holocene (recently active) silicic volcanism. Exploration has shown that the geothermal reservoirs consist of fragmented and pumiceous volcanic rock.

According to the 1976 Status Report, the Eastern Sierra Region has a higher potential for development than the Imperial Valley Region. Of particular interest, according to the report, are the Coso Hot Springs KGRA, thought to be a vapor-dominated system, and the Mono-Long Valley KGRA, believed to contain liquid-dominated systems. Recent analyses made on water samples at a new well in the Coso area, however, suggest the presence of a liquid-dominated, rather than vapor-dominated system.

The JPL Status Report estimates that the potential electrical generating capacity for the Eastern Sierra Region is 10,616 MWe for a 30-year period. However, recent data suggest that the Mono-Long Valley resources may be 3,000 MWe less than this projection.

Northeast Region

The Northeast Region includes Plumas, Shasta, Siskiyou, Lassen, Tehama, and Modoc Counties. Although Sierra, Nevada, and Placer counties are not technically identified as part of the region, they should be considered part of it. This region contains the Lake City-Surprise Valley, Wendel-Amedee, and Lassen KGRAs. Of these only the Lassen KGRA is believed to be a vapor-dominated system.

Much of the Northeast Region contains fractured and faulted volcanic rock. The fractures may act as conduits for hot water and steam. Much of the region contains closed drainage systems flowing to surface lakes. Porous sedimentary rocks in the lake basins also may form geothermal reservoirs. The heat sources for the reservoirs are thought to be associated with Holocene volcanism.

Reservoir temperatures for the Lassen and Wendel-Amedee KGRAs are about 210° and 140°C, respectively. According to the JPL Status Report, the electrical energy potential of the Northeast Region is estimated to be 2,256 MWe for a 30-year period. Currently, only small scale, non-electric uses of geothermal resources exist in the area. More non-electric applications of geothermal resources are expected in the near future.

Central Coast Region

The Central Coast Region consists of the coastal area from Ventura County to Santa Clara County. The geothermal resources of the region remain largely unexplored. To date, the only identified KGRA is Sespe Hot Springs, located north of the City of Santa Paula in Ventura County.

RESOURCES ASSESSMENT

Exploration for geothermal resources requires a combination of geological, geophysical, and geochemical techniques to identify suitable areas for drilling. The most helpful technique is the drilling of shallow holes for temperature measurements. Final confirmation always requires drilling deep holes to prove the presence of the geothermal resource and to estimate the magnitude of the reserve. There is no single technique which is always best for exploring and assessing geothermal resources prior to confirmatory deep drilling. The ideal methods for a given area depend upon the geologic setting and the regulatory and environmental constraints on the operation. Geologic techniques are used to identify surface manifestations of the resource and to map and delineate areas for additional exploration. Geophysical techniques use instruments to interpret sub-surface geologic conditions from survey data. Geochemical techniques are employed to deduce subsurface temperatures by analyzing the proportions of dissolved solids in water. Usually, geological and geochemical investigations are followed by geophysical and heat-flow measurements and then by drilling.

Techniques for indirectly measuring subsurface data can only indicate prospective areas. Drilling into the potential reservoir is the only method that can reliably determine if an area is capable of commercially producing geothermal energy.

Geologic Techniques

Geologic investigation is the necessary first stage which provides data so that other exploration techniques can be effectively applied. Surface and subsurface data are used to find a general area of interest. A developer can use each of the geophysical techniques described below to identify

certain geologic phenomena. Collectively, the results of surveys aid in the exploration and assessment of a geothermal resource.

Geophysical Techniques

1. Resistivity Surveys measure the ability of near-surface rocks to conduct electrical currents. Heat may change the conductivity of rocks within a geothermal area, causing a change in the measured resisitivity.

2. Gravity Measurements reveal contrasts in the density of material within the crust of the earth. Heat may change the density of rocks in a geothermal area and thereby create a gravity anomaly near the geothermal resource.

3. Seismic Refraction and Reflection Surveys are useful in locating faults and revealing the structural configuration of sedimentary rocks. These very expensive techniques are useful for detailed structural refinements.

4. Telluric and Magneto-Telluric Methods are used to map changes in electrical conductivity in the earth. For deep measurements, these techniques are more useful than resistivity surveys. Zones of increased salinity, rock alteration, and heat can be detected over extensive areas. Actual temperature changes are not measured directly, but are inferred.

5. Acoustic Techniques are used to map noise anomalies which may coincide with geothermal resources. They are not, however, reliable methods to define in detail the extent of a geothermal resource.

6. Magnetic Measurements are used to locate magnetic "blanks" or low spots. The natural magnetic properties of rocks can be destroyed if the rocks are exposed to temperatures above 578°C, the Curie Point of the magnetic mineral, magnetite. Magnetic lows may thus exist near a heat source.

7. Microseismicity Instrumentation is used to record very small earthquakes which may occur in geothermal anomalies. These earthquakes may indicate

the presence of faulting and fracturing that could allow deep, hot fluids to rise to shallow depths and form a geothermal fluid reservoir.

8. Heat-Flow Measurements are used to define underground thermal gradients and the amount of heat flowing out from the earth's interior. This technique requires drilling and coring of temperature probe holes for observation to define areas having large amounts of heat. The technique is limited by its cost and, in some cases, by the necessity to obtain governmental approvals for drilling. Also, extrapolation of heat-flow characteristics much beyond the depth of the test holes must be made with great care.

9. Remote Sensing uses aerial photography or satellite imagery to survey prospective geothermal areas. This technique is useful in remote regions whose geology is little known. Industry, however, seldom places great reliance on remote sensing since it can produce many false clues. The usefulness of this technique is generally limited to early reconnaissance programs.

10. Self-Potential Surveys are based on the principle that fluids moving through porous rocks develop a measurable electrical charge, known as a streaming potential. If the convective movement of water takes place around an unusually hot area, streaming potentials can be developed. The usefulness of the method is limited because it is difficult to obtain the same results in consecutive surveys.

Geochemical Techniques

In some cases, the chemistry of solids dissolved in near-surface geothermal waters can be used to determine the temperatures of rocks and fluids that have been in chemical equilibrium in geothermal systems deep within the earth. This geochemical technique, however, is not useful if the geothermal water analyzed has been mixed with a surface aquifer.

Drilling and Well Testing

Reliable reservoir assessments cannot be made without drilling and testing a number of wells. Analysis of well pressures must be conducted to determine

the extent, permeability, and production characteristics of the reservoir. Analysis of the fluids and non-condensable gases present is required to develop plans for disposal and pressure maintenance systems.

Well tests are conducted when a geothermal reservoir has been drilled and are used to determine whether the reservoir is capable of sustaining high rates of production. This type of information is only available for those resource areas that have been drilled and tested successfully, such as The Geysers-Calistoga, Brawley, East Mesa, Heber, and Niland. Resource areas that have been drilled but not yet fully tested include the Mono-Long Valley and Coso Hot Springs KGRAs.

TECHNOLOGY FOR ELECTRIC AND NON-ELECTRIC APPLICATIONS

Electric Conversion Technology

The method selected to convert geothermal energy to electricity depends on whether the geothermal reservoir is dominated by dry steam or by hot water. In a dry steam reservoir, such as The Geysers, the resource may be used almost directly in the generating turbines. This simple conversion technology involves taking dry steam directly from the ground and expanding it through a steam turbine-generator unit to generate electric power.

Several methods may be used to produce electricity from liquid-dominated reservoirs. These include the single or multiple-flash, binary, combination of flash and binary, and total flow systems. In a flash system, the turbines run on the vapor created when geothermal fluids under high pressure and at temperatures greater than 150°C are withdrawn from a reservoir and flashed to steam. The number of flashing stages depends on the temperature and pressure of the resources. In a binary system, the turbines operate on vapor created when the geothermal fluid is used to vaporize a second fluid, such as freon or isobutane, which has a significantly lower boiling point than the geothermal fluid.

1. Vapor-Dominated Reservoirs

   At The Geysers, Pacific Gas and Electric uses steam directly from the ground in turbine-generators because this method is the most thermo-

dynamically and economically efficient. Steam enters the turbine at approximately 178°C and at a pressure of 114 pounds per square inch absolute. The steam expands in the turbine, converting its heat and pressure to mechanical energy, which in turn is converted to electrical energy by the generator. Steam is discharged from the turbine at a pressure of approximately 4 inches of mercury absolute and a saturation temperature of 52°C. The steam is condensed with cooling water in a direct contact condenser located below the turbine.

From the condenser, the 49°C mixture of cooling water and condensate is pumped to the cooling tower and cooled to 27°C. The cooling cycle is completed as the water flows from the tower to the condenser by force of gravity and by the vacuum in the condenser. Steam condensate makes up for the loss of water evaporated in the cooling tower. Under all conditions, the cycle has a net surplus of condensate, eliminating the need for an external source of water. Excess condensate water is injected into the geothermal steam reservoir.

Noncondensable gases entering the condenser with the steam include carbon dioxide, nitrogen, ammonia, methane, hydrogen, and hydrogen sulfide. These are continuously removed from the condenser by steam jet ejectors which require about 4 percent of the total incoming steam for operation.

Approximately 2 million pounds of steam per hour from about 15 wells are required to operate a plant with a gross rating of 114 MWe. Power required for plant operation, including pumps and cooling tower fans, is about 4 percent of gross power production or 4 MWe, giving a net power output of 110 MWe.

2. Liquid-Dominated Reservoirs

The systems for handling liquid-dominated geothermal resources are generally more complex than those for vapor-dominated reservoirs. The four approaches most commonly considered are the single- or multiple-flash, binary, the combined flash and binary, and total flow processes.

Single- and Multiple-Flash Process

The conventional approach employs single, double, or even triple flashing of the liquid. This technology is presently in operation at Cerro Prieto (Mexico), Wairakei (New Zealand), and in Japan. The process can lead to difficulties such as: 1) deposition on turbine blades of the solids carried in the steam; 2) plugging of liquid flow lines as pressure is reduced; and 3) precipitation of solids from cooling geothermal solutions. The advantage of the flash systems, however, is that the wells can be self-flowing, with the pressure reduction and flashing occurring in the well bore.

Binary Cycle

A second process is the binary fluid cycle. It uses the hot liquid from the geothermal resource to heat a second fluid which operates the turbine. The turbine cycle is closed; fluid is continuously circulated between the turbine and condenser. This cycle prevents the corrosive, concentrated brine from contacting the turbine and condenser materials. The working fluid is a non-corrosive, organic compound: freon, isobutane, isopentane, or propane. The binary fluid system has the advantage of keeping the working fluid loop clean and free from scale and corrosion, and thereby minimizing turbine maintenance.

The binary approach, however, has drawbacks. The capital investment is higher because of the large heat-transfer surface needed to extract thermal energy from the hot geothermal fluid to heat the working fluid. Turbines capable of handling these organic working fluids do not presently exist in the 50-MWe sizes that will eventually be required. Another problem is scaling on the heat exchanger tubes as the geothermal fluid cools and solids precipitate from solution. An extensive program of equipment development will be needed to solve these problems.

Studies of the binary cycle for power production from the geothermal resources in Imperial County have been underway since 1973. Grants from the National Science Foundation to TRW Corporation and Bechtel Corporation resulted in design studies for a 10-MWe binary cycle demonstration plant

for resources of moderate temperature and low to moderate salinity, such as those found in East Mesa and Heber in Imperial County.

Further, the Atomic Energy Commission (AEC) originally initiated efforts to comply with Public Law 94-310 which calls for a program of demonstration plants to foster a geothermal industry. Design studies for systems and components have been continuing under the AEC's successors, the Energy Research and Development Administration (ERDA) and the Department of Energy. Equipment under study includes down-hole pumps, heat exchangers, and conversion machinery. An initial test facility was established in cooperation with San Diego Gas and Electric to test heat exchanger technology for the hot brines at Niland, California.

In testimony before the Task Force, Ben Holt of Ben Holt and Company noted that despite the lack of large scale demonstration plants in the United States, he believes that the binary cycle system represents state-of-the-art technology. David G. Elliott from the Jet Propulsion Laboratory, on the other hand, felt that the two-stage flash steam cycle using self-flowing wells is the best technique available. He further stated that the development of a system to pump fluid and prevent heavy scaling, or the development of a binary cycle to handle non-condensable gases in resources with high gas content, should await a finding that such resources can produce a significant amount of power. He also stated that the usefulness of the binary cycle for increased output may be nullified by high cost.

The Electric Power Research Institute has independently initiated studies for a demonstration plant project. The first phase of the study indicated that the most feasible operation for the near term would be a 50-MWe binary power plant at Heber, California. The second phase of the program, a contract with San Diego Gas and Electric Company to prepare the detailed technical design and specifications, is currently underway. The State of California, through the Energy Commission, has supported this program by agreeing to participate in a 5-year effort to construct the demonstration plant.

Magma Power Company plans to construct a 10-MWe binary cycle plant in the Imperial Valley. Magma is convinced that the closed binary cycle is

preferable to the flash system for Imperial Valley resources in the temperature range of 150° - 200°C.

Combined Binary and Flash

Another process for geothermal brines involves flashing the brine and then using it to heat a second working fluid in a binary cycle. This process prevents the fouling of heat-exchanger tubes by brine cooled by direct contact with the heat exchanger surface, which is a major problem for highly saline geothermal fluids.

Total Flow

The total flow system is another approach for using hot water. This system eliminates the need for heat exchangers or a separate flashing steam system. Theoretically, this system would be the most thermodynamically efficient. Nevertheless, problems remain to be solved to attain efficient designs of expansion nozzles and turbines. Additional research and development is needed to control scaling and erosion of turbines and nozzles.

The flash and binary systems described earlier can be used in powerplants with a capacity in excess of 50 MWe. These plants require extensive field development and fluid transmission networks. An alternate approach would be to install conversion systems with a capacity of 1 to 15 MWe on individual wells or well pads. Such systems could use a total flow process in which both the thermal and kinetic energy of the geothermal fluids are used for production of electricity.

This concept has led to the impulse turbine in which fluid is directly expanded at the wellhead for maximum energy extraction. A single-stage, axial flow laboratory model has been built using this concept. The nozzle used in the laboratory model, however, is not suitable for use with brines.

A second development is the helical rotary screw expander. The screw expander uses pressure reduction to cause a continuous series of flashes.

A 62.5 kilo-volt prototype has been successfully tested with moderately saline fluids. ERDA has contracted for the development of a larger prototype system of about 1.25 MWe.

A third development is the bladeless turbine, which has a series of narrow channels between disks on a shaft. Geothermal fluids are introduced through nozzles, and rotary force results from viscous drag between adjacent disks. The optimum size unit for this is thought to be 10 MWe. The construction of a prototype system of 0.25 MWe is nearing completion and will be tested at Heber in Imperial County.

Electricity from liquid-dominated geothermal reservoirs is presently produced on a commercial scale outside the United States, for example, at Cerro Prieto in Mexico and Wairakei in New Zealand. However, because of the thermal and chemical characteristics of the geothermal systems and the requirements for reinjection of waste fluids in the Imperial Valley, current technology is not adequate for commercial production of electricity from Imperial Valley liquid-dominated reservoirs. Research is progressing rapidly on equipment for use on these reservoirs, including turbines for binary and total flow applications, brine-flash drums and separators, down-hole pumps, and heat exchangers.

To encourage the development of liquid-dominated reservoirs, the Task Force passed the following resolution:

> The State Geothermal Task Force respectfully memorializes the Congress of the United States to provide immediate federal funding for a hydrothermal binary cycle demonstration plant in California.

The Task Force further resolved to:

> Memorialize the President of the United States to take action through the appropriate agencies and departments of the Executive Branch of the federal government to require early implementation of a hydrothermal binary cycle demonstration plant in California.

Cooling Processes

All processes converting geothermal energy to electricity eject waste heat from the power-generation cycle. The fraction of the geothermal heat rejected as waste depends on the particular energy conversion cycle and on the temperatures of the heat source and the heat sink, or receiver. Each geothermal resource has its own limitations depending on the available heat sink, the location of the resource, the source of cooling water, and the prevailing ambient air temperature.

Cooling water requirements differ for power plants based on vapor-dominated and liquid-dominated geothermal systems. For example, powerplants at The Geysers require no external source of cooling water, but powerplants based on liquid-dominated systems in Imperial Valley will require substantial amounts of cooling water.

1. Technology for Cooling Geothermal Powerplants

The Geysers

The following description of alternative cooling systems is derived from PG&E's Geysers Unit 13 Environmental Data Statement (Chapter X, Section F, "Alternative Cooling Methods"). It is typical for all units operating on the vapor-dominated geothermal system at The Geysers. The cooling procedure at The Geysers Unit 13 includes a surface condenser and a 10-cell cooling tower with mechanically induced draft. Since the rate of geothermal steam flow will be greater than the cooling tower evaporation rate, the condensed steam will be used to replenish water in the cooling tower.

Alternative cooling methods considered at The Geysers include:

No Cooling System, Atmospheric Turbine Exhaust

This system was considered in early geothermal cycle studies, but was discarded because of its inefficiency. Further studies showed that a condensing cycle provides a more efficient use of steam than does a method which exhausts directly to the atmosphere.

Air-Cooled Condenser

In this system, steam is condensed in a tubular heat exchanger with air

passing over the tubes. This system has been installed in smaller fossil-fueled plants of approximately 20 MWe, but may not be economical because it requires an extremely large cooling surface. Plant efficiency may also be reduced because of higher turbine back pressure.

Direct Contact Condenser

Existing units at The Geysers employ direct contact condensers in the cooling cycle. The direct contact condenser mixes the steam from the turbines directly with the cooling water and pumps the mixture to the top of the cooling tower. The cooling water returns to the condenser by both gravity and the vacuum developed by the condenser. Although a direct contact condenser costs less than the surface condenser being used for The Geysers Units 13, 14, and 15, the surface condenser simplifies hydrogen sulfide abatement control and is more economical in terms of annual cost and cost per unit of net electricity generated.

Once-Through Cooling System

The use of a once-through cooling system with a surface condenser was rejected at The Geysers because it requires large amounts of flow-through water.

Natural Draft Towers

Natural draft towers are not suitable for power plants of 110 MWe or larger at The Geysers. Natural draft towers would have to be very large to create the required air flow. A natural draft cooling tower is estimated to cost 4 to 5 times as much as a mechanical draft tower which depends on a fan to pull steam through the tower.

Closed-Cycle Cooling with a Dry Cooling Tower

It is possible to construct a system that does not need to discharge vapor or use cooling water from outside sources. Such a cycle involves circulating water through a condenser to cool the steam. The water is heated in the condenser and is then cooled in a dry cooling tower. Automobile engines use this method of cooling. At The Geysers, use of closed-cycle cooling would mean that all the condensed steam would have to be reinjected into the steam reservoir. The non-condensable gases in the steam would still have to be released to the atmosphere and would

require treatment to comply with air quality standards. The cost of closed-cycle cooling is expensive and consumes large amounts of steam. PG&E does not consider dry cooling to be technically or economically feasible at The Geysers at the present time because it would be expensive and would consume large amounts of steam.

Imperial Valley

It is estimated that powerplants using the liquid-dominated geothermal resources in the Imperial Valley will require 3 to 5 times as much cooling water as would fossil fuel or nuclear plants producing the same amount of electrical energy. This greater requirement results from the lower efficiency of a geothermal powerplant operating with a low temperature and pressure geothermal fluid compared to the high temperature and pressure steam produced in a fossil-fuel or nuclear plant. More water is required to carry away the greater amount of heat generated per unit of useful electrical energy produced.

The amount of cooling water required varies with the type of geothermal energy conversion system and cooling technology used. In Imperial Valley, the primary conversion systems presently under consideration are the flash and binary systems.

A Jet Propulsion Laboratory study concludes that a binary system using a brine of 150°C requires about 72 percent more cooling water than a flash system. This difference decreases as the temperature of the resource increases.

It is anticipated that geothermal developers in the Imperial Valley will be required to reinject the same quantity of fluid as the amount of geothermal brine they take from the ground in order to prevent subsidence. Therefore, external water supplies will be required to meet the total cooling and reinjection water requirements.

2. Alternative Cooling Methods for Imperial Valley Geothermal Systems

There are four methods of cooling which are applicable to the Imperial Valley geothermal developments: (1) evaporative cooling using a cooling tower; (2) once-through cooling; (3) dry cooling; and (4) combination wet/dry cooling.

The use of an evaporative cooling system with a cooling tower is the most likely near-term cooling method for Imperial Valley systems. Once-through cooling is not practical. Although once-through cooling systems have the smallest consumptive use of water, such a large flow-through volume of water is needed that they require a major water supply source such as the ocean or a very large river.

Dry cooling systems use air forced around condenser tubes and involve almost no consumptive use of water. Due to the high temperatures which are characteristic of the Imperial Valley climate, the cost of dry cooling is considered prohibitive at present.

A wet/dry cooling system is a combination of a wet system and a dry system. This could be used in Imperial Valley as a compromise between using a wet system (evaporative cooling) or a dry system.

3. Water Consumption in Imperial Valley

There are widely varying estimates of the amount of geothermal power that will be developed in the Imperial Valley. If technical problems of hot water geothermal systems can be solved, estimates of 1000 MWe by the year 1990 and 2000 MWe by the year 2000 appear to be reasonable. This would mean that cooling water supplies of approximately 100,000 acre-feet per year would be required by the year 1990 and 200,000 acre-feet per year by the year 2000.

Water requirements for geothermal development in the Imperial Valley pose special problems because the possible sources of cooling water in the Valley are very limited. They include: (1) Colorado River water from the All-American Canal; (2) ground water; (3) Salton Sea water; (4) geothermal brines or condensed geothermal steam; and, (5) agricultural drain water.

Colorado River Water from the All-American Canal

This water supports the agricultural industry of the Imperial Valley. Its consumptive use for cooling geothermal powerplants could decrease the availability of irrigation water for agricultural production in the Valley.

Ground Water

Ground water is an unlikely source of cooling water in the Valley because the majority of the geothermal resources appear to be located where ground water supplies are very limited. Also, the hydrology of the Valley is such that withdrawal of a significant amount of ground water from the western or eastern edges of the Valley would be expected to reduce the amount of relatively low salinity water presently entering the Salton Sea.

Salton Sea Water

The high mineral content of the Salton Sea would limit use of its water in evaporative cooling towers, due to potential scaling and corrosion. Returning cooling tower blowdown to the Salton Sea would increase the salinity of the Sea. Land disposal of blowdown water would require large solar evaporation ponds which could severely impact local agricultural land uses.

Geothermal Brines or Condensed Geothermal Steam

Relatively cool geothermal brines from low salinity reservoirs could be considered as a source of cooling water. The extremely saline brines near the Salton Sea, however, could not be used. Some corrosion and scaling problems could be expected even from low salinity fluids. Also, removal of more geothermal fluids than were reinjected might reduce reservoir life and cause surface subsidence.

Agricultural Drain Water

Irrigation water in excess of that required for plant growth is applied to the cultivated fields in the Imperial Valley to remove salt buildup. Excess irrigation water percolates through the soil and is collected in drainage ditches. These drains are the primary water source for the New and Alamo Rivers which in turn support the Salton Sea. Due to the high evaporation rate in the Imperial Valley and the salt loads of the agricultural drains, the salinity of the Salton Sea has now risen to approximately 38,000 parts per million (ppm) and is now increasing at the rate of approximately 600 ppm per year. By comparison, ocean water salinity is approximately 35,000 ppm. Unless some attempt is made to control this salinity, the levels are expected to rise so high in the next decade that

they will substantially reduce or eliminate the sport fishery in most of the Salton Sea, except around the mouths of the New and Alamo Rivers where salinity would remain below toxic levels.

At present, the San Diego Gas and Electric Company views agricultural drain water as the most attractive source of cooling water for geothermal powerplants in the Imperial Valley. Diversion of agricultural drain water would be desirable because agricultural lands, as well as lands of the Salton Sea National Wildlife Refuge, have been inundated by a rising shoreline in recent years. However, a reduction in flow to the Sea will result in increased salinity due to removal of some of the diluting effects of the agricultural drain water.

Geothermal energy production in the Imperial Valley will require large quantities of cooling water for plant operations. Water availability is of great concern to utilities and developers since most surface waters are appropriated. Further, testimony before the Task Force indicates that problems in obtaining available water and the costs associated with purifying it may be a limiting factor to development. The Task Force therefore recommends that each developer meet with the appropriate jurisdictions early in the planning stages to determine the sources of available water. (Dissent filed)

Costs

According to data received by the Task Force, the cost of power generated at The Geysers from 1961 through 1974 averaged about 5.6 mills per net kilowatt hour (kWh). Capital costs averaged $126 per kilowatt (kW) for units installed through 1975. Because of the additional cost of abating the release of hydrogen sulfide and of inflation in general, the cost of power production for units beginning production in 1979 is estimated to range from 20 to 30 mills per kWh; capital costs will range from $250 to $350 per kW. While no plant using liquid-dominated geothermal resource conversion technologies is currently in operation in the United States, the Federal Department of Energy (DOE) estimates the capital costs at slightly more than $700 per kW (in 1975 dollars) for Bechtel's recent conceptual design of a binary steam plant at Heber, California.

Direct Use of Geothermal Resources

Worldwide, the direct use of geothermal energy for heating is far more widespread than its use to generate electricity. According to an article, "The Worldwide Electric and Non-electric Geothermal Industry" by Peterson and Nabil (Geothermal Energy, November 1975), nearly 2,280 thermal megawatts for direct use of geothermal heat was produced worldwide in 1975, as compared to electrical production of 1,240 MWe. Uses fall into the following categories: agriculture, spas, tourism, industrial processing, space heating, cooling, and refrigeration.

Direct use of geothermal energy for heating is generally limited by location of the resource and demand. Hot fluids cannot be economically transported long distances, so users must be located near the geothermal resource.

Promising areas in California for direct heat projects are: Susanville in Lassen County; Lake County; Mammoth Lakes Village in Mono County; and the Imperial Valley. Many other significant areas with direct heat potential exist in northeastern California, the eastern Sierra, Mojave Desert, Diablo Range, and The Geysers.

1. Utilization and Limitations to Use

The use of geothermal energy for direct heating in Iceland, France, Hungary, New Zealand, Japan, and the Soviet Union is well documented. In the United States, use is not as widespread as the distribution of the resource might indicate.

Klamath Falls (Oregon) and Boise (Idaho) are notable exceptions which employ geothermal resources primarily for space heating. Klamath Falls uses about 400 hot water wells to heat approximately 500 buildings. The Boise Warm Springs Avenue heating system heats 175 homes with two wells and has been operating since the 1890s. In addition to heating buildings, hot water in Klamath Falls is used for pasteurizing milk, melting snow, keeping a floor from freezing in a cold storage plant, curing concrete, washing in a commercial laundry, and heating swimming pools.

Small scale yet significant uses also are in operation in Reno, Nevada; Calistoga and Susanville, California; Salt Lake City, Utah; and Colorado. Most of these areas use shallow warm water wells for space and water heating.

Unfortunately, experience to date has been primarily on the scale of one well per user, rather than with more efficient district systems. The applications are varied and numerous--almost any process requiring moderate temperature can be adapted to a geothermal energy source.

Although geothermal fluids are transported in Iceland more than 10 miles without a significant drop in temperature, present economics in California based on current competing fuel costs and pipeline costs preclude long distance transport of geothermal fluids. Applications are most promising for potential users near a geothermal source.

Direct heat uses of geothermal energy are eventually expected to make a significant energy contribution to California. It is difficult, however, to predict when anticipated applications will prove economical. As competing fuel prices rise, and as clean burning fuels such as natural gas become less available, it is certain that direct uses of geothermal energy will increase. ERDA estimated that annual direct use of geothermal heat nationwide could amount to 0.1 quad by 1985 and 1 quad by 2000 (a quad is equal to 10^{15} BTUs). This estimate is rough and probably high.

2. State Program

The Energy Commission is supporting efforts that will lead to increased use of direct heat applications of geothermal energy. Specific projects receiving support include:

a. A mapping project in Susanville to identify specific geologic conditions responsible for the geothermal anomaly in the Susanville area.

b. An economic study of low temperature geothermal resources in Lassen and Modoc Counties to consider five direct applications of geothermal energy in northeastern California: greenhousing, kiln drying of lumber, food processing, cattle raising, and aquaculture.

c. The Desert Hot Springs Geothermal Project to study cascaded uses of geothermal energy. Cascading means that as the geothermal fluid is

utilized and progressively loses heat, it is applied to different uses.

d. The Mammoth Lakes Direct Heat Utilization Demonstration Project to test various components of a future major district heating system.

CONCLUSIONS

According to industry representatives, the technology for successful use of the vapor-dominated resource at The Geysers is available and requires no significant research and development. The process used at The Geysers is the most thermodynamically efficient that can be used with a dry-steam resource. Additional research, however, is needed to develop efficient measures to protect the environment, including hydrogen-sulfide abatement techniques.

Additional research and development is needed for commercial conversion of liquid-dominated geothermal resources to electric power. Work needs to be done on the basic process and designs of turbines for binary and total flow applications, brine flash drums and separators, down-hole pumps and heat exchangers. Pilot and prototype plants should be designed, constructed, and operated to establish firmly the economic feasibility and operating characteristics of liquid-dominated geothermal systems. Both the Electric Power Research Institute and the Department of Energy are studying the feasibility of installing such demonstration plants.

Powerplant cooling technology and sources for cooling water should continue to be investigated particularly for the liquid-dominated systems. Considerable work also is needed to identify applications for direct uses of geothermal energy, to design equipment for such uses, and to construct pilot facilities for verification of their technical economic feasibility.

ENVIRONMENTAL CONSIDERATIONS

Power production from geothermal resources is often called "clean energy." This statement is not entirely true. It may be a cleaner process than burning fossil fuels such as coal, but it also can affect air quality, most notably with emissions of hydrogen sulfide. Geothermal energy production also has impacts on land and water use. A geothermal powerplant with its related facilities commits surface land to power generation. Further, certain processes for geothermal energy conversion to electricity consume substantial amounts of cooling or make-up water.

From testimony at the Task Force public hearings and from additional information collected by the Task Force, it is apparent that the development of geothermal resources for electric and non-electric uses has and will have impacts on the environment. The magnitude of the environmental effects is largely dependent on the location of development.

Consequently, governmental agencies must examine important environmental considerations associated with geothermal development such as: air quality, water quality, geologic hazards, noise levels, land use, hot springs, cultural and archaeological resources, and fish and wildlife.

AIR QUALITY

Geothermal fluids are not pure water. Both the steam and hot water contain several noncondensable gases, some of which can cause air pollution if allowed to escape to the atmosphere. The most important of these is hydrogen sulfide, a colorless gas with the strong, unpleasant odor of rotten eggs. The nuisance caused by release of this gas is one of the most serious environmental effects observed from present geothermal developments at The Geysers and is of some concern in future developments in Imperial County.

Other potentially significant air contaminants accompanying geothermal fluids in California are boron, arsenic, mercury, and radon. To date, none of these has been observed in concentrations which are believed to constitute an air pollution problem. However, their presence indicates they should be taken into account as geothermal development proceeds.

Sources and Control of Hydrogen Sulfide

When geothermal fluids reach the atmosphere, the hydrogen sulfide they contain is released to the air. In a vapor-dominated field such as The Geysers, where the steam is used to generate electric power, about 90 percent of the hydrogen sulfide comes from the powerplant and 10 percent from the wells, pipelines, and other steam supply operations. In liquid-dominated fields, such as those in the Imperial Valley, emissions of hydrogen sulfide will be essentially confined to the powerplant because there will be little opportunity for the hot liquid to come in contact with the air.

1. Vapor Dominated Reservoirs - The Geysers

When geothermal steam is used directly to generate electricity, the hydrogen sulfide it contains is released from the steam in the condensers. All existing powerplants at The Geysers use direct contact condensers in which cooling water is sprayed directly into the steam. A large portion of the hydrogen sulfide in the noncondensable gases dissolves in the cooling water and is carried to the cooling towers where it escapes to the atmosphere. The balance is discharged from the ejector with the other non-condensable gases.

According to the Northern Sonoma County Air Pollution Control District (APCD), the 11 powerplant units in operation at The Geysers in Sonoma County discharge an estimated 1,790 pounds of hydrogen sulfide per hour into the air. This has resulted in the air quality standard for hydrogen sulfide being exceeded downwind in Lake County. Recent hydrogen sulfide controls in Geysers Powerplants 3 and 4 are estimated to have reduced field emissions to about 1,174 pounds per hour. However, odor complaints have continued to be received from people in communities 4 or 5 miles downwind.

Chemical treatment to remove hydrogen sulfide was incorporated into the original design of Geysers Unit 11. An iron compound is used as a catalyst to convert the hydrogen sulfide in the circulating water to elemental sulfur. The system is intended to remove about 90 percent of the hydrogen sulfide. However, its full evaluation has not yet been completed and the atmospheric measurements and the frequency of odor complaints suggests that it is not fully effective.

The catalyst system, however, significantly increases corrosion and produces a precipitate which is difficult to collect. Once collected, the precipitate must be disposed of in a facility of the class designed to accept the most hazardous solid and liquid wastes. This system is to be employed in Unit 12 under construction and has been placed on Units 3 and 4. More substantial data supporting the effectiveness and reliability of this technology are necessary.

Three new powerplants under construction at The Geysers will be equipped with a new control system, the Stretford process, which uses surface condensers to prevent hydrogen sulfide from coming in contact with the cooling water and dissolving in it. Almost all the hydrogen sulfide is expected to remain in gaseous form to be conducted to a sulfur recovery unit similar to those used in the petroleum industry. Units equipped with this kind of abatement are expected to remove approximately 90 percent of the hydrogen sulfide without the troublesome operating problems associated with the iron catalyst system.

Large quantities of hydrogen sulfide are also emitted when wells are drilled and tested and when steam is vented from wells while a powerplant is shut down. These steam supply emissions represent about 10 percent of the hydrogen sulfide discharged at The Geysers.

During the long period when wells stand idle, awaiting completion of the powerplant, they must be protected from steam condensing in the cool, upper portion of the well. If the steam is allowed to condense, the water will collect in the bottom of the well and shut off the steam production. An idle well is therefore protected by a bleed pipe which continuously emits a small quantity of steam. Sufficient hydrogen sulfide escapes from these bleeds to produce detectable odors in the immediate vicinity.

Steam vented during a powerplant shutdown is a particularly serious problem because it is discharged at a single point, completely bypassing any installed hydrogen sulfide controls. There are two general remedies for this situation: not venting the unused steam or cleaning the hydrogen sulfide from the steam before venting. Currently, there is some mitigation by partially throttling the flow from some wells and rerouting some steam to neighboring generating units. Studies are underway on methods to remove the

hydrogen sulfide from the steam before it is delivered to the powerplant unit, and this technique shows great promise. One method may have a hydrogen sulfide removal efficiency in excess of 95 percent. Pre-cleaning the steam would not only control hydrogen sulfide emissions when plants are both operating and shut down, but would eliminate the need to use expensive surface condensers and Stretford units.

Measures to reduce emissions of hydrogen sulfide are employed at only a few of the existing units in The Geysers. Retrofitting of existing units and incorporation of effective controls in the design of units under construction should reduce hydrogen sulfide emissions below present levels. The new power units already under permit are designed to emit less hydrogen sulfide than existing units, but effectiveness and reliability of the control systems have not been fully demonstrated. These controls, however, will not be sufficient to maintain emissions below present levels if the field is developed to its estimated capacity. Furthermore, some future developments will occur closer to communities and in the valleys where hydrogen sulfide will be less likely to disperse. These circumstances will increase the impact of hydrogen sulfide emissions on the public.

Extrapolation of present rates of hydrogen sulfide emission is not a wholly satisfactory guide to future developments. The natural steam from some recently developed parts of The Geysers apparently contains less hydrogen sulfide than the steam developed for Units 1 through 11 and other locations in Big Sulfur Creek. Some parts of the KGRA may have as little as one-tenth the hydrogen sulfide of the geothermal steam supply for Units 3 and 4, for example. Nevertheless, it is anticipated that full development of The Geysers field will not be possible until technology for improved hydrogen sulfide removal becomes available.

The Task Force therefore recommends that the Air Resources Board (ARB) recommend solutions to air pollution problems at The Geysers. In formulating its recommendations, the ARB should include consideration of: (1) the current and expected emissions; (2) the present and future air quality in the region; (3) the availability of hydrogen sulfide emissions controls; and (4) the air pollution control enforcement in Lake and Sonoma Counties. From the findings, the Task Force recommends

that the ARB propose for adoption by Lake and Sonoma APCDs regulations for control of air pollution from geothermal operations at The Geysers consistent with the orderly development of the KGRA.

2. Liquid-Dominated Reservoirs

Hydrogen sulfide problems in liquid-dominated geothermal fields are essentially confined to powerplants, since in most cases geothermal fluids would not be discharged to the atmosphere. This is particularly true in non-electric applications. In addition, hydrogen sulfide concentrations in the Imperial Valley geothermal region vary from trace amounts to quantities about equal to those at The Geysers.

If well testing, which might produce some hydrogen sulfide, is kept to a minimum, emissions will depend mainly upon the method used to convert the heat in the brine to electricity. The closed-cycle, binary conversion process keeps brine under pressure and retains hydrogen sulfide and other noncondensable gases in solution in the spent fluid, thus preventing them from reaching the atmosphere. A flash process, on the other hand, allows the noncondensable gases to come out of solution and to be released to the air if not otherwise controlled.

Where the quantity of hydrogen sulfide is small, pollutants from a flash process may be sufficiently diluted by use of a tall stack or by mixing with air from the cooling tower. Higher concentrations of hydrogen sulfide, however, may require emission control systems similar to those employed at The Geysers.

3. Air Quality Standard for Hydrogen Sulfide

The State Air Resources Board (ARB) is authorized to establish ambient air quality standards for the protection of public health, safety, welfare, aesthetic visibility, and economic values. Air Pollution Control Districts (APCDs) are empowered to implement and enforce measures to control emissions to attain the maintained air quality standards.

In 1970 the State Air Resources Board promulgated an ambient air quality standard for hydrogen sulfide of 0.03 parts hydrogen sulfide per million parts

of air (by volume) for one hour, based on the recommendation of the State Department of Health. This standard is generally referred to as the odor threshold for hydrogen sulfide because the detectable concentration is highly dependent upon each individual's sense of smell. Some people can detect hydrogen sulfide concentrations of 10 parts per billion (ppb) or lower. The standard is designed to prevent strong odor from continuing.

The State ambient air quality standard for hydrogen sulfide has been exceeded in the vicinity of the powerplants at The Geysers. Violations have also occurred in communities a considerable distance downwind in Lake County. Even at The Geysers, however, the observed air quality measurements do not show hydrogen sulfide at concentrations known to be toxic to human beings. Nonetheless, residents of Lake County have reported health effects attributed to the emissions from geothermal operations.

The complaints and the measurements both indicate that the concentration of hydrogen sulfide at any downwind location is highly dependent on meteorological conditions. Understanding the meteorological factors of dispersion will aid in determining the degree of control and the siting requirements necessary for future wells and powerplants.

The current measurement program by Stanford Research Institute (SRI) does show that the air quality standard is violated in parts of Lake and Sonoma Counties as a result of the present developments at The Geysers. It is not clear, however, that violations of the 30-ppb standard are responsible for the odor complaints, which the Sonoma County APCD reports correlate poorly with air quality measurements. However, this may be the result of 30 ppb being too high a concentration or the averaging time too long to be applied as a standard to continuous emission from geothermal powerplants.

Although the present air quality standard can be criticized as not preventing odors and odor complaints, it is intended to restrict the annoyance associated with hydrogen sulfide in the air and to provide a target for control measures. It represents the best currently available statement of the degree of control required for hydrogen sulfide emissions.

The Task Force recommends that the Air Resources Board review the State hydrogen sulfide standard to determine whether it is an adequate guide for the future.

Air Pollution Impacts

1. Odor

Hydrogen sulfide has a pungent and disagreeable odor which humans can detect in extremely low concentrations. Hydrogen sulfide odors in parts of Lake County has given rise to many complaints from the local population. Residents of The Geysers area dispute the source and origin of any odor nuisance. Some contend that the odors originate from natural emissions and have been present since early days. Others maintain the odors are very severe and can be traced to the more recent geothermal developments at The Geysers. Additional reliable, objective data on the concentrations of hydrogen sulfide downwind of the powerplants would assist in resolving this controversy. Unfortunately, quantitative data on air quality in Lake County are presently limited to a few studies by the Lake County APCD and the ARB, and to progress reports from an ongoing study by SRI. These data are not entirely satisfactory because of the difficulty in making reliable measurements of hydrogen sulfide in very low concentrations, such as the 30-ppb standard, which is near the detection limit of the instrumentation. Also, except for current monitoring, the studies were made at different locations and different times of the year so that the data are not readily comparable.

2. Health

No one has made systematic studies of public health effects of geothermal developments in the United States. In view of repeated reports of nausea, dizziness, loss of sleep, and other health complaints, some epidemiological investigation of the health impact of geothermal emissions is needed.

The Task Force recommends that the State Department of Health establish health monitoring programs in regions with developing or expanding geothermal operations to identify their effects on community health.

3. Vegetation

Hydrogen sulfide has been suspected of harming vegetation near The Geysers, but direct evidence of this effect is lacking. Studies conducted in greenhouses by investigators at the University of California at Riverside show that hydrogen sulfide damage to grapes, alfalfa, and pine trees does not occur at concentrations below 100 ppb. Concentrations of this magnitude are occasionally observed at The Geysers, but their duration is much shorter than the greenhouse experiments.

Hydrogen sulfide can oxidize in the atmosphere to form sulfur dioxide and sulfate compounds, both of which are more acid and toxic to plants than hydrogen sulfide. The oxidation reaction takes some hours, however, and atmospheric tests for sulfur dioxide have not indicated significant concentrations near geothermal developments in California.

Boron

At the Geysers, boron compounds are dissolved in the condensate from the power units and are carried into the air with moisture from the cooling towers. Studies by the Pacific Gas and Electric Company show that boron damages some native plants, primarily the local species of maple tree, near the power generating units. This effect is apparently confined to distances of a few hundred feet downwind of the cooling towers.

The hot brines of Imperial County also contain boron. Boron emissions in the rich agricultural areas could be much more serious than at The Geysers.

Mercury, Arsenic, and Other Heavy Metals

Steam at The Geysers contains mercury, arsenic, and other heavy metals including lead and vanadium. The amount of heavy metals released from geothermal operations needs to be studied to assess potential public health risks. The local APCDs should periodically test the fluids and emissions for the presence of mercury, arsenic, and other toxic substances. Whenever such measurements indicate that significant quantities of hazardous substances exist, local APCDs should undertake monitoring programs for these substances.

To date, concentrations of these substances in California's geothermal areas have not endangered public health.

Radon

Geothermal fluids contain small amounts of radon derived from the decay of radium in the earth's crust. Measurements have shown that the radon concentrations in the vicinity of present geothermal developments are the same as background concentrations in similar non-geothermal areas in California. However, radon concentrations about 3 times the permissible atmospheric standard are present in the condensers of The Geysers powerplants. This does not pose a health hazard, however, because people cannot enter the condenser while the plant is in operation. Undesirable increases in radon in the vicinity of the plant are avoided by dilution of the radon with large volumes of air in the cooling tower.

Research and Development

The Task Force supports research and development to solve air quality problems, and commends industry, the ARB, the Energy Commission, and the Department of Energy for supporting such research.

Near-term research, development, demonstration projects and applications should focus on new methods of hydrogen sulfide abatement which rely on pre-treatment of the geothermal steam upstream of the powerplant. These methods may be more effective and reliable than post-powerplant hydrogen sulfide abatement technologies currently being considered. Further, these upstream abatement technologies may be applicable to abating hydrogen sulfide emissions normally "stacked" during powerplant shutdowns. Substantial reduction of hydrogen sulfide in the steam before it enters the powerplant should also reduce metal embrittlement of steam turbine components induced by the presence of hydrogen sulfide. Substitution of steam pre-treatment for post-powerplant catalyst abatement technologies producing substantial quantities of sludge would eliminate the waste disposal problem. Finally, should more stringent hydrogen sulfide abatement be necessary, powerplants utilizing pre-treated steam could be fitted with post-powerplant hydrogen

sulfide abatement technologies for the additional control. Pre-treatment abatement technologies should also be applicable to abating emissions occurring during well drilling and cleaning operations.

WATER QUALITY

Impacts of geothermal development on water quality vary according to location. The most common problems are thermal and/or mineral pollution. Construction activities associated with all phases of geothermal development may also alter the quality of surface and subsurface water. Furthermore, accidental spills during drilling and powerplant operation may result in waste discharges of geothermal fluids which may harm plants and wildlife in surrounding areas. State and federal water pollution control laws are administered by the State Water Resources Control Board (SWRCB) and 9 Regional Water Quality Control Boards (RWQCBs). The appropriate Regional Water Quality Control Board must issue a Waste Discharge Requirement or National Pollution Discharge Elimination System permit for any activity which results in a discharge of waste to surface or subsurface water.

Thermal and Mineral Discharges

Geothermal development can cause thermal and mineral pollution of stream systems or groundwater basins. No increase or decrease in the temperature of the water receiving a geothermal discharge is allowable unless the project sponsors demonstrate to the appropriate RWQCB that such temperature alterations are harmless to the environment and do not impair any other uses of the water. The SWRCB also establishes limits for acidity, dissolved oxygen, biostimulation substances, sediment, bacteria, toxicity, and chemical constituents.

Requirements of RWQCBs for geothermal development provide for self-monitoring of discharges and accidental spills. When an accidental spill or a breakdown of equipment occurs causing violation of water discharge requirements and basin objectives, the discharger must notify the RWQCB of the occurrence immediately. Further, the operator must submit a letter describing all details of the occurence, damage to the environment, and efforts to correct the situation. In the North Coast Region, there were 21 reported spills associated with geothermal operations between May 15, 1974, and June 2, 1977.

In areas of special biological significance, where spills occur frequently, the RWQCB can and must require construction of secondary holding facilities to reduce the possibility of pollution.

The Task Force recommends that the geothermal developer contact the appropriate Regional Water Quality Control Board at the earliest possible date to obtain the thermal and mineral guidelines for discharge to surface streams and groundwater in the proposed areas of development. (Dissent filed)

GEOLOGIC HAZARDS

Subsidence

Development of liquid-dominated geothermal resources may cause subsidence (sinking of the land) if the reservoir is not properly managed. Particularly in Imperial County, subsidence has the potential to damage structures, irrigation canals, pipelines, and drainage facilities. Subsidence does not seem to be a potential problem in other known geothermal areas in California.

Recognizing that subsidence could be a problem if geothermal resources are developed in Imperial County, a consortium composed of representatives from industry and government sponsored a grid survey to measure earth movements. The first survey was made in 1971, a second in 1973, and a third was to be completed in 1976-77. Between 1971 and 1973, there was natural subsidence of about 9 centimeters at the north end of the area adjacent to the Salton Sea. Little or no variation in elevation was observed throughout the rest of the County.

Because of the potential economic damage that subsidence could cause in the Imperial Valley, it may be necessary to maintain pressure in geothermal reservoirs while fluids are extracted for power production. This can be accomplished in many ways. In flow-through power generation systems, waste fluids can be reinjected. If the flash system is used and cooling water required, it may be necessary to acquire an outside source of water for reinjection. This could be accomplished either by purchasing water from the Imperial Irrigation District or by pumping water from the Salton Sea. Testimony at the Task Force hearings indicated that proper management of pumping from the

Salton Sea could have beneficial environmental effects and extend the useful life of the Sea.

The Task Force recommends that the Division of Oil and Gas require geothermal operators in the Imperial Valley area to provide for reinjection at locations and times necessary to prevent differential settling of the land. (Dissent filed)

Seismicity

Active or potentially active faults exist within or near many geothermal reservoirs; hence inadequately designed geothermal facilities may be damaged as a result of an earthquake, either by earthquake shaking or, in some instances, by fault displacement. According to the Division of Mines and Geology, the geothermal areas with greatest potential for earthquakes are: The Geysers; Surprise Valley; Honey Lake; Mono-Long Valley; the Coso area; and Imperial Valley.

Although The Geysers is located about 30 miles northeast of the San Andreas Fault, a great earthquake (with magnitude greater than 8 on the Richter scale) on the San Andreas would produce significant bedrock accelerations up to 0.5 times the force of gravity (0.5g) within The Geysers area. In the Surprise Valley geothermal area, the Surprise Valley fault is considered capable of producing an earthquake with magnitude 7.5 on the Richter Scale, with undetermined ground acceleration. The Honey Lake Fault and Fort Sage Fault near Susanville could produce an earthquake with a Richter magnitude of 6 to 7. In the Mono-Long Valley area, the Owens Valley Fault could produce an earthquake with a Richter magnitude of 8 and ground accelerations up to 0.6g. The Coso geothermal area is located close to the Garlock Fault as well as the Owens Valley Fault. Each of these faults could produce an earthquake with a Richter magnitude of 7.75 to 8.25.

Many geothermal fields in the Imperial Valley are located close to or essentially astride active faults. A portion of the San Andreas fault and one of its branches, the Sand Hills Fault, could produce an earthquake of magnitude of 7 to 7.5 on the Richter Scale. Other faults near Brawley and the City of Imperial could produce earthquakes of magnitude 6 to 7.

The likelihood of a maximum credible earthquake occurring is very limited and therefore most standards for construction are based on maximum probable earthquakes. The maximum probable earthquake is the maximum earthquake that is likely to occur during a 100-year interval.

The Division of Mines and Geology Report 122 indicates that within the area mapped by McLaughlin in 1974, 91 of 168 geothermal wells drilled in The Geysers had been sited on relatively unstable terrain, and could be damaged by earthquakes or landslides. The design standards of the Division of Oil and Gas for the casing integrity of geothermal wells have so far been adequate to protect the wells from seismic damage. The Division now requires that trained engineers and geologists must inspect all potential well sites to ensure proper siting prior to issuing a permit to drill a well. Sites on landslides need to be avoided because movement on a landslide can break open a well, resulting in a blowout. Landslide movement can be triggered by seismic shaking. Because of these hazards, the Division is continually inspecting old wells and requesting operators to improve substandard drilling sites.

Because earthquakes cannot be predicted, all new wells, transmission lines, power plants, and related facilities should be designed to meet performance criteria which consider all possible factors relating to the location, geology, and service area of the potential power plant. In addition, the performance criteria should consider the health and safety of neighboring communities and the possible environmental effects of an earthquake. In this way, possible earthquake damage to geothermal facilities and, in turn to the environment, may be reduced. The Task Force therefore recommends that powerplants and related facilities be designed to withstand no less than the maximum probable earthquake at a given site. (Dissent filed)

Erosion

Accelerated erosion from construction of roads, drilling pads, powerplant sites, and other activities is a problem at The Geysers, and is a potential problem in many areas. Erosion and sediment transport may threaten water quality and may destroy wildlife habitats. Although the RWQCBs require submission of an engineering plan for construction of these facilities, and the counties require

plans and furnish inspections, subsequent land use and/or deficiencies in construction may destroy the effectiveness of the precautionary measures. In many sensitive areas, regardless of the plans and specifications required for construction of facilities, there is an increase in erosion.

Erosion and sedimentation are natural phenomena. Through these processes, rock and soil are carried from elevated areas into drainage systems and ultimately to the ocean. Natural sedimentation is essential to maintain normal river systems, beaches, and coastal areas, and to support the life cycle of organisms living in them. The construction of roads, drilling pads, and powerplants, however, upsets natural erosion processes. Even under the best management and construction procedures, there generally is at least a temporary increase in erosion and downstream sedimentation.

Slope Stability

The susceptibility of geothermal areas to problems of slope instability varies according to the topography, geology, and weather conditions present in each area. At The Geysers, for example, all of these factors contribute to hazardous slope conditions. The Imperial Valley, on the other hand, is relatively flat, and is not as susceptible to problems of slope stability.

It is possible to locate structures, roads and other improvements on potential landslide terrain with satisfactory results; however this can be accomplished only by careful consideration of the total geologic conditions at each individual site. For example, a road cut or well pad inserted on a hillside, which undercuts and removes support from a geologic formation that dips downslope, will usually result in failure of the hillslope. Geothermal well pads and powerplants located on terrain which is unstable may renew movements of old landslides.

Because landslides are natural phenomena in many geothermal resource areas, they should be considered in siting roads, wells, pipelines, powerplants, and transmission lines. Reactivation of old landslides or triggering of new ones are problems that can only be lessened by detailed site-specific studies made prior to the beginning of construction.

To ensure protection from landslide hazards, the Task Force recommends that the geologic assessment of each well pad, powerplant, and road site shall be continued prior to and during any construction in order to mitigate landslide activity.

NOISE

Geothermal operations tend to increase existing noise levels. In general, geothermal development has occurred in rural areas where the noises from geothermal operations can be heard over long distances. While trucks and tractors, drilling rigs, and powerplants produce some noise, the major noise source is the roar of steam vented into the atmosphere at full pressure from wells or steam lines.

In the process of putting a well into service, operators "blow" the well to: (1) meter the quantity of steam in pounds per hour; (2) clear the well bore of rock and particles; and (3) assess the reservoir potential.
It has been the practice to blow the wells at full force for 1 to 3 days without mufflers.

To reduce the noise in nearby communities, mufflers are desirable. Considerable progress has been made over the last few years in developing improved mufflers for both drilling operations and venting of powerplants. The rock-filled mufflers now being employed are capable of reducing noise levels by approximately 90 percent.

The California Noise Control Act of 1973 requires all state agencies to administer programs under their control so that the public is protected from the intrusion of noise which may be hazardous to health or welfare. The Act also established the Office of Noise Control within the Department of Health.

The Task Force recommends that each county adopt its own noise standards for geothermal operations. Further, counties should apply these standards when issuing conditional use permits or other approvals of geothermal projects.

LAND USE

At The Geysers, each 110-MWe powerplant with its related facilities requires 700 to 1,000 subsurface acres for its geothermal fluid supply; 7 to 15 percent of

that total is needed at the surface for wells, roads, pipelines, and the powerplant. In the Imperial Valley, where slant drilling techniques can be used to a greater degree, surface land requirements are expected to be lower.

Known Geothermal Resources Areas are generally sparsely populated areas presently devoted to agricultural, wilderness, recreation, or low density residential use. The introduction of industrial facilities for geothermal field development and electrical generation may therefore fundamentally change the character of local land use patterns. Further, such operations may threaten public health, safety, and welfare.

Such significant changes are threatening to some people in any community. For example, existing businesses relying heavily on recreational trade may suffer because of the introduction of a geothermal industry. Although recreational sites may not be destroyed, noise and air pollution from geothermal operations may reduce an area's recreational attractiveness. Residents may also be concerned that industrial facilities are too close to their homes. Although the proximity of geothermal development may not cause a decline in property values, increased noise and air pollution could seriously detract from the tranquil, rural atmosphere presently enjoyed by the local residents in certain geothermal areas.

The Oil and Gas Supervisor can alleviate certain of these threats. The Supervisor can require operators to submit all pertinent information that will allow the Division to impose the necessary mitigation measures or to prohibit drilling in inappropriate locations. The Task Force therefore recommends that the Supervisor in consultation with the Geothermal Resources Board and the Director of the Department of Conservation promulgate requirements, consistent with existing Division of Oil and Gas statutory authority, specifying information to be submitted with Notices of Intention to Drill geothermal wells so as to ensure public health, safety, and welfare. (dissent filed)

HOT SPRINGS

Geothermal development near hot springs may substantially alter the environment and may affect the temperature, quantity, and quality of water in the springs. Springs so affected could disappear or become unusable.

The Task Force recognizes that there are fragile natural resources that can be threatened by encroaching geothermal development. In order to ensure that state laws are capable of adequately protecting these resources, which are used for medicinal, therapeutic, cultural, religious, or historic purposes, the Task Force recommends that the Division of Oil and Gas and the Energy Resources Conservation and Development Commission in consultation with the Native American Heritage Commission, the State Office of Historic Preservation of the Department of Parks and Recreation, and the Department of Health sponsor legislation which designates significant hot springs as endangered areas of statewide concern. In this way, the Legislature can ensure that certain hot springs, valuable for medicinal, therapeutic, cultural, religious, or historic purposes will be adequately protected from the adverse impacts of geothermal development. (dissent filed)

CULTURAL AND ARCHAEOLOGICAL RESOURCES

Some geothermal areas have significant Native American and archaeological values attached to them. Many Native California Indians value hot springs for their spiritual and medicinal value. In addition, archaeological or cultural resource sites contain fragile and non-renewable resources; even a seemingly harmless geophysical survey can irreversibly alter existing surface patterns and thus diminish the value recognized by both the Native California Indian and scientific communities.

The National Historic Preservation Act and the National Environmental Policy Act require that, prior to any agency decision concerning an undertaking, governmental agencies must inventory, locate, and evaluate any significant cultural and archaeological resources which may be impacted directly or indirectly by the undertaking. Furthermore, agencies considering an action in an area of cultural or archaeological significance are required by the California Environmental Quality Act to balance the benefits derived from a proposed exploratory or developmental program against potential damage to the area.

The California Native American Heritage Commission, created in 1977, is statutorily required to prevent severe and irreparable harm to public land sites which are socially or religiously significant to Native California Indians.

Additionally, where necessary to protect such sites, the Commission is empowered to conduct investigations, hold public hearings, and where appropriate, initiate court actions through the Attorney General's Office.

Procedural compliance of federal agencies with national preservation legislation is monitored in California by the State Office of Historic Preservation whose function in this respect is regulatory. The State Office of Historic Preservation also has special expertise in cultural resource matters and may, under the California Environmental Quality Act, act as a reviewing agency within California for non-federal undertakings.

The Task Force recommends that governmental agencies preparing environmental reports on geothermal projects near significant, known hot springs describe to the extent technologically possible the impact of the geothermal project on the hot springs. Such geothermal project environmental reports should describe the nature and content of the springs' waters and whether the flow, composition, or temperature of the springs will be affected by proposed geothermal drilling in the area. (Dissent filed)

The Task Force further recommends that the governmental agency approving the geothermal project near a significant hot spring require monitoring of the springs throughout the life of a geothermal project. If geothermal extraction activities result in unreasonable change in the temperature, quantity, or quality of the springs' waters, the project sponsor should take proper measures to to correct the problem. (Dissent filed)

FISH AND WILDLIFE

Geothermal exploration and development activities affect fish and wildlife resources. The primary impact is caused by the loss and/or alteration of habitat. People unfamiliar with wildlife biology believe that wildlife forced out of an area because of habitat loss or modification will move into adjacent areas. Studies show that wildlife displaced by the loss or modification of its habitat will compete with other wildlife in adjacent areas for the available food and cover. The end result is the actual loss of wildlife and in some instances damage to the remaining habitat. Although there are slight wildlife habitat changes occurring every day, all available wildlife habitats in

California are at their maximum carrying capacities with respect to animal species and numbers. Some of these habitats are essential to perpetuate certain wildlife species. This is especially true for species listed as rare or endangered. The Department of Fish and Game believes that when geothermal exploration and development activities are being proposed in areas having high wildlife values, adequate wildlife compensatory measures should be included to offset losses.

The State Department of Fish and Game and the U.S. Fish and Wildlife Service are responsible for protecting wildlife, including rare and endangered species. Further, every governmental agency is required to consider measures to protect the State's environment under the California Environmental Quality Act and the National Environmental Policy Act.

California geothermal resource areas often coincide with areas of significant fish and wildlife value. For example, the Bureau of Land Management and the U.S. Geological Survey have identified the Mono-Long Valley area near Mammoth Lakes, California, as having high geothermal resource potential. This area also has exceptional fish, wildlife, recreational, and aesthetic values that could be harmed by development. Some of the exceptional fish and wildlife values include the Hot Creek Fish Hatchery; Hot Creek, which is a designated wild trout stream; Crowley Lake; Owens River; and several meadow areas required by sage grouse for successful reproduction.

Extensive land disturbance is normally associated with the construction of geothermal facilities including roads, drill pads, sumps, steam lines, powerplants, and electric transmission lines. These construction activities eliminate wildlife habitat. It has been estimated by the Department of Fish and Game and the U.S. Fish and Wildlife Service that between 10 and 20 percent of the surface area will be disturbed during the construction of these facilities. The indirect impacts of geothermal development can occur in several ways. As additional electrical energy is made available to the consumers in areas previously without abundant energy sources, community growth is stimulated. As communities grow, the demand for space intensifies to provide new facilities such as homes, factories, and schools. Agricultural, forest, brush and range lands are converted into residential and industrial tracts.

There are areas in California, on the other hand, where geothermal development can proceed without significantly affecting fish and wildlife resources provided that adequate measures are taken to protect these resources.

The Department of Fish and Game believes that some non-electric uses of geothermal energy such as greenhousing facilities, chemical extraction plants, food processing systems, and associated housing and support facilities could have greater impact on fish and wildlife resources than electric power production. For example, the construction of extensive greenhousing facilities on native wildlife lands would result in wildlife losses. In addition, the appurtenant facilities required to operate, store, and transport the products of geothermal greenhousing would also require space, resulting in more demands for wildlife lands. The same can be said for chemical extraction and food processing systems. Space heating within the confines of present urbanized areas, however, will have little impact on wildlife unless geothermal fluids are discharged into surface waters. The thermal and toxic properties of discharged geothermal fluids could adversely affect aquatic animal and plant life.

Wells and powerplant operations may result in other unforeseen impacts on fish and wildlife. For example, a well blowout or rupture of a condensate line could discharge highly toxic materials resulting in the loss of wildlife and its habitat. The corrosive properties of The Geysers dry steam condensate are considerably less severe than those of some geothermal fluids in liquid-dominated systems in the Imperial Valley. This condensate, however, is toxic to plant and animal life. Liquid-dominated systems have the potential to cause greater pollution problems with respect to accidental discharges of geothermal fluids to adjacent watercourses. It probably would be impossible to prevent all accidental discharges of geothermal fluids, but it is possible to design and construct containment facilities in areas most likely to have spillage problems, such as powerplants, well sites, cooling towers, and sumps.

Baseline Data

At the present time, 290 steam wells and 11 powerplants are operating in The Geysers. Four additional powerplants are under construction. The Department of Fish and Game estimates that at least 1,700 acres of wildlife habitat have been

destroyed in the construction of these wells and powerplants. As more wells and powerplants are constructed, the Department believes that more wildlife habitat will be destroyed. Further the Department feels that improved mitigation of the cumulative environmental impacts can be achieved only when sufficient baseline data are available prior to development.

Currently, adequate baseline data for many of the identified Known Geothermal Resources Areas are incomplete or non-existent. These data must be available so that governmental agencies can implement necessary monitoring and environmental protection measures.

The baseline data need not include identification of every species of wildlife present in the project area. Instead, key species should be selected which would exhibit changes in behavior or population densities resulting from geothermal exploration and development activities.

Collecting fish and wildlife baseline data prior to any extensive land disturbance will assist in identification of previously unknown, sensitive, or critical habitat areas. Sensitive habitat areas can be defined as those key habitat areas (such as breeding or nesting areas, fawning grounds, winter and summer ranges for big game, spawning gravels, migration routes, feeding areas) that are required by many species of fish and wildlife to maintain populations at present levels. An example of a sensitive habitat is the strutting grounds for sage grouse.

The Department of Fish and Game recommends that fish and wildlife data collection should begin when a lessee makes a decision to drill an exploratory well and should continue for a period of at least one year. The Department further recommends that once a commercially valuable geothermal resource is discovered, the fish and wildlife baseline data collection should be completed prior to governmental approval of the production wells, powerplant, or other commercial use. In some instances, it would be beneficial if the operator contacted the Department of Fish and Game prior to the drilling of shallow wells to measure thermal gradients in areas previously determined to have critical or sensitive wildlife values.

The Department of Fish and Game believes that geothermal operators should give immediate attention to areas where critical wildlife habitats are found. In

cases where mitigation measures are too costly, the operator should consider relocating the project.

The Task Force recommends that baseline data on fish and wildlife resources should be collected at the resource owner's and/or lessee's (developer's) expense, in cooperation with the Department of Fish and Game, for all geothermal resource and/or lease areas prior to the adoption of an Environmental Impact Report for any post-exploratory field development. (Dissent filed)

Further, the Task Force recommends that the Department of Fish and Game review all fish and wildlife monitoring programs designed to measure the impacts of geothermal exploration and development activities on these resources. The results of the monitoring programs will be submitted to the Department of Fish and Game for its review and comment. (Dissent filed)

Mitigation Measures

State law requires the Department of Fish and Game to protect, preserve and enhance fish and wildlife resources of the State. The Department, however, does not have regulatory authority over all development projects that may affect these resources.

The California Environmental Quality Act requires environmental reports to identify possible mitigation measures which lessen or reduce a project's adverse impacts. However, the Act provides that no mitigation would be required if economic, social or other conditions make it infeasible to mitigate one or more significant effects. The law requires each public agency to make findings supporting its approval of a project which has a significant effect on the environment.

Generally, mitigation measures to offset fish and wildlife losses resulting from geothermal development involve improvement of the available habitat so that it can support more animals and developing and/or providing sources of new water orhabitat. Examples of wildlife mitigation techniques include the following:

Brush Clearing

Dense brushfields are often considered biological deserts. Removing some

of the brush by fire or mechanical means increases the "edge effect" which could benefit more wildlife than solid stands of brush.

Planting Food and Cover

Some plant species are important to wildlife for food and cover. In areas where little cover and few food plants exist, plantings can improve conditions for wildlife. Any wildlife habitat plantings must be protected from incompatible uses such as livestock grazing and unrestricted off-road vehicle use until the plantings have become well established. Especially in arid regions, watering will usually be necessary during the initial growing phases.

Water Source Development

Developing and/or providing new water sources through the exploration for and development of geothermal resources could provide important benefits to many species of fish and wildlife, because many identified Known Geothermal Resource Areas in California are in arid regions. Although these areas lack significant quantities of surface water, they contain numerous springs and seeps which seem relatively insignificant sources of water but which are extremely critical for the survival of most wildlife. Extensive geothermal well drilling and extraction of geothermal fluids could cause some of these springs and seeps to dry up. Therefore, it is important to maintain and develop new water sources for wildlife.

In some cases, geothermal fluids may offer new water sources for wildlife. For example, chukar partridge in the Randsburg area have been drinking water of geothermal origin for several years without any observed ill effects. Many geologic and thermal gradient test holes encounter potable water sources which could be developed for wildlife uses. Further, when deep wells are drilled, additional water sources may be discovered. These deeper sources could also be used for wildlife purposes, if the wells are properly managed. To enable certain geothermal waters to be used for wildlife, amendments in some state and federal regulations governing well drilling, well abandonment, and surface water discharges will be needed.

Constructing artificial watering structures (guzzlers) would also benefit certain wildlife species in arid regions. These structures have water catchment aprons that direct rainfall into a covered water tank buried in the ground. During unusually dry years these tanks could be filled by other means.

Compatible Land Uses

The development of geothermal resources will in some instances conflict with other land uses. The federal government controls a large percentage of the areas in California under which potential geothermal reservoirs are located. These areas are currently being used for other purposes including grazing, timber production, recreation (off-road vehicle use, hiking, fishing, hunting, and sightseeing), mining, and fish and wildlife production. The present problem is that the cumulative impacts from current land uses such as mining, grazing, and timber production are adversely affecting fish and wildlife resources.

The Department of Fish and Game believes that relatively few mitigation measures have been implemented in these current land use programs to compensate for fish and wildlife losses. Geothermal activities could cause further losses in wildlife populations and some species may not be able to sustain themselves. If geothermal resources are developed, it may be necessary to reduce the intensity of other land uses to prevent further degradation to fish and wildlife resources. The Department of Fish and Game believes that land managers and geothermal developers should assess the compatibility of developing geothermal resources with the other land uses. If land use conflicts are identified, the Department stresses that mitigating measures should be implemented to lessen the cumulative impacts.

The Department of Fish and Game believes that when fish and wildlife resources are adversely affected by geothermal operations, mitigation and/or compensation should be required and damaged habitat should be restored. The Department feels that habitat destroyed or damaged by geothermal activities should be either replaced or enhanced.

A fish and wildlife mitigation recommendation was proposed for consideration before the Geothermal Task Force. The proposed language was as follows:

> "The Task Force recommends that developers mitigate for fish and wildlife losses. The Task Force further recommends that developers cooperate with the Department of Fish and Game in developing and implementing appropriate mitigation measures."

The Task Force did not adopt this recommendation, because it decided the substance of the recommendation was covered by provisions of the California Environmental Quality Act.

The Department of Fish and Game believes that without adequate fish and wildlife mitigation, adverse impacts resulting from geothermal exploration and development activities will continue to deplete fish and wildlife resources.

REGULATORY ISSUES

Uncertainties and delays in the state and local permit and regulatory process can be the most frequent and frustrating problem confronting geothermal developers. Geothermal developers must comply with numerous federal, state, and local government regulations including the California Environmental Quality Act and the National Environmental Policy Act.

The Geothermal Task Force reviewed state agency permits to identify any duplication of regulatory requirements. Extensive testimony was heard on the subject in the eight days of hearings held during April and May, 1977. Many witnesses encouraged the Task Force to eradicate this duplication, in order to rationalize and reduce the time required for decisions by state agencies. The only jurisdictional overlap the Task Force discovered involved the State Water Resources Control Board, the Department of Health, and the Solid Waste Management Board's responsibilities for monitoring drilling sumps.

To help resolve potentially overlapping authority that can lead to delays and uncertainties, the Task Force recommends that local government make land use decisions on geothermal wells and that the Energy Commission approve powerplant sites. The Task Force endorses state technical and fiscal support to local government for geothermal planning and also proposes the elimination of several regulatory requirements at the state level. It recommends that a reconstituted State Geothermal Resources Board coordinate the geothermal regulatory activities of various state agencies and cooperate with federal regulatory agencies on geothermal matters.

PHASES OF GEOTHERMAL DEVELOPMENT FOR ELECTRICAL GENERATION

All levels of government presently have some role in regulating geothermal development. Currently, wells are regulated by local, state, and federal agencies. Powerplants, however, are regulated at the state and federal levels. Regardless of regulatory responsibility, all development of geothermal resources is essentially a two-phase process. The first phase involves acquiring or leasing land for exploration and exploring and confirming the resource. The second phase includes construction of the powerplant.

Principal activities of the first phase include constructing drilling pads and platforms, installing drilling rigs and industrial safety equipment, and drilling individual exploratory wells. Drilling a single exploratory well requires about 3 months. Although individual cases differ, on the average, industry must drill at least 3 wells to prove the presence of sufficient geothermal resources to support a powerplant. The total work time for industry from the commencement of exploration to confirmation of the reservoir requires about 9 to 12 months under ideal operating conditions.

Governmental actions usually required during the first phase include: (1) an environmental report; (2) a city or county use permit; (3) a Regional Water Quality Control Board waste discharge permit for a drilling sump; (4) a Solid Waste Management permit for a drilling sump; (5) a Department of Health permit for a drilling sump; (6) a Division of Oil and Gas permit to drill a well; and (7) an Air Pollution Control District authority to construct and a permit to operate. If the proposed project is on state lands, the operator must also obtain a prospecting permit and a lease from the State Lands Commission. If the proposed project is on federal lands, the operator must also obtain permits from the U.S. Geological Survey or the Bureau of Land Management.

The second phase involves construction of the powerplant and other related facilities by a utility company and usually coincides with full development of the resource by the field operators. According to industry, the construction of the powerplant and its related facilities requires approximately 27 months to complete. This includes the construction of the plant and associated facilities such as steam pipelines, power transmission lines, water injection systems, and maintenance roads. Meanwhile, drilling operators require about 30 months time, or 2 months per well, to drill the estimated 15 production wells necessary to support a 110-MWe powerplant. Thus, total time from the commencement of development drilling to actual power production is about 2-1/2 years under ideal conditions. This does not include the time required to drill makeup wells required to supply energy during the entire 30-year life of the plant.

Each well drilled in the final phase requires the same permits required in the first phase. Governmental actions required for a powerplant include: (1)

an environmental report; (2) approval of a notice of intent for an application of site certification from the Energy Commission; (3) approval of an application for site certification from the Energy Commission; (4) a certificate of Public Convenience and Necessity from the Public Utilities Commission (if investor owned); (5) a waste discharge requirement from the Regional Water Quality Control Board; and, (6) an authority to construct and a permit to operate from the Local Air Pollution Control District.

ENVIRONMENTAL REPORTING REQUIREMENTS

Both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) require governmental agencies to consider the environmental impact of a proposed project prior to approving a permit or other entitlement for that project. Typically, each phase of geothermal development requires the preparation of a separate environmental document.

California Environmental Quality Act (CEQA)

The California Environmental Quality Act (CEQA) is designed to provide timely, useful information to decision-makers and the general public regarding the potential environmental effects of proposed projects.

The Act declares that it is the state's policy to "develop and maintain a high quality environment now and in the future, and to take all action necessary to protect, rehabilitate and enhance the environmental quality of the state." To ensure that environmental protection is the "guiding criterion in public decisions," CEQA requires governmental agencies which "regulate activities of private individuals, corporations, and public agencies to regulate such activities so that major consideration is given to preventing environmental damage."

Any governmental agency proposing to approve a project which may have a significant environmental impact must consider a statement describing the environmental effects of the project before making a decision on the project. The statement may take the form of an environmental impact report, a negative declaration, or a notice of exemption. An environmental impact report describes the project's significant adverse effects in

detail. A negative declaration indicates either that the project has no significant adverse effects or that measures have been taken to mitigate the project's adverse effects. A notice of exemption indicates that neither a negative declaration nor an environmental impact report is required for the project.

Further, the agency preparing the environmental document must make it available for public review prior to the time a decision is made. After making a decision, a public agency must find: (1) that the project has no significant effects; or, (2) that the project has significant effects but that the project sponsor has incorporated into the project measures to lessen those effects; or, (3) that such measures are not feasible for social or economic reasons.

Since a geothermal project is almost always associated with environmental impact, some kind of report is always required. Under CEQA, a state or local agency involved in geothermal regulation acts as either a lead agency, a responsible agency, or a reviewing agency.

Section 15030 of the State CEQA Guidelines defines a lead agency as: "the public agency which has the principal responsibility for preparing an environmental document and for carrying out or approving a project which may have a significant effect on the environment." A county is usually the lead agency for exploratory and production wells, while the Energy Commission is usually the lead agency for a powerplant. Prior to the creation of the Energy Commission, the Public Utilities Commission was the lead agency for powerplants.

According to Section 15039, a responsible agency is "a public agency which proposes to undertake or approve a project, but is not the lead agency for the project. It includes all public agencies other than the lead agency which have approval power over the project." The following agencies are usually responsible agencies under CEQA for geothermal projects: State Lands Commission; Division of Oil and Gas; State Water Resources Control Board; California Public Utilities Commission; Local Air Pollution Control District; Regional Water Quality Control Board; and, Solid Waste Management

Board. As responsible agencies under CEQA, they are required by law to consider the lead agency's environmental document. Additionally, the following agencies review environmental documents because of expertise or interest: Governor's Office of Planning and Research; Air Resources Board; Department of Food and Agriculture; Department of Parks and Recreation; Department of Forestry; Department of Health; Department of Water Resources; Department of Transportation; Department of Fish and Game; and Division of Mines and Geology. At the local level, other interested parties, including residents and environmental groups, may review and comment on environmental reports concerning geothermal projects.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) requires all federal agencies to prepare an environmental impact statement (EIS) for evaluating any major federal action or project which may significantly affect the environment. Major federal actions or projects include participating in the project through such actions as funding, leasing, and licensing.

In California, the Bureau of Land Management is usually the federal lead agency and U.S. Geological Survey the responsible agency, while the Environmental Protection Agency and the U.S. Fish and Wildlife Service serve as reviewing agencies. Where the proposed development is located on National Forest lands, the Forest Service becomes the lead agency. Similarly, if the development is on an Army or Navy base, the Army or the Navy would be the lead agency. NEPA also requires the federal lead agency to obtain comments on a draft EIS from interested state and local government agencies and from the public.

NEPA and CEQA are very similar, but not identical. The primary differences between them are: (1) NEPA defines the environment to include the "human environment" while CEQA speaks to the "physical environment;" and (2) CEQA focuses on significant harmful environmental effects while NEPA requires a description of all environmental effects. With these exceptions, environmental documents prepared under NEPA or CEQA could be identical.

An environmental impact report (EIR) prepared under California law must contain all of the information NEPA requires in an EIS. However, CEQA further requires a description of the growth-inducing effects of the project and of any measures which can be taken to lessen the project's effect on the environment. The Federal Council on Environmental Quality guidelines for NEPA have eliminated the difference between the two acts by requiring federal agencies to cover mitigation measures and growth-inducing impacts within existing requirements.

The critical difference between the two acts is timing. Generally, the state environmental review process is nearing completion before the federal process begins. The CEQA process is started when an agency receives an application for a permit, or proposes to undertake an activity which will affect the environment. Traditionally, project sponsors make their application to the local agency, thereby triggering the CEQA process and then sometime later apply to a federal agency triggering NEPA.

To eliminate potential duplication between state and federal environmental reports, the Task Force recommends that:

1. Federal agencies preparing environmental documents under the National Environmental Policy Act:
   (a) use the environmental document prepared under the California Environmental Quality Act; or,
   (b) join with the appropriate state or local agency to prepare a single environmental document that will meet the requirements of both state and federal law, and include a description of the proposed federal regulatory action in the environmental document.
2. State and Local agencies:
   (a) use the environmental document prepared under the National Environmental Policy Act in the preparation of the state document; or,
   (b) join with the appropriate federal agency to prepare a single environmental document which will meet the requirements of both state and federal law.

ENVIRONMENTAL REPORTS

Counties are usually responsible for the preparation of environmental reports on drilling projects. Thus, the contents of the environmental report will vary according to the scope of the decision the local jurisdiction makes. In some cases, the documents are prepared for individual wells; in other cases, a single document covers an entire leasehold or full-field development project.

Full-field Environmental Reports

An environmental report on a full-field development has advantages and disadvantages to industry, government, and environmentalists.

One advantage to industry is that one environmental impact report could be used to approve many drilling sites. This can reduce time spent in public review and in the public decision-making process. The biggest advantage, however, is that the geothermal operator knows the environmental measures he is required to take to develop an entire field.

On the other hand, a full-field environmental report is more expensive initially and there may be a greater chance of opposition because of the large geographic area covered in the report. The undesirability of preparing a full-field report at the exploratory stage is increased by the possibility that steam in commercial quantities will not be found and the chance that much time and effort may be wasted.

From the point of view of government agencies, the primary advantage of a full-field report is that decisions can be made in the long-range context of full-field development rather than on an incremental well-by-well basis.

Environmentalists support the full-field document because they feel that incremental decisions made on individual wells will result in little or no mitigation of the cumulative environmental effects of developing a whole geothermal field. If the government agency does not require corrective measures, the environmentalist has no recourse except to challenge the action in court.

The Task Force recommends that the Division of Oil and Gas sponsor legislation to establish an exemption from the environmental reporting requirements for individual wells drilled in a field for which the

Division of Oil and Gas has adopted a full-field environmental impact report. (Dissent filed)

Current law requires the Oil and Gas Supervisor to provide for the orderly development of a geothermal field. The Division of Oil and Gas regulates the drilling, maintenance, and abandonment of all geothermal wells on state and private lands. Its regulatory responsibilities include ensuring protection of groundwater and geothermal reservoirs, promoting the efficiency of well recovery systems, and enforcing state-wide drilling regulations including those for well casings, disposal sumps, injection systems, and safety devices. The State Guidelines for CEQA, however, allow exemptions to environmental reporting requirements for activities that the Secretary for Resources determines will not have a significant effect, or where legislation has been enacted to create a functional equivalent to the reporting requirement.

Under the recommendation, the Division could examine well logs on exploratory wells to determine whether a commercial resource exists in the field. If there is a reasonable probability that a commercial resource exists, the Oil and Gas Supervisor would consider designating the field as a geothermal resource area for administrative purposes. To make the decision, the Division would have to prepare an environmental impact report on the field describing the effects of full-field development and the general effects of a powerplant and/or other potential commercial activity.

After the Division has adopted the report and the appropriate mitigation measures, and the Supervisor has designated the area as a field, all subsequent wells drilled in the field would be exempt from further environmental reporting requirements. If extenuating circumstances arose, however, such as the discovery of an endangered species, additional environmental information would be required before a government agency could approve a project at that particular site.

PERMIT COORDINATION

State and Local Agencies

State regulation of development projects takes the form of many separate and distinct permit processes, linked together by the California Environmental Quality Act (CEQA). Under CEQA, the regulatory agency making the first

decision to approve a project that may have a significant environmental impact must prepare an environmental document. This document is subsequently considered by all other permit-granting agencies before they reach a decision on their permits.

No statute, however, requires coordination of permit actions for geothermal projects, and there is no central source of information on all necessary permits. At the present time, each permit-granting agency begins its evaluation of a project when the project sponsor files a permit application. After the filing of a permit application with one agency, or the preparation of an environmental report, other agencies may become aware of the project and notify the sponsor of their permit requirements.

The Task Force debated the advantages of a single-agency permitting concept, commonly referred to as "one-stop shopping." This concept has a wide range of meanings, varying from a simple permit information system to a process in which a single agency is enpowered to approve all permits for a given project. Some geothermal operators urged the Task Force to recommend that a single entity at either the state or federal level be empowered to issue all permits for a geothermal project, thereby minimizing the time required to obtain governmental leases and permits.

One objection to the single-agency concept is that such an agency would need to employ technical experts for permit analysis covering a wide range of topics, such as water quality, air quality, and well engineering. The Task Force was reluctant to advocate such a concentration of power in a single agency. Further, a state, regional, and local one-stop shopping system would require a determination of which level of government should approve geothermal projects. By contrast, under the existing system, many levels of government act on any given geothermal project, and each action is usually based on a different aspect of the project. Local governments generally make land use decisions while state and regional decisions usually concern the effects of the project on a public resource such as air or water. Finally, while one-stop shopping sounds attractive, the size of the bureaucracy that would have to be created to run the system might result in the same coordination problems that currently exist.

To solve problems of coordination at the state level, the Task Force recommends that the Geothermal Resources Board coordinate state agency policies and mediate conflicts between permitting agencies for geothermal wells. (Dissent filed)

The Geothermal Resources Board in the Department of Conservation is composed of the Director of the Department of Conservation (who is the Chairperson), the State Geologist, the State Oil and Gas Supervisor, the Executive Officer of the State Lands Commission, the Chairman of the State Water Resources Control Board, the Director of Water Resources, the President of the Public Utilities Commission, and the Director of Fish and Game. The statutory responsibilities of the Board include: (1) recommending areas for the Oil and Gas Supervisor to designate as geothermal resource areas; (2) granting certificates of primary purpose for waters produced by a geothermal well; (3) approving agreements for two or more operators to manage a single field jointly; and (4) hearing appeals of rulings of the Oil and Gas Supervisor on geothermal matters.

Most of the state agencies regulating geothermal development are members of the board. The Energy Commission, however, is not a member, and there are no public representatives on the board.

With the addition of members representing the Energy Commission and the public, the board could provide a forum for state agencies to resolve policy problems relating to geothermal development. Further, given adequate staff, the Board could serve as an information center on state geothermal regulatory activities and mediate disputes between state permitting agencies and geothermal operators.

The Task Force therefore recommends legislation to add the Chairman of the Energy Commission and three public members to the Geothermal Resources Board. The Task Force also recommends legislation to add permit coordination for geothermal projects to the duties of the Board. (Dissent filed)

Federal and State Agencies

Although the Task Force was not mandated to address geothermal development of

federal lands in California, the Task Force sought to be kept informed of the federal government's geothermal programs. The Task Force held two meetings and one set of hearings specifically devoted to presentations by and discussions with representatives of federal agencies relating to the respective roles of state and federal agencies in regulation of geothermal development. In recognition of the necessity for intergovernmental cooperation in this field, the Task Force recommends that the Geothermal Resources Board monitor and assist in all federal efforts to develop geothermal resources. (Dissent filed)

WELL AND POWERPLANT SITING

Geothermal developers complain that government has imposed redundant and often confusing regulations upon their efforts to site geothermal powerplants. The Task Force therefore investigated the desirability of delegating siting authority exclusively to local government, to the Public Utilities Commission, or to the Energy Commission. It also considered the alternative of delegating dual siting authority to local government and one of these commissions. These agencies were considered for pre-eminent control over powerplant siting because they alone have broad statutory authority to guide geothermal development according to their determination of the general public welfare.

Local Planning

In keeping with California's strong tradition of home rule, local legislative bodies (city councils and county boards of supervisors) have exclusive authority over the types of uses permitted on private land. Local geothermal regulation is now achieved in one of two ways:

1. The local planning agencies set aside given geographical areas for potential geothermal development; or,
2. Local zoning ordinances set aside areas as "unclassified," or multiple use zones (most KGRAs are zoned "unclassified") and require special use permits for all development in such areas.

State planning law requires cities and counties to formulate and adopt a comprehensive, long-range general plan to serve as a guide in all land use

decisions. A general plan expresses a community's desires regarding growth and sets priorities for environmental, social, and economic development. The general plan, in turn, is put into effect by zoning ordinances, which are required by state law to conform to the general plan.

Zoning ordinances set forth the types of land use allowed in specified areas. Typically, such ordinances are designed: (1) to protect existing land uses by completely prohibiting "incompatible uses" or by allowing designated and potentially incompatible uses through Planning Commission issuance of "special use permits;" and (2) to provide for orderly growth and development according to the community's determination of its desirability.

Counties issue conditional use permits on a project-by-project basis for exploratory drilling, developmental drilling, and powerplant construction. Counties also issue grading and building permits for roads and construction during each phase of geothermal development. This process requires anywhere from 3 to 19 months, depending upon the size of the project, the extent of the leasehold area, and the magnitude of the environmental problems encountered.

1. County Procedures

Sonoma County

Conditional use permits are required for all geothermal energy activities in Sonoma County. A Board of Zoning Adjustment composed of representatives of various county agencies reviews all applications for such permits. This committee has two primary functions: (1) to review the Planning Department's initial study of the proposed project and recommend ways to lessen environmental harm; and (2) to determine whether the project requires a Negative Declaration or an Environmental Impact Report. Practically all projects, however, require preparation of an environmental impact report (EIR). The Board of Zoning Adjustments next reviews the project and the EIR and makes a decision on the permit application. The applicant can appeal the decision to the Board of Supervisors. If an EIR is required for a project, the applicant is responsible for depositing sufficient funds with the County to pay for its preparation by a consultant selected by the county. Sonoma then allows an applicant to decide whether the EIR should discuss development on the entire parcel or on an initial portion of not less than 400 acres. If

the proponent chooses the small portion, the first stage of an EIR addresses the specifically proposed project and the environmental setting of the entire leasehold. Then, as development continues, the county prepares site-specific studies of all subsequent projects in the leasehold. Thus, when the applicant develops adjacent parcels, only an addendum to the original EIR is required.

Lake County

Lake County regulates geothermal development beginning with use permits for exploratory wells. These permits are obtained from the County Planning Commission and almost always require an EIR. Approximately one-half of the Commission's decisions are appealed to the Board of Supervisors.

To date, all EIRs have been site-specific documents referring to exploratory drilling projects of 2 to 4 wells within large individual, but different, leaseholds. As in Sonoma County, Lake County EIRs are prepared by consultants hired by the county and paid for by the applicants.

Under the terms of the use permit, the geothermal operator is required to pay for county inspections to ensure compliance with all environmental regulations.

Colusa and Mendocino Counties

Colusa and Mendocino Counties have had little experience with geothermal development and have not as yet instituted a process designed to deal specifically with it. County procedures for geothermal permits, however, are expected to follow the general pattern set by experiences relating to oil drilling. In both cases, county regulation begins with exploratory activity. Unlike Sonoma and Lake Counties however, environmental reports may be prepared by consultants selected by the applicants.

Napa County

Napa County requires a use permit for all stages of geothermal energy development. EIRs are frequently required. Selection of consultants is done by the County and is subject to applicant's approval.

The County's "Conservation and Environmental Quality Committee" reviews all environmental documents. This body is composed of representatives of the public and state and local government. It makes non-binding recommendations to the County Planning Commission regarding the adequacy of the project's environmental reports.

Napa County also has an ordinance specifically governing geothermal exploration and development. The ordinance requires, among other things, that the Board of Supervisors deny an application for a use permit for geothermal development if it finds that: (1) adequate mitigation measures do not exist for all significant environmental impacts; and (2) public health and welfare will be harmed either directly or indirectly through damage to "components of the ecological system" from causes such as acid, rain, smog, induced seismic activity, or the emission of considerable quantities of heat, water, vapor, or steam.

Lassen County

Lassen County requires a use permit for all phases of geothermal development, from temperature-gradient testing through production of electricity or heat. Applications for use permits are submitted to the County Planning Department. The County's Environmental Advisory Committee, comprised of representatives of various county departments, then reviews the project and recommends the type of environmental documentation required by the Planning Commission.

Environmental documents are then prepared by the county or by a consultant selected by the County. The project's use permit and environmental document are then considered by the Planning Commission and the permit is either granted or denied. Commission decisions may be appealed to the Board of Supervisors.

Mono County

Mono County's Planning Department must grant a conditional use permit for all stages of geothermal development. Environmental documents are prepared by the County or by a consultant selected by the County. Since approximately 81 percent of Mono County is managed primarily by the federal government, the County is seldom required to prepare environmental documents. In most

instances, the County simply acts as a reviewing agency for projects on federally controlled lands and intervenes when property or citizens' interests could be harmed. Mono County does not have a special energy ordinance.

Imperial County

Imperial County's geothermal regulatory process entails 3 separate steps:

(1) Exploratory Stage: Developers must obtain a county use permit for all exploratory wells drilled.

(2) Testing Stage: Additional use permits are required before developers may drill or use wells in determining the extent and nature of the resources.

(3) Production Stage: Separate county approval is also required before a developer may construct a geothermal powerplant.

The County's Planning Commission staff prepares all environmental documents for the first two stages. Environmental documents for production facilities are prepared by consultants selected by the County and paid for by the applicants. An "Environmental Review Board," comprised of county department chiefs, reviews all environmental documents.

Imperial County is unique in that it has prepared a geothermal element for the County's General Plan. The County Planning Department prepared the element based upon research done by the University of California, Riverside, and by the California Institute of Technology.

2. Improving Land Use Decisions

The Task Force believes that the state has an interest in accelerating geothermal development in areas where a commercial resource exists and where the operator can take measures to lessen the project's harm to the environment.

As indicated earlier, all counties in the state regulate geothermal wells through the use of conditional use permits or zoning variances. Only Imperial County has developed a geothermal element for its general plan and zoning ordinances for geothermal projects. Under the system of use permits, a separate environmental report is required for each decision.

The Task Force recommends that local jurisdictions adopt zoning ordinances designating areas for geothermal development. This recommendation would eliminate the need for the conditional use permits currently issued on a case-by-case basis. By definition, zoning to permit geothermal development in designated areas precludes the issuance of conditional use permits on individual projects. The county lead agency would not exercise discretionary authority on a project-by-project basis, on a single well, well cluster, or leasehold area, but would process individual permits administratively. The county would prepare one environmental report on the decision to adopt a zoning ordinance. Proposed wells which are adequately described by this EIR would not require further environmental documentation. Local government officials expressed concern over this recommendation with regard to the funds required to pay for a geothermal element and zoning actions. To overcome this difficulty, the Task Force recommends that the State Geothermal Resources Board identify areas in the State with the highest probability of development and that the State provide funds to the appropriate local jurisdiction to prepare the documents necessary for zoning decisions for the area. (Dissent filed)

Imperial County reported to the Task Force that the cost of preparation of the geothermal element of its general plan and its environmental impact report was approximately $450,000.

Based on the current rate of exploration and development, high priority should be given to state financial assistance for geothermal planning grants to Lake, Sonoma, Mono, and Sierra Counties. Assuming that $450,000 is needed to prepare a plan and environmental report, the total program would cost approximately $2 million in the first year.

Wells

As indicated earlier, the Task Force determined that appropriate local jurisdictions are best equipped to ensure that geothermal wells are sited consistently with all social, economic and environmental criteria. This determination was based on the assumption that there is a need to balance state and local concerns for geothermal development, and that the best way to achieve this balance was to give both parties authority to approve aspects of

geothermal development. The primary argument in favor of the Energy Commission having jurisdiction over geothermal wells is that the Commission's statute charges it with the authority to site powerplants. Without jurisdiction over the wells, the Commission cannot exercise its authority over geothermal plants.

The argument against the Commission's being given jurisdiction over geothermal wells is based on the assumption that: (1) the Commission does have indirect control of well siting, in that if a proposed power-plant were to run into serious opposition and Energy Commission approval were in doubt, drilling in that area would soon cease; and (2) only the utilities can prepare an application for powerplant site selection.

Under current practice, the developer (usually an oil company) is drilling or has completed drilling the wells necessary to support the plant during the time that the utility company is waiting for the approval necessary to construct the plant. Therefore, if the Energy Commission were to assume jurisdiction over the wells, the developer would have to file an application with the Commission. Theoretically, a geothermal operator could be forced to file the application before he negotiated a contract to supply steam to a utility and to wait for Energy Commission approval before continuing his drilling program. If it is assumed that the Commission has jurisdiction over the wells, several key questions and points of law must be clarified, including: (1) identification of the point at which the resource is capable of supporting a powerplant; (2) determination of whether the geothermal operator is capable of providing the information the Commission requires for a Notice of Intent and an Application for Certification; (3) deciding whether the operator can identify a site for a powerplant without the assistance of the utility; (4) deciding whether the utility or the operator should bear the burden of the Commission's site-approval process; and (5) deciding whether the operator must cease all drilling within some area adjacent to the powerplant site.

Because of these questions and because of the Task Force's determination that state and local interests should be balanced, it is the Task Force's intention that local government should make land use decisions with regard to geothermal wells, steam transmission lines, and related facilities.

State Agency Jurisdiction

1. Public Utilities Commission

The Public Utilities Commission (PUC) was constitutionally created to regulate the formation and operation of all investor-owned "public utilities" in California. Its primary objectives are:

A. To assure that the state's utilities render adequate service and have sufficient facilities to meet the public's needs.

B. To assure that the state enjoys stable and efficient utility service by:

   1. limiting those supplying public services to applicants demonstrating financial responsibility and a capacity to render adequate service, and

   2. regulating the supply, mode, and area of delivery of service so that utilities do not engage in potentially disruptive competition.

C. To provide the public with dependable services at the lowest possible rates.

D. To promote public safety and reduce accidents by establishing and enforcing safety regulations for utilities.

The PUC is authorized to require utilities to operate facilities to promote and safeguard the health and safety of employees, customers, and the public.

All privately-owned public utilities must comply with the Commission's orders and must do everything necessary to secure compliance by all of their officers, agents, and employees. In addition, no public utility may construct a powerplant without first obtaining the PUC's certification that the present or future public convenience and necessity requires such construction.

The PUC has traditionally prepared environmental documents for all new powerplants. For geothermal development, however, the PUC prepares all EIRs jointly with the local county. These co-sponsored environmental documents cover construction activities from production wells to power generation. To do this, the PUC accepts an EIR prepared by the county on the leasehold and wellhead activities and incorporates it by reference into its own EIR.

The PUC does not review or modify the content of the county's environmental report, but considers its content in approving applications for certificates of public convenience and necessity for geothermal powerplants. Final certification of the powerplants is therefore based on the environmental assessment of the entire project, commencing with geothermal exploration and concluding with power production and use. This process has required from 2-1/2 to 3-1/2 years to complete.

2. Energy Resources Conservation and Development Commission

The Energy Commission was established by Public Resources Code Section 2500 et seq. Its primary functions are to site powerplants and related facilities, to prepare a biennial report on energy in California, and to establish measures to promote energy conservation and development of alternative sources of energy. The Commission, in exercising its siting authority, may override the authority of all other state-authorized regulatory agencies in matters relating to thermal powerplant siting, design, and construction.

At the time of the Task Force's deliberations in 1977, the Commission's jurisdiction over geothermal powerplants was clouded by the question of whether wells drilled to support a geothermal powerplant are included within the definition of a thermal powerplant and related facilities. The Commission had not yet resolved this question and had not yet adopted administrative code provisions governing utilities' applications for approval of proposed geothermal powerplants.

The Warren-Alquist Act, which created the Energy Commission, requires utilities to submit 3 alternative sites for a proposed powerplant. In the case of geothermal plants however, the statute does not require 3 alternative sites. Furthermore, the Commission must process all geothermal applications (both the Notice of Intent to site a powerplant and an Application for Certification of that site) in a total of 18 months, which is one-half the time specified in the statute for other kinds of plants.

The Energy Commission's geothermal regulatory process requires that the developer secure a Notice of Intent (NOI) and an Application for Certification (AFC). According to this process, the Energy Commission would review

an NOI to site a geothermal powerplant for a maximum of 9 months. During this period the Commission would assess the demand for power and determine whether the proposed site is generally acceptable, based upon as yet unspecified criteria. After approving an NOI for the site, the Commission would next act on the AFC, and this process would also last 9 months. By this stage, the Commission must have prepared all required environmental documents.

Powerplants

The Task Force considered a proposal to shift geothermal powerplant siting authority from the Energy Commission back to the PUC and local government. It was argued that such a move would effectively reduce potential delays arising from the Energy Commission's regulation of geothermal powerplant siting. Specifically, it was pointed out that if the Energy Commission were to receive an application or an NOI for a geothermal powerplant, the Commission would take at least 18 months to make a decision. This is because of the Commission's 9-month statutory review of the NOI and the additional 9-month period to rule on the subsequent AFC of the powerplant. These time periods do not include delays resulting from applications the Commission deems incomplete. Further, they do not acknowledge the possibility that applicants fearful of a negative decision might request a further delay in hopes of increasing the chance of approval.

In addition to potential delays due to the Energy Commission permit processing, it was pointed out that geothermal powerplants are treated differently from other types of plants under the Commission's statute. As noted, applicants for a geothermal plant need only identify one site, not three sites as required for other powerplants. This provision significantly reduces the scope and importance of Energy Commission involvement in siting geothermal powerplants. The Commission is thus left with the question of "whether" not "where." The question of "whether" includes the need for the power produced at the plant and the measures the applicant will have to take to mitigate the plant's environmental impact.

The question of need can probably be answered quickly. The typical geothermal powerplant unit produces 100 MWe, far less than the 1000 to 2000 MWe that several of the proposed coal-fired or nuclear plants would produce.

In a paper presented to the Task Force, Energy Commission staff stated: "We agree that it may not be efficient to determine the need for individual geothermal plants because of their small size. However, we do not believe that any state agency other than the Energy Commission should determine the need for geothermal power on a statewide basis." In essence, then, the Commission agreed with the Task Force's concept of "whether" and not "where."

The question of environmental protection is more difficult to deal with, but is not unique to the Energy Commission. Current law requires any governmental agency considering a project which would have a significant environmental impact to assess the project's environmental impacts.

The Task Force also heard arguments that the issue of "whether" is best left with local government and the PUC since: (1) the counties have the interest and capacity to make expeditious and responsible land use decisions; and (2) the Public Utilities Commission has the engineering and administrative expertise necessary to complete all necessary technical and environmental reviews.

On the other hand, it was suggested that the Energy Commission is the state agency best qualified to balance the advantages for geothermal development with the need for environmental protection, and that it should retain its authority for geothermal powerplant siting for a number of reasons.

First, returning the approval of geothermal powerplants to the PUC could cause even greater delays in the development of geothermal energy for electrical use. The PUC has required from 27 to 41 months to issue a Certificate of Public Convenience and Necessity for a geothermal plant. By contrast, the Energy Commission's statute limits the geothermal powerplant site certification process to two 9-month segments, including the environmental documentation required by CEQA. It was thus argued that the Commission's 18-month process is already an improvement over the PUC's past record. In addition, there is no evidence to date that the PUC could certify a geothermal plant in any less time.

Second, it was suggested that elimination of the Energy Commission's broad siting authority over geothermal plants in favor of the PUC's more limited siting function is undesirable from an energy planning perspective. The

Energy Commission must consider the need for geothermal plants in the context of other energy sources such as nuclear, oil, and coal. Transferring the geothermal siting authority to the PUC would only limit the Commission's ability to condition approval of non-geothermal powerplants on the use of geothermal power. Transfer of the regulatory authority of the Energy Commission to the PUC would therefore hamper the Commission's ability to plan effectively for use of geothermal power in view of the state's electrical energy needs.

Third, giving the PUC this authority would unnecessarily split the state's responsibility for approving proposed electrical generating facilities, both geothermal and non-geothermal, between two state agencies. Under current law, the PUC regulates private utilities but it does not approve proposed facilities of publicly-owned utilities such as the Los Angeles Department of Water and Power. On the other hand, the Energy Commission must approve the proposals of both public and private, investor-owned utilities.

Energy Commission Exemption

The Task Force considered exempting geothermal powerplants of less than 150 MWe from the Energy Commission's jurisdiction, on the basis that most geothermal powerplants will be less than 150 MWe. This exemption, however, would severely limit the Commission's control over powerplant siting. The argument in favor of this proposal was: (1) since the location of the resource determines the site of the powerplant, the Commission's siting authority is redundant; and (2) the Commission's planning responsibilities are only properly evoked when the size of the powerplant becomes significant in terms of statewide energy needs. The argument against this suggestion was identical to that set forth above against completely eliminating the Energy Commission's jurisdiction. The Task Force, however, voted not to recommend the 150 MWe exemption.

After considering the arguments, the Task Force recommends that:
(1) land use approvals of geothermal wells, steam transmission lines, and related facilities remain with the appropriate local jurisdiction; and
(2) approvals of geothermal powerplants excluding wells, steam transmission lines, and related facilities, remain with the Energy Commission. (Dissent filed)

Pre-Application Jurisdiction

The Task Force also considered a related proposal regarding the point in time at which the Commission should begin to exercise its jurisdiction over geothermal development.

Discussion of this proposal led to the following conclusions: (1) filing an application with the Energy Commission signifies a utility's belief that a powerplant can be built at the proposed site; (2) filing an application represents a definite commitment to dedicate a specific site for an electric powerplant; and (3) the decision to seek approval of powerplant construction specifically evokes the Energy Commission's jurisdiction over powerplant siting. The Task Force therefore concluded that making the Commission's jurisdiction contingent upon the filing of such an application simplifies geothermal regulation by strictly delineating state and local responsibilities. The Task Force therefore recommends that the Energy Commission's jurisdiction begin at the point an application is filed for approval of a geothermal powerplant site. (Dissent filed)

Although the Task Force is of the opinion that the Energy Commission should not have regulatory control over geothermal wells, it nevertheless acknowledges the necessity for promoting the Commission's involvement in a local government review of geothermal projects which may eventually result in construction of geothermal powerplants.

Siting Procedure

The Task Force also considered whether it would be in the best interest of the state to retain the Energy Commission's current two-stage regulatory procedure for licensing powerplants. The first step includes the study and selection of a site for a powerplant and assessment of the need for the plant, while the second step involves completion of the details involved in actual construction.

For geothermal projects, however, the first and second stages involve examination of a single site. Thus, either the site will be examined in detail twice, or the second stage will be a rubber stamp of the first. Neither of these approaches makes much sense. The Task Force therefore considered the relative merits of a one-step regulatory process.

The Energy Commission's staff expressed the opinion that the two-stage process is required: (1) to enhance the Commission's ability to influence the imposition of environmental controls on the siting of geothermal wells; and (2) to augment the Commission's effectiveness in regulating powerplant design and plans of operation.

The Task Force, however concluded that: (1) the predetermined location of geothermal resources significantly reduces the Commission's ability to approve alternative geothermal plant sites; (2) environmental and planning benefits derived from a two-stage review can be achieved through a one-stage process with active Energy Commission participation in local government's environmental review of pre-construction phases of geothermal development; and (3) since most geothermal powerplants are one-tenth the size of conventional powerplants, it is unnecessary for the Commission to determine the need for geothermal plants on an individual basis.

The Task Force recommends that the Energy Commission establish a single 9-month review process and sponsor legislation eliminating the requirement to determine whether individual geothermal powerplants conform to the 10-year forecast of statewide and service-area power demands. (Dissent filed)

Implementation

The Task Force is concerned that the problems described in this report be resolved prior to the time the Energy Commission receives an application for a geothermal powerplant. Solving these problems after the Commission receives an application will cause unnecessary delays in reaching a decision on that application.

The Task Force therefore recommends that the Energy Commission adopt these recommendations as policy prior to July 1, 1978, and that the legislation suggested by the Task Force include urgency clauses. (Dissent filed)

WHEELING

One hurdle confronts almost all potential geothermal markets - the 50-year-old "wheeling" controversy over transmitting power to public and industrial distribution systems through electrical lines controlled by a privately-owned utility.

A good example of the wheeling problem is illustrated by the attempts of the publicly-owned Northern California Power Agency (NCPA) to obtain access to Pacific Gas and Electric's transmission facilities out of The Geysers. In the absence of clarifying state legislation, this battle has continued in both administrative and judicial tribunals, while possible gains in geothermal-based generating capacity have been delayed.

In 1976, legislation, now Public Utilities Code Section 2801 et. seq., was enacted which authorized the PUC to order both interconnection and wheeling for "private energy producers" of other than "conventional power sources," which would have logically included geothermal resources. The PUC then, would set rates for compensating the owners of the transmission lines which were forced to wheel.

This legislation, however, defined private energy producers as the opposite of "electrical corporations." Entities which are subject to state law and under the jurisdiction of the PUC are identified as "common carriers" in the broadest sense and "electrical corporations" in the narrowest sense.

The PUC currently does not consider publicly-owned utilities within their jurisdiction except for safety purposes and has done so only since a 1963 State Supreme Court decision which interpreted the state constitution grant of authority to the PUC to include non-private utilities. In view of this construction of the state constitution, it is unclear whether publicly-owned utilities fall within the definition of private energy producers as defined in the wheeling statute. Further, the wheeling statute also includes the phrase "and not for sale to others," in its definition of "private energy producers." While this is not troublesome to some industrial users, the language might be construed as negating the statute's protection to publicly owned utilities seeking to obtain transmission line access for geothermal resources.

The Task Force therefore recommends that the Public Utilities Commission sponsor legislation giving common-carrier status to the transmission facilities of all electric utilities, publicly or privately owned, requiring necessary interconnections to allow transfer of electrical energy and authorizing the PUC to set rates of compensation for such practices. (Dissent filed)

UNITIZATION

Many developers participate in unitization on a voluntary basis. Unitization allows for centralized reservoir management, appropriate well spacing, and reservoir-wide determination of maximum production rates. Unitization agreements also include pooling tracts of land to create a single drilling unit in order to insure that drilling wells meet minimum spacing requirements.

Current law allows lessors, lessees, and operators to unitize only with the approval of the Geothermal Resources Board, in order to protect geothermal resources from unreasonable waste. Further, Section 3715 of the California Public Resources Code allows the Oil and Gas Supervisor to ask operators to use "practices known to industry for the purpose of increasing the ultimate recovery of geothermal resources," which may include unitization.

The Union-Magma-Thermal operation at The Geysers is unitized. Leases in a contiguous unit are pooled and one of the lessors, Union, has been named as field operator. In southeastern Lake County, Aminoil, USA, Inc., is acting as field operator on its own leases, as well as those of Natomas and Occidental. Discussions have taken place with McCulloch Oil concerning possible future pooling of steam from two leases to the northeast of the Union state lease, to supply a generating plant. If agreement can be reached, a unit will probably be formed. In the Heber field in the Imperial Valley, discussions are underway to join Union and Chevron leases and make Chevron the operator. In addition, Aminoil has recently unitized two leases at The Geysers. The lessors benefit from this arrangement by dividing the risk; Aminoil benefits by treating two leases as one reservoir for development purposes, therefore reducing the costs of doing business.

Industry has indicated that it supports unitization for economic reasons, but it stresses that mandatory unitization could create friction among the participants, eventually making unitization impossible.

Because so little is known about the nature of geothermal reservoirs, it appears that unitizing leases before any drilling is done would be unwise. Each participant would believe that his property is the most valuable, therefore making agreement virtually impossible. Once the resource is assessed, however, sharing decisions can be made on a factual basis.

Unitization will work only if the participants want to proceed to develop the resource for sale. If the developers see no market for their steam, the question of unitization is moot.

The Task Force supports voluntary unitization and pooling. The Task Force recommends that no governmental agency force industry to unitize.

REGULATION OF SUMPS

During the public hearings held by the Geothermal Task Force, many geothermal industry representatives expressed concerns about the regulatory requirements to obtain permits for drilling sumps, and indicated their belief that one permit would be sufficient. These representatives were concerned about the time required to obtain permits from the State Solid Waste Management Board (SSWMB) and the Regional Water Quality Control Board (RWQCB). Witnesses also cited the duplication that exists among the SSWMB, the RWQCB, and the Department of Health in regulating temporary disposal sumps for geothermal waste.

Presently, a geothermal operator must obtain a Report of Waste Discharge requirements from the Regional Water Quality Control Board, a hazardous waste permit from the Department of Health, and must submit a Notice of Intent (NOI) to the Solid Waste Management Board so that the Board may determine whether the proposed facility is in conformance with the County Solid Waste Management Plan (CoSWMP). In addition, the geothermal operator must obtain a facility permit from a local enforcement agency under a program which the SSWMB administers.

State Solid Waste Management Board

The Nejedly-Z'berg-Dills Solid Waste Management and Resource Recovery Act of 1972 was enacted to establish and maintain comprehensive policies and programs in California for solid waste management and resource recovery. This legislation requires the SSWMB to develop and maintain state policy for solid waste management.

The SSWMB and the counties regulate the siting of solid waste management facilities through county solid waste management plans. Pursuant to Section 66784 of the Government Code, operators are required to submit a Notice of Intent before being granted approval to use or construct a facility. The specific purpose of the NOI is to determine if a facility is in conformance with the CoSWMP.

To facilitate the processing of the NOIs for geothermal sumps, the SSWMB has adopted a shortened form of the NOI for geothermal projects. This procedural change has reduced the time for processing considerably.

Legislation was passed in 1977 to allow certain classifications of solid waste facilities to be exempt from the requirements of Government Code Section 66784. Categories of exempt facilities may be established by administrative regulations when the following findings are made:(1) that the exemption is not contrary to the public interest; (2) that the quantity of solid wastes to be disposed of at each site is insignificant; and, (3) that the nature of the solid wastes poses no significant threat to the public health, the public safety, or the environment.

The Z'berg-Kapiloff State Waste Control Act of 1976 established a state-administered program of permit issuance for the operation of a solid waste facility by local enforcement agencies. These local agencies set the terms and conditions of the permit with concurrence of the SSWMB. The terms and conditions and approval of the permit are based on the facility being in compliance with the state minimum standards and the CoSWMP. In drafting regulations to administer the Act, the SSWMB recognized the unique nature of geothermal development and the associated waste. Therefore, on July 29, 1977, the SSWMB adopted regulations to allow an exemption from a permit for drilling mud disposal sumps used in geothermal development. The exemption is for sumps which have been issued a Waste Discharge Requirement and which are used for less than one year. However, a permit is required if "significant" quantities of hazardous or toxic materials are present in the muds, fluids, and cuttings. The applicant must apply to the local enforcement agency to obtain an exemption.

Regional Water Quality Control Boards

Nine Regional Water Quality Control Boards (RWQCBs) regulate pollutant discharges to surface and subsurface waters. Discharges to surface waters are regulated pursuant to California's federally authorized National Pollutant Discharge Elimination System; regulation of subsurface discharges is governed by state law. The RWQCB's responsibilities include: (1) formulating, imposing, and monitoring waste permits describing the quality, quantity, and method of discharging pollutants (called waste discharge requirements); (2) designating waste disposal sites; and (3) generally implementing the water quality policies and procedures recommended by the SWRCB.

Persons seeking RWQCB approval of geothermal projects must file an application for a waste discharge permit at least 4 months before development is scheduled to begin. After a thorough review of the project's potential water quality impacts and development of all appropriate mitigation measures, the RWQCB issues its "Report of Waste Discharge Requirements" covering all discharges of liquid, solid, gaseous, and radioactive wastes from geothermal wells. Waste discharge requirements are issued within 3 to 6 weeks.

Statutory responsibility for the prevention of water pollution resulting from the drilling, operation, maintenance and abandonment of geothermal wells rests with the Division of Oil and Gas. The SWRCB and the Division have adopted a joint coordinated procedure for reporting geothermal field waste water discharges and for prescribing discharge requirements. The Division of Oil and Gas prescribes requirements for discharge of wastewater by injection in geothermal wells. RWQCBs may either concur in the Division's requirements or may prescribe separate discharge requirements, in either case notifying the Division.

Since RWQCBs are never the first governmental agency to act in relation to geothermal projects, they are never responsible for preparing environmental documentation under CEQA.

After reviewing the permitting requirements of the SSWMB and the RWQCB the Task Force has determined that present duplication of requirements for permits by these state agencies is minimal. The issuance of the waste discharge requirements from the RWQCB are exclusively aimed at water quality protection, not at overall disposal operations which is the responsibility of the SSWMB. The SSWMB has taken steps to reduce the time necessary to process the NOIs and to provide a method for exempting drilling sumps beginning on January 1, 1978. Further, the SSWMB has provided a method by which geothermal sumps could be exempted from permits issued by the local solid waste enforcement agencies under the Z'berg-Kapiloff Solid Waste Control Act.

The Task Force concludes that the problems associated with the geothermal sumps are more of a water quality than a waste management concern and that the waste discharge requirements of the RWQCB adequately address the SSWMB's concerns about sump development and operation.

The Task Force therefore recommends that the SSWMB sponsor legislation to eliminate the permitting procedures established by A.B. 2439 of 1976 for sumps and mud pits for geothermal operations. The Task Force also recommends that the SSWMB adopt regulations to exempt sumps and mudpits from the requirements of Government Code Section 66784. The Task Force further recommends that the waste discharge requirements of the RWQCB's remain unchanged.

Department of Health

The Department of Health (DOH) issues permits for facilities which handle, process, store, or dispose of hazardous wastes, as defined by the department's regulations. Most, if not all, geothermal well sumps contain some such hazardous wastes and are therefore subject to the DOH permit.

Both state law and DOH regulations, however, provide mechanisms for avoiding the necessity of obtaining a permit from the Department. California Health and Safety Code Section 25143 authorizes the DOH to waive the permit requirements when DOH determines that the handling, processing, or disposal of hazardous waste is "adequately regulated by another governmental agency." Similarly, DOH regulation 60171 allows the department to grant a variance from the requirement for a permit if the hazardous waste involved is an insignificant human health hazard or is handled, processed, or disposed under the regulations of another governmental agency.

Since the Regional Water Quality Control Boards have been adequately regulating the handling, processing, and disposing of wastes from geothermal wells for many years, the Task Force recommends that the Department of Health waive the requirement for a hazardous waste permit for geothermal well sumps, or grant variances for geothermal well sumps. (Dissent filed)

PUBLIC AGENCY GEOTHERMAL OPERATIONS ON STATE LANDS

Under existing law, public agencies do not qualify for leases of oil, gas, or mineral resources on state-owned lands.

The State Lands Commission (SLC) is the legal owner and administrator of state lands, including all lands granted to the state by the federal government for

support of state schools (state school lands), tidelands, swamps, overflow lands, and the beds of all navigable rivers and lakes. As a land manager, the SLC sells, leases, and otherwise develops its property at its discretion, subject only to the condition that the lands be used in the best interests of the people of California. The SLC also has jurisdiction over geothermal resources on lands owned by other state agencies. The Commission may issue leases and permits on such lands subject to agency consent and under such reasonable conditions as will protect the surface use.

The SLC issues geothermal prospecting permits for exploration on lands not classified as being within a Known Geothermal Resources Area designated by the Commission. These permits require environmental documentation and are issued to the first qualified applicant who satisfies the Commission's regulatory requirements. They are valid for 3 years and may be extended for an additional period of 2 years. It takes from 6 to 12 months for the SLC to grant such permits. If a prospector confirms discovery of a geothermal resource capable of commercial development, the Commission will grant a lease for development, subject to additional environmental review.

The Commission leases lands within Commission-established Known Geothermal Resources Areas to the highest qualified bidder for developing geothermal power. Bidding is usually on the basis of a net profits bid factor. These leases retain the SLC's authority to approve each phase of development and to collect royalties and a percentage of net profits on income derived from state-owned resources. Once a KGRA has been declared by the Commission, it takes the Commission from 2 to 12 months to issue a lease by competitive bid.

Environmental documents are required for both geothermal prospecting permits and leases and for any development which the Commission must approve under the terms of a lease or permit. Applicants, permittees, and leaseholders pay for preparing and processing all such documents.

State agencies and local governments are already involved in the development of geothermal resources. The City of Santa Clara, the City of Burbank, and the Department of Water Resources (DWR) have all been active in attempting to obtain geothermal resources as a source of electrical power.

As a matter of policy, there appears to be no good reason why public agencies should not qualify as lessees of public lands and be entitled to qualify for oil, gas, or mineral leases on state land. If a proposal is narrowly drawn to limit such leases only to geothermal leases, it would avoid questions relating to leasing oil, gas, or other mineral interests to public agencies. It would appear that the rationale for such a limitation is primarily political, since the same policy questions arise concerning leases for other forms of natural resources.

Under existing law, DWR could purchase energy for geothermal development from private lessees. Hence, the option to purchase geothermal energy is not foreclosed. However, there is no assurance that geothermal resources will be sufficiently developed at any given point in time to meet DWR's energy needs. Thus, if DWR were permitted to qualify as a geothermal lessee, DWR would be in a better position to expedite development. In addition, because of contractual requirements by steam producers, it is sometimes not clear whether such a form of energy would be cost effective. If DWR could obtain leases on state lands by competitive bidding, it could avoid the middle man.

Current law requires the SLC to give priority to applications from public agencies. State law also requires the SLC to issue geothermal permits to the first qualified applicant. Under this arrangement, public agencies would always be the first qualified applicant, and would always receive geothermal permits. The Task Force decided that this provision should be amended so that public agencies would not have an unfair advantage over private energy producers.

Whether public agencies should be allowed to compete with private industry in developing public resources, such as geothermal steam, remains to be determined. If cost effective and in the public interest, there is no good reason why public agencies should not compete with private industry to develop public resources to operate public projects, such as the State Water Project. Since present law does not prohibit public agencies from competing with private industry in developing privately-owned resources, it seems logical that such competition should be allowed in developing public resources.

The Task Force recommends that the Governor sponsor legislation to amend Section 6801 of the Public Resources Code to allow public agencies to lease

and develop state geothermal lands. Additionally, Section 6223 of the Public Resources Code should be amended to eliminate the public agency priority of time of filing geothermal lease or permit applications. (Dissent filed)

REGULATION OF DIRECT HEAT APPLICATIONS

Currently, any person or organization proposing to drill a shallow well for a direct heat application of geothermal energy must obtain a use permit from the local jurisdiction where the well will be located. Local jurisdictions may also require that project proponents comply with the provisions of CEQA. At the state level, the Division of Oil and Gas requires proponents to file an application to drill a low-temperature well. As part of the permit to drill the well, the Division requires the applicant to secure a bond. The bonding requirements of low-temperature wells are: $10,000 for wells less than 5,000 feet; $15,000 for wells less than 10,000 feet; and $25,000 for wells deeper than 10,000 feet. Project sponsors must maintain these bonds for the life of the well. The purpose of the bonds is to ensure that the wells are properly used, maintained, and abandoned. In addition, wells are bonded to protect the environment and to insure the state against potential financial and resource losses.

Furthermore, developers drilling low-temperature geothermal wells must obtain waste discharge requirements from the Regional Water Quality Control Board and authorities to construct and to operate from the local Air Pollution Control District. The developer must also obtain a permit from the State Lands Commission, if the resource is located on state lands.

In general, proponents intending to use low-temperature resources must obtain many of the permits required for other types of geothermal wells.

The few records that the Division of Oil and Gas has on low-temperature geothermal wells show that these wells may not be a threat to health and safety or the environment. Therefore the Task Force recommends that the Division of Oil and Gas sponsor legislation to eliminate bonding requirements for the "life of the well" for low-temperature geothermal wells which are not a threat to health, safety, or the environment.

THE ECONOMICS OF GEOTHERMAL DEVELOPMENT

Many of the problems confronting geothermal development in California are economic, including pricing, uncertainties in reservoir modeling, cost of hydrogen sulfide abatement technology, unproven systems for using hot water resources, federal tax treatment, and uncertain permitting procedures at federal, state, and local levels. The availability of cooling or makeup water can also be a major economic problem in some localities. All of these problems represent economic disincentives, making it difficult for developers to obtain funding for geothermal projects. When a potential developer computes the costs of these disincentives, the rate of return or profit from geothermal development is often less than that of other energy investment opportunities.

PRICING GEOTHERMAL ENERGY

Energy resources and electrical generating and distribution facilities are frequently owned by different entities. The electric utilities purchase energy resources from independent operators. The prices for energy resources other than geothermal resources (such as oil, gas, coal, and uranium) are set in the current marketplace. Thus, there are many possible arrangements for pricing geothermal energy, since costs of producing geothermal fluids are uncertain and vary by the resource and the cost of generating electricity. Geothermal energy prices can be based on the British Thermal Unit (BTU) method; the reliability of supply; the current price of other available fuels; the developer as the utility; the utility as the developer; or, by government control.

According to the BTU method, the price depends on the thermodynamic properties of the fluid. It is determined by the net quantity of heat delivered, which is measured in millions of BTUs above some negotiated reference temperature. This method sets the cost of energy to the utility in the same framework as other fuels and encourages the utility to improve its efficiency in terms of the number of geothermal BTUs required per kilowatt hour of electricity.

A second method ties the price of geothermal energy to that of a stable energy resource, such as coal, to allow for changes in generating efficiency over the life of the fuel contract. Provisions for reduced or improved performance, such as changes in heat content of the geothermal fluid or

efficiency of the powerplant turbines, could be added to allow the producer and the utility to share in the profits from lowered costs of producing electricity.

A third method for pricing geothermal fluids, especially for the more technically uncertain hot-water resources, adapts the pricing policy used at The Geysers steam field, in which the return to the supplier is determined by a formula of the costs of alternate fuels available to the utility, adjusted for the differences in plant costs. Under such a contract, the return in mills per kilowatt-hour is determined by the output and efficiency of the plant, which the utility is required to operate as close to full capacity and as continuously as practical.

A fourth method holds the geothermal resource producer responsible for the generation of electricity. Under this method, the price of the electricity at the busbar is negotiated between the energy supplier and the utility. This method could be useful to a utility which had small amounts of capital or little experience in the production and conversion of geothermal energy. It could also be useful to the producer who can manage the power production and conversion cycle with greater efficiency.

A fifth alternative allows the utility to purchase part or all of the geothermal resource. As either a partner or complete owner, the utility would have more control over developing the resource, but would also incur greater risk. This method of pricing with higher risks for utilities may be unacceptable to the Public Utilities Commission.

Governmental regulation could also set wellhead prices for geothermal steam. An Energy Commission study, however, concluded that this method would neither provide more equitable pricing in the public interest nor accelerate the use of geothermal energy in any way.

After considering the various arrangements for pricing geothermal energy, the Task Force recommends that the price of geothermal resources be determined among buyers and sellers in the market place.

COSTS OF GEOTHERMAL FIELD DEVELOPMENT, PRODUCTION, AND MAINTENANCE

Figures supplied to the Task Force by industry representatives show that the average cost of drilling a geothermal well varies approximately from $600,000 to $1 million at The Geysers and $250,000 to $500,000 in Imperial Valley. The total costs for other associated activities displayed in Table I, including regional investigations, leasing, explorations, CEQA and NEPA compliance, siting and building well pads and roads, and completing reservoir assessment and drilling confirmation wells, range from approximately $2.6 million to $16.3 million for a vapor-dominated reservoir. Table II for a liquid-dominated reservoir displays the same activities at a cost range from $1.5 to $15.7 million. The wide disparity in these figures is based on the cost of completing reservoir assessment and drilling confirmation wells. These figures, however, do not reflect the cost of mitigation measures which state regulatory agencies require the developer to take in order to protect the environment.

Production activities include field development and replacement activities, field production, and field maintenance. Cost of such field development for a 110-MWe powerplant with a life of 30 years at The Geysers (1976 dollars) are estimated at $90 million (Table III).

Table IV shows expenses for field development, production, and maintenance over the 30-year life of a 50-MWe powerplant using liquid-dominated resources. The estimated costs, $325 million (1976 dollars) are upper limit estimates which were supplied to the Task Force by various industry representatives.

TABLE I

ESTIMATED COSTS OF EXPLORATION AND RESOURCE

ASSESSMENT FOR A VAPOR-DOMINATED RESERVOIR

Activity	Cost
Geologic investigation	$ 4,000 - $ 20,000
Leasing	$ 1 - $ 40 per acre (approximately $40,000)
Intensive exploration	$ 10 - $ 100 per acre up to $ 20,000
CEQA compliance (EIR or negative declaration)	$ 6,800 - $ 10,000
Well pad siting and road construction	$ 200,000
Drilling and completion of reservoir assessment	$ 600,000 - $ 1,000,000
Drilling confirmation wells and reservoir assessment	$ 1.8 million - $ 15 million
Resource marketing	$ 25,000
TOTAL	$ 2.6 to $ 16.3 million

TABLE II

ESTIMATED COSTS OF EXPLORATION AND RESOURCE ASSESSMENT FOR A LIQUID-DOMINATED RESERVOIR

Activity	Cost
Geologic investigation	$ 4,000 - $ 20,000
Leasing	$ 1 - $ 40 per acre (approximately $ 40,000)
Intensive exploration	$ 10 - $ 100 per acre up to $ 20,000
CEQA Compliance (EIR or negative declaration)	$ 6,800 to $ 10,000
Well pad siting and road construction	$ 40,000
Drilling and completion of reservoir assessment	$ 300,000 to $ 500,000
Drilling confirmation wells and reservoir assessment	$ 1 million to $ 15 million
Resource marketing	$ 50,000
TOTAL	$ 1.5 to $ 15.7 million

TABLE III

AVERAGE ESTIMATED COSTS OF VAPOR-DOMINATED FIELD PRODUCTION TO SUPPLY ONE 110-MWe POWERPLANT FOR 30 YEARS

Activity	Cost
Field development (replacement of wells pipelines, roads, etc.)	$ 20 million
Field production (injection wells, etc.)	$ 40 million
Field maintenance	$ 30 million
TOTAL	$ 90 million

TABLE IV

AVERAGE ESTIMATED COSTS OF LIQUID-DOMINATED GEOTHERMAL FIELD PRODUCTION TO SUPPLY ONE 50-MWe POWERPLANT FOR 30 YEARS

Activity	Cost
Field development (replacement of wells, pipelines, roads, etc.)	$ 75 million
Field production (injection wells, etc.)	$ 130 million
Field maintenance	$ 120 million
TOTAL	$ 325 million

Mitigation measures normally required of a geothermal operator to protect the environment during the exploratory and production phases of geothermal development include: well-site stabilization, noise and dust (particulate emission) suppression, hydrogen sulfide abatement, proper waste disposal, blowout prevention controls, maintenance of well-casing integrity, directional drilling to reduce the number of drill sites, cut slope revegetation, erosion control, wellhead throttling valves, steam pipeline mufflers and rock catchers, and an injection well program. According to industry representatives, the cost of all these measures totals $245,000 per well or $6,275,000 per 110-MWe powerplant at The Geysers.

Once the geothermal operator confirms the resource, negotiations begin with a utility for the sale of the steam for conversion to electrical power. The utility then must incur the costs of developing and building the powerplant and its support facilities. Measures which utilities may be required to take to protect the environment include: plant stabilization, erosion control, revegetation, hydrogen sulfide abatement, noise suppression, and steam condensate injection. These activities are reported to cost approximately $2.6 million per powerplant at The Geysers.

The utility also pays for the cost of any further environmental reports required by CEQA. In addition, the utility must obtain the Energy Commission's approval before actual plant construction may begin. According to industry, compliance with CEQA and with the Energy Commission's regulations may cost the utility approximately $400,000. Table V, for The Geysers field, shows that the estimated cost for constructing a 110-MWe plant is $36 million (1976 dollars). Plant maintenance for a 30-year period for an individual Geysers plant, according to utility representatives, is approximately $6.6 million (1976 dollars).

For liquid-dominated geothermal systems, the cost of building a 50-MWe powerplant according to industry representatives would be approximately $50 million (1976 dollars). A 30-year life for such a plant would involve a maintenance cost of $30 million (1976 dollars). Table VI summarizes these activities and costs.

TABLE V

AVERAGE ESTIMATED COSTS FOR A 110-MWe VAPOR-DOMINATED POWERPLANT FOR 30 YEARS

Activity	Cost
CEQA leasehold EIR and plant approvals	$ 400,000
Plant construction	$ 36 million
Plant production	$ 2.6 million
Plant maintenance	$ 6.6 million

TABLE VI

AVERAGE ESTIMATED COSTS FOR A 50-MWe LIQUID-DOMINATED POWERPLANT FOR 30 YEARS

Activity	Cost
CEQA leasehold EIR and plant approvals	$ 500,000
Plant construction	$ 50 million
Plant production	$ 10 million
Plant maintenance	$ 30 million

FEDERAL TAX TREATMENT

Under current federal tax laws, geothermal resources are allowed a percentage depletion allowance only to the extent that they are found to be a "gas." This definition rises out of a court decision (Reich v. Commissioner) of the United States Ninth Circuit Court of Appeals, in which the Court held that operators drilling geothermal wells at The Geysers could qualify for a percentage depletion and could deduct intangible costs of well drilling from their gross income. This affirmed the holding of the Tax Court, which was based upon the finding that dry steam at The Geysers was a "gas" for purposes of the percentage depletion section of the Internal Revenue Code. The Internal Revenue Service had stipulated that such a finding would apply to intangible costs, thereby giving developers at The Geysers both incentives.

Unfortunately for the geothermal developer, this stipulation was entered into only in this one case, and the Internal Revenue Service has opposed subsequent attempts by developers to claim depletion and deduct intangible drilling costs. Therefore, geothermal developers must presently capitalize all their pre-production costs over extended periods of time. More favorable tax treatment of geothermal exploration and development expenditures is necessary for geothermal developers to compete in money markets for risk capital.

The Task Force therefore recommends that the Legislature memorialize Congress to enact legislation that will put the geothermal developer on equal terms with oil and gas developers with regard to depletion and deductions for intangible drilling costs. The Task Force further recommends that, after the federal government has acted, the California Legislature should amend state tax laws to conform with the federal laws, thereby providing additional tax incentives for geothermal developers. (Dissent filed)

BARRIERS TO MUNICIPAL AND INDUSTRIAL USES OF GEOTHERMAL RESOURCES

Many public and private entities would like to develop geothermal resources for their own use or that of their customers, yet their inability to raise adequate capital prohibits them from doing so. A small municipal electric system or private industrial user which attempts to secure loans or float bonds for geothermal field development or plant construction faces significant

financing hurdles. These include lender unfamiliarity with geothermal resources, and financial limitations due to the relatively modest size of most of these potential users.

The Federal Geothermal Loan Guarantee Program (GLGP) was set up to ameliorate the difficulties these organizations experience in obtaining capital. The program, however, requires the applicant to put up 25 percent of the project's capital costs. Testimony received during Task Force's public hearings indicates that the GLGP also entails large administrative costs for the applicant. Finally, the federal government will not guarantee tax-exempt financing. These circumstances effectively preclude public entities from participating in the program.

In order to solve this problem, state assistance may be necessary. There are already nearly a dozen programs currently in operation under state law which cast a specially-created "agency" of the State of California, but not the "full faith and credit" of the state itself, in the role of either directly financing or guaranteeing market financing of projects considered to be socially desirable. These programs involve guarantees of pollution control bonds, construction bonds for college and university facilities, public housing bonds, etc. It is noteworthy that in none of these instances is the state putting its "full faith and credit" or its "taxing power" behind the bonds so issued or guaranteed. A statement to that effect is printed on the face of each bond so issued or guaranteed.

The Task Force therefore recommends that the Energy Commission sponsor legislation to create an energy finance agency to assist municipal and small utilities in obtaining either direct financing or in guaranteeing market financing. (Dissent filed)

Another form of state assistance involves research and development expenditures for projects which, like geothermal, are unable to secure private financing. The Energy Commission is already involved in several such geothermal demonstration projects, either by providing technical or financial support. The Task Force recommends that the Energy Commission provide financial and technical support to public and private entities proposing to institute demonstration projects to prove the feasibility of both electric and non-electric uses of geothermal resource areas within California.

EXEMPTION FROM PROPERTY TAX UNTIL PRODUCTION

Property taxes on geothermal lands not yet in commercial production are an economic burden to geothermal operators because of lengthy lead times between exploration and the sale or production of the resource. The act of signing the contract for sale of the resource, however, could in some instances suffice as the equivalent to the receipt of income for assessment purposes.

The Task Force considered an exemption from ad valorem taxes for geothermal properties which have not yet begun to produce revenue. The Task Force, however, decided that this proposal was not feasible.

APPENDIX I

DISSENTING OPINIONS

Jack McNamara, Public Member

James A. Walker, Deputy Executive Director
Energy Resources Conservation and
Development Commission

Richard T. Forester, Department of Fish & Game

Senator John Stull

Senator Omer Rains

MEMORANDUM

To: Priscilla Grew
Judy Warburg

From: Jack McNamara

Date: December 16, 1977

Re: Dissenting Views of
Jack McNamara, Public Member

While I am extremely impressed with the work of the Task Force in resolving many issues critical to the expeditions development of geothermal resources in California, I must dissent on four points, two involving "Regulatory" matters, the other two "Economics":

(1) Regulatory Chapter:

(a) I believe that the Task Force should recommend that those counties eventually selected by the Geothermal Resources Board for state assistance in the creation of geothermal zoning ordinances be given a definite time period (no longer than one year) for the performance of this important task.

If the Energy Commission can be asked to perform its power plant siting responsibilities within nine months, I see no reason why the counties, with state financial and technical assistance, an existing data base and, in many instances, a history of geothermal development and its impacts already in hand, cannot complete their land use/zoning decision within 12 months.

By leaving the issue open, we invite additional delay and an undermining of our best efforts to give local government a chance to exercise its land use judgment while wimultaneously giving developers certainty as to the duration of the process and the ultimate decision. This is also in keeping with the thrust of A.B. 884, which gives state agencies a one year time frame.

(b) As for the Energy Commission siting procedure, I feel that

the Task Force has taken a large step forward by recommending a unitary, nine month procedure for geothermal power plants siting. Voices within the Commission staff have been trying to get approval of some form of expedited geothermal siting procedure for a while, and we have strengthened their hand substantially with our proposal to eliminate the NOI portion of the process. But, here again, I feel that we risk subverting our purpose and betraying the compelling logic of our supporting rationale with a recommendation that stops short of guaranteeing certainly in the regulatory process.

The nine-month time period should commence upon the initial filing of an application for certification, not upon the Commission's "acceptance" of that application. This would put the burden on the Commission to fully inform utilities of their data requirements, in contrast to the costly volleyball game of NOI-shuffling that we have seen thus far.

Similarly, a final Commission decision should be required within 270 days (nine months) of filing, or the application should be granted automatically. This approach has recently been applied to all other public agencies in the state except the Energy Commission by A. B. 884 (see Pub. Res. Code §§ 65956, 65922). Again, the burden would be on the Commission, and I do not think it an unfair one.

A bevy of land use and permitting decisions on precisely the same areas presented to them as power plant sites would have already been made — by the counties, a welter of state agencies, and various federal entities as well. The data already available (and presumably up to date) would be voluminous, and The Commission's task in coming to a siting decision would bear little resemblance to that facing them in other, non-site specific, thermal generating venues.

The specific language of my additional recommendation in this area is as follows:

The Task Force recommends that the Energy Commission establish, no later than March 1, 1978, a single, nine-month certification process for the siting of geothermal powerplants. Said process shall commence on the day such an application for certification is initially filed with the Commission, and in the event the Commission fails to act within 270 days of said filing, the application shall be deemed to have been approved and the certification shall be granted.

The Task Force further recommends that, in the event the Commission fails to establish such an unconditional, single phase, nine-month procedure for geothermal power plant siting by March 1, 1978, the Legislature immediately commence a re-examination of the Commission's jurisdiction over geothermal power plant siting and adopt expediting or exempting legislation for said facilities by amendment to the Warren-Alquist Act.

(2) Economics Chapter:

(a) Property Tax Deferral

While ad valorem taxes are clearly not as significant an economic barrier to geothermal development as, e.g., present federal tax treatment, they nonetheless pose an obstacle, particularly for smaller operators.

Our recommendations as to local, state and Energy Commission permitting procedures may indirectly alleviate part of the financial difficulties posed by ad valorem taxes. This backhanded approach, however, is hardly a satisfactory resolution of the problem.

It also strikes me as more than a bit misguided for the Task Force to recommend state enactment of both intangibles and percentage depletion incentives which have, at best, minimal impact upon developer cash flows, while simultaneously failing to deal with the greater impact of ad valorem taxes.

Nor is it clear why, from the perspective of state energy policy, solar heating and cooling should be given a whopping 55% investment tax credit, while geothermal operators are accorded no relief from property taxes.

The costs and benefits would seem to justify a property tax exemption until initiation of an income stream. The taxes initially foregone by foreclosing geothermal properties from levy prior to production would be more than offset by the receipts flowing from the eventually-developed leases. On balance, the affected localities would probably profit from otherwise marginal ventures induced by this rather inexpensive incentive. My suggested recommendation follows:

The Task Force therefore recommends that the Legislature seek an amendment to the Constitution to provide an exemption from ad valorem taxes for geothermal properties which have not yet begun to produce revenue.

(b) Exemption of Small Energy Producers from PUC Jurisdiction:

Due to the seeming inability and/or unwillingness of many of the states utilities to commit themselves to geothermal resources as a generating fuel, geothermal developers are being forced into the position of building their own generating plants, in order to demonstrate the feasibility of hot water geothermal utilization technology and the viability of reservoir performance over time. Magma Power Co. and Republic Geothermal Inc. are going ahead with the first two such facilities, both at East Mesa in the Imperial Valley. Others will surely follow. Surely the state should support and encourage these efforts, particularly when a costless way of doing so is readily available.

In order to support these ventures, these geothermal operators

must attract outside capital. Some may choose a federal loan guarantee. Others will prefer to raise risk dollars through limited partnership offerings which. Under current law, rate regulation would apply to sales of electricity from these plants.The necessary capital will be available only if potential investors perceive returns commensurate with the risks attendant in such an undertaking. Utility-style price regulation hardly provides such a return. In the normal run of utility regulation, reduced returns are justifiable in view of the guaranteed monopoly accorded the regulated firm. But the current and projected geothermal plants we are dealing with here, as well as their operators, hardly fit into the standard "utility" mode. These are, in fact, private geothermal demonstration projects, built without expenditure of public funds.

The state, moreover, has made other policy decisions which result in an exemption from utility style siting regulation in cases where the rationale for such oversight is absent. The Energy Commission, e.g., has no jurisdiction over "thermal power-plants" of less than 50 megawatts capacity (Pub. Res. Code § 25120). Thus, both the Magma (10 MWe) and Republic (48 MWe) facilities will not be subject to Energy Commission jurisdiction. Unfortunately, there is no parallel exemption from the P.U.C.'s siting and, most importantly for Task Force purposes, rate-setting jurisdiction.

I feel that, in view of the need for hot water geothermal demonstrations in California, the logic underlying the cited exemption from Energy Commission jurisdiction should be extended to the P.U.C.'s rate-making responsibilities as well, for power-plants of less than 50 megawatts net capacity.

State of California — The Resources Agency of California

Memorandum

To : Priscilla Grew
Chairperson
State Geothermal Task Force

Date : December 21, 1977

From : Energy Resources Conservation and Development Commission
1111 Howe Avenue
Sacramento, 95825

JAMES A. WALKER James A Walker
Deputy Executive Director

Subject: ENERGY COMMISSION STAFF DISSENT TO PORTIONS OF STATE GEOTHERMAL TASK FORCE EXECUTIVE SUMMARY

GENERAL COMMENTS

The staff of the Energy Commission has reviewed the Executive Summary and Recommendations of the Report of the State Geothermal Task Force. The Executive Summary represents the culmination of a formidable effort by the Task Force and its staff in dealing with a subject of great breadth and complexity. Many of the findings and recommendations contained in the Executive Summary are significant and potentially beneficial to acceptable development of geothermal energy in California. Although the Energy Commission shares the Task Force goal of encouraging the maximum acceptable use of geothermal resources, we are not in total agreement with the path chosen by the Task Force to attain that goal. The following comments thus represent the Commission staff's dissent from some of the specific recommendations of the Task Force.

Before recording our dissents to specific recommendations I would like to comment on the overall impression of the Report. The primary shortcoming of the report is that it doesn't seem to get to the heart of the geothermal problem and does not give reason to expect that if the recommendations are followed a significant increase in geothermal utilization will result. The Report gives the impression that the regulatory and institutional constraints are the key barriers to more widespread and a aggressive commitments to geothermal resource development and utilization. While we recognize the significance of regulatory issues as a constraint, particularly those issues surrounding land use decisions, we believe that the technological and economic uncertainties regarding the utilization of liquid dominated resources are the factors most responsible for the present limited commitment to geothermal energy. The state can do much to resolve these uncertainties if it can assure that demonstration plants are constructed in a timely manner.

Secondly, some cf the recommendations with the potential for far-reaching consequences do not appear to be supported by appropriate legal, policy, and practical analysis. The net effects of some of the recommendations appear to us to involve quite a radical change in the roles of certain agencies despite the statement on page v of the Summary that the Task Force sees no need for radical changes. Also, some of the "short term solutions to immediate problems" would seem to require considerable

time to implement. The recommendations concerning the roles and future functions of the Geothermal Resources Board and the Division of Oil and Gas are examples which will be further developed below.

Thirdly, we feel that the Report fails to give sufficient recognition to the positive role of the Energy Commission in encouraging geothermal development. The Commission was established to consolidate the state's responsibility for electricity supply planning and power plant siting. Additionally, we are charged with coordinating the state efforts to promote geothermal development. These powers and responsibilities place the Commission in a unique position to encourage geothermal through direct regulatory practices in conjunction with other efforts to resolve constraints to development and to support research and development.

For purposes of the specific dissents which follow, we have grouped related recommendations together and have commented on their combined effect.

DISSENTS TO SPECIFIC RECOMMENDATIONS

1. Recommendations Regarding GRB

Two of the Task Force recommendations dealing with the Geothermal Resources Board are cited below:

(a) Page 21: The Geothermal Resources Board (GRB) should be enlarged to include the Chairman of the Energy Commission and three public members. The GRB should coordinate State agency bodies, resolve conflicts between permitting agencies and mediate disputes between applicants and permitting authorities. (Now page 60)

(b) Page 24: The GRB should identify areas in the State with highest probability of development; the State should provide funds to the appropriate local jurisdiction to prepare the documents necessary for zoning decisions for the area. (Now page 66)

Commission Staff Dissent

(a) If this recommendation is to prove effective it will likely do so in the long term. The recommendation will require the time necessary for legislative action. Additionally, the GRB will require considerable staff and budget to perform its designated duties. It will thus take time to select staff, define their methods of operation, and gain the experience necessary if the duties are to be performed effectively. The recommendation raises many questions. How will the GRB perform its coordinating and mediating functions without becoming, essentially, another layer in the permit process? What will be the method of conflict resolution? Will the GRB hold hearings? Will its findings be binding? If the findings are binding, will they also be binding as to local agencies?

well safety and resource conservation. The recommendation could create a potential for duplication of effort and interjurisdictional disputes between the DOG and those agencies explicitly charged with air and water quality responsibilities, etc.

(b) As the summary notes (page 19), current law empowers the DOG to designate "commercial fields" for administrative purposes. (Emphasis added.) This recommendation vastly expands the purposes of such a designation and, again acts to increase the statutory responsibilities of the DOG considerably beyond that of an agency charged with ensuring the propriety of drilling operations. The recommendation would make the DOG a land use and planning agency. As such, we believe the recommendation can hardly be seen as calling for a "non-radical" change. The recommendation may in fact be creating a possibility for duplication of effort. The recommendation would appear to have the DOG perform the EIR function presently done by the counties for wells and by the Energy Commission for powerplants, because the recommendation calls for the DOG to evaluate the impacts of powerplants. Further, the Summary fails to clarify the relationship between this recommendation and the recommendation calling for the Geothermal Resources Board to designate areas on which to concentrate local planning. (now page 58)

3. Recommendations on Regulatory Jurisdiction

The Commission staff dissents from certain aspects of the following four recommendations on regulatory jurisdiction:

(a) Page 25: Land use approvals of geothermal wells, steam transmission lines and related facilities should remain with the appropriate local jurisdiction; (Now page 72)

(b) Page 25: Approvals of geothermal powerplants, excluding wells, steam transmission lines and related facilities, should remain with the Energy Commission; (Now page 72)

(c) Page 25: The Energy Commission's jurisdiction should begin at the point a utility files an application for approval of construction of a geothermal powerplant; and (Now page 73)

(d) Page 26: The Energy Commission should establish a single nine-month review process and sponsor legislation eliminating the requirement to determine whether individual geothermal powerplants conform to the ten-year forecast of statewide and service area power demands. (Now page 74)

Commission Staff Dissent

These recommendations are founded in a Task Force preference for "home rule" and thus the desirability of placing counties in the exclusive land use decision-making role. (See our earlier comments regarding local planning.) This results in the treatment of geothermal energy development

as a purely local problem. It ignores the legislatively recognized fact that geothermal is but one energy source and that energy issues are of statewide, if not nationwide concern. It further ignores the fact that for most energy-related issues, strict "home rule" regarding land use is the exception rather than the rule. That consideration is basic to the Warren-Alquist Act, which places the ultimate land use decision for thermal powerplants with the state. Note also the recent LNG legislation and the process for certification of hydroelectric plants. The Task Force is clearly recommending a different treatment for geothermal energy. But aside from noting the site-specific nature of the resource, the report fails to justify the subordination of state interests to local interests in the lone case of geothermal. A stronger justification is needed for placing geothermal, which is one of the state's most promising energy alternatives, on a level different from that afforded other significant resources, such as nuclear, coal, oil, etc. The Task Force recommendations would allow the counties to control the pace and timing of the development of geothermal resources in a manner presently not applied to other sources for generating electricity.

The assertion is made that respective jurisdictional recommendations are designed to balance state and local interests. The assertion is simply not justified by the recommendations themselves. Specifically, the balance tips heavily in favor of local interests by allowing counties to totally control the question of whether and when geothermal will be developed. The recommendations give the state no strong proactive role, other than the use of state funds for local planning.

The Energy Commission staff feels the Task Force's regulatory strategy reduces the Commission's role to that of a ministerial agency that would routinely endorse county decisions after substantial monetary expenditures by industry. An appropriate role for the Commission would allow early regulatory involvement strong enough for the Commission to indicate to a utility its belief that a powerplant can be built somewhere within the area of the potential geothermal field being considered. Such a role would more accurately reflect the state's interest in energy planning and in geothermal development as expressed in the Warren-Alquist Act.

JAMES A. WALKER
Deputy Executive Director

State of California — The Resources Agency

Memorandum

To : Judy Warberg
Office of Planning and Research

Date: December 21, 1977

From : Department of Fish and Game

Subject: Dissenting Opinion - Environmental Considerations, Fish and Wildlife - Geothermal Task Force Draft Report

The Geothermal Task Force on December 9, 1977 discussed three recommendations regarding fish and wildlife baseline information, monitoring, and mitigation. The recommendations on baseline data collection and monitoring were accepted with considerable modification. The proposed recommendation on mitigation, "The Task Force recommends that developers mitigate for fish and wildlife losses. The Task Force further recommends that developers cooperate with the Department of Fish and Game in developing and implementing appropriate mitigation measures." was voted down by a 9-4 margin.

I would like to point out to the Task Force that one of the questions it was to address stated "Are there environmental considerations in the development of geothermal resources, and if so, what are they and what are the most feasible methods of insuring that geothermal resources are developed with the least possible impact upon the ecosystem, and how might unavoidable impacts be mitigated or compensated?" (emphasis added)

I would like to point out that testimony presented at the public hearings by the U. S. Fish and Wildlife Service and the Department of Fish and Game indicated a critical problem regarding the loss of fish and wildlife habitat. These agencies also stated that mitigation should be required to protect and maintain these resources.

The Task Force's draft report states that geothermal development is affecting fish and wildlife resources. It further states that large tracts of land currently relegated to agriculture and/or recreational use will be required to develop electrical energy. The industrialization of these lands will have both short-term and long-term impacts on fish and wildlife. Geothermal resources in most instances can be developed provided local, state, and federal agencies mandate the protection of other surface and subsurface resource values. Mitigation measures to compensate for fish and wildlife losses is essential to protect the public's interest in these resources.

It is obvious that most of the state agencies on the Task Force are energy development oriented and therefore believe the trade off of fish and wildlife resources for additional electrical energy is acceptable. The Department of Fish and Game is mandated by the Legislature to protect these valuable public resources and as such cannot accept the eradication of vital habitat without suitable mitigation. It was argued that CEQA provides for mitigation and therefore the Task Force does not need to consider this issue. CEQA refers to the protection of the environment in Section 21001, and discusses mitigation in Sections 21002 and 21002.1. However, Section 21002.1, which in part states:

> "In order to achieve the objectives set forth in Section 21002 the Legislature finds and declares that the following policy shall apply to the use of environmental impact reports prepared pursuant to the provisions of this division:
>
> (a) The purpose of an environmental impact report is to identify the significant effects of a project on the environment, to identify alternatives to the project, and to indicate the manner in which such significant effects can be mitigated or avoided.
>
> (b) Each public agency shall mitigate or avoid the significant effects on the environment of projects it approves or carries out whenever it is feasible to do so.
>
> (c) In the event that economic, social, or other conditions make it infeasible to mitigate one or more significant effects of a project on the environment, such project may nonetheless be approved or carried out at the discretion of a public agency, provided that the project is otherwise permissible under applicable laws and regulations." (emphasis added)

permits public agencies to approve projects without mitigation. This is particularly in evidence when public agencies consider fish and wildlife mitigation measures. Therefore, it is my contention that CEQA does not adequately address mitigation with respect to fish and wildlife resources.

I believe the action taken by the Task Force not to consider how might unavoidable impacts be mitigated or compensated is contrary to the Legislature's request. Furthermore, there is no state or federal law requiring the implementation of mitigation measures for fish and wildlife losses. Since the Task Force was unable to resolve this major issue, fish and wildlife resources will continue to be adversely affected by geothermal development.

Dick Forester

Richard T. Forester
Geothermal Task Force Member

RTF:dd

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EDUCATION COMMISSION
OF THE STATES
STATE GEOTHERMAL RESOURCES
TASK FORCE
CHAIRMAN
SUBCOMMITTEE ON
EDUCATOR EVALUATION

JOHN STULL
SENATOR
THIRTY-EIGHTH DISTRICT
SAN DIEGO, RIVERSIDE AND IMPERIAL COUNTIES

December 20, 1977

Statement and Dissent

of

Senator John Stull

Member, State Geothermal Resources Task Force

Attached you will find my dissents and comments to specific sections of the Task Force's Executive Summary. In addition I would like to make a few remarks.

Geothermal energy is big business in California; we produce more electricity from geothermal resources in this state than does any other country in the world. Millions of dollars are being spent on technology to reduce pollution and to further utilize resources other than dry steam. In the Geysers there has been some discomfort from these operations but in Imperial Valley the degree of planning and cooperation between government, business, and individuals, is exemplary.

As long as government does not overly intrude into this growing alternative energy resource, development should continue at a satisfactory pace. Most of the important environmental standards have already been established and industry will do its best to meet them. In the absence of new and stifling regulations, procedures, programs, constraints, and red tape, the profit motive will motivate enough entrepreneurs into the field as are required to meet our future needs, and this is as it should be.

Most of the Task Force members, who are competent and dedicated state civil servants, understand this fact and are not eager to expand the regulatory domain of their employer agencies. Possible exceptions are the Energy Commission, which as a young and plenipotent agency has yet to establish and successfully defend its jurisdictional

turf from encroachment by others, and Fish and Game, which feels somewhat powerless because it never issues permits. By and large, though, the Executive Summary displays the general conservatism of its members.

I strongly support the recommendation on pages 18 and 19, which (Now page 57) would reduce the bureaucratic paperwork during geothermal development. I also strongly support the recommendations on page 25 and (Now page 73) (Now page 74) 26 which would limit the role of the Energy Commission, leave local land use decisions to local authorities, and speed up the Commission's procedures. These recommendations would remove roadblocks to geothermal development.

Finally, I would like to emphasize our great need for locally produced energy, free from price or supply controls arbitrarily imposed by foreign countries. Geothermal fits that description and is relatively clean and safe too. If a few choice homesteads or rural glens are unavoidably blemished by power plant construction, that is the price that must be paid to most benefit the greatest number of California's citizens. Geothermal power plants are small and beautiful and their technology is appropriate; if we leave them alone they will sprout and grow healthily.

Sincerely,

John Stull

JOHN STULL
Senator, 38th District

Senator Stull

DISSENT

* = first recommendation on a page
** = second recommendation on a page

Page	Comment
v* (now page 75)	In my opinion the recommendation on page 28 would radically change the role of the PUC, not only in geothermal but in much of its utility regulation which has no relation to geothermal whatsoever.
5* (Now page 22)	This sophomoric recommendation apparently refers to the Imperial Valley, which is entirely within my senatorial district. Insofar as water is the lifeblood of that area, this recommendation will have no effect on raising the already heightened consciousness of Valley residents regarding water.
9* (Now page 36)	This is a self-evident recommendation.
10* (Now page 37)	Insofar as Imperial County has operated a sophisticated subsidence sensing system for several years, and requires special reinjection procedures prior to issuing geothermal permits, it is not necessary now or in the foreseeable future for the Division of Oil and Gas to require reinjection.
10** (Now page 38)	This is another self-evident recommendation.
12* (Now page 41)	This recommendation is already a legal requirement due to the passage of AB 884, Chapter 1200, Statutes of 1977; however, I object to its implication that the Division of Oil and Gas should involve itself in local land use decisions or policies.
13* (Now page 42)	This recommendation was adopted largely due to last minute pressure from a particular hot springs owner who lists several high-level gubernatorial appointees as recent visitors to his resort. The major Indian hot springs of religious significance, Coso Hot Springs, is on federal land at the China Lake Naval Weapons Station and thus outside of state jurisdiction.
14* (Now page 43*)	Such descriptions are already required under CEQA. It should be noted, however, that the flow, composition, and temperature of most springs, hot or cold, fluctuate widely and can rarely be predicted with assurance. Thus it is virtually impossible to know whether nearby operations would or already have affected such flow, composition, or temperature.
14** (Now page 43**)	Again, it will be exceedingly difficult in many cases to attribute an "unreasonable change" (whatever that is) to a particular cause.
21* (Now page 60*)	The Geothermal Resources Board is an unfunded, unstaffed entity hardly in a position to accomplish much of anything. Furthermore, AB 884 (cited above) which is now law, should resolve those problems at the root of this recommendation.
22* (Now page 60**)	If the legislature adds more members and more duties to the Geothermal Resources Board, it should staff the Board to accomplish its tasks. However, it is my opinion that AB 884 should be utilized for awhile before this alternative remedy is attempted.

(continued) Senator Stull

DISSENT

Page	Comment
22** (Now page 61)	Same comments as in 22*
28* (Now page 75)	The Task Force heard no testimony whatsoever on this "common carrier" recommendation, which was hastily considered at its last two meetings and adopted with little discussion. This is the most radical proposal by the Task Force, going far beyond geothermal energy and greatly expanding bureaucratic control over our economy. It suggests that the PUC have authority to totally and completely reorganize our statewide electrical distribution system, including nuclear, hydro, conventional, and alternatively generated electricity. In my opinion the law (Public Resources Code Sections 2801 et seq) already allows the PUC to order "wheeling" to promote geothermal development, which would be sufficient remedy for the alleged ill; otherwise that law could accept a minor amendment. However this proposal to greatly expand the PUC's jurisdiction is unwarranted and unwise.
29* (Now page 80**)	The Department of Health was never contacted or consulted regarding this proposal and I am unable to form an intelligent opinion on the matter.
30* (Now page 82)	I object to this reference to the Governor. Furthermore, public agencies should contract out work whenever the private sector can perform the job adequately; however, the law now allows public agencies to compete with the private sector in geothermal development on private lands. Since the law fails to prohibit public agencies from developing private lands, they should not be prohibited from developing public lands either.
32* (Now page 83**)	I heartily concur.
34* (Now page 93)	This passed by a vote of 7-6, over my objections. If these municipalities and small utilities cannot raise capital on the open market, and if banks are unwilling to accept them as clients for federally guaranteed loans, the state should not get involved, and risk public funds, by underwriting their ventures. The pace of geothermal development in California is satisfactory, and we do not need to tap the state treasury or create special bonding programs in an attempt to hasten development by special parties.

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OMER L. RAINS

EIGHTEENTH SENATORIAL DISTRICT
SANTA BARBARA AND VENTURA COUNTIES

CALIFORNIA LEGISLATURE

COMMITTEES
BUSINESS AND PROFESSIONS
ELECTIONS AND REAPPORTIONMENT
PUBLIC UTILITIES, TRANSIT AND ENERGY
TRANSPORTATION

CHAIRMAN, SENATE SUBCOMMITTEE ON POLITICAL REFORM

MEMBER, COMMISSION OF THE CALIFORNIAS
MEMBER, GEOTHERMAL RESOURCES TASK FORCE

Senate

Chairman, Senate Majority Caucus

December 19, 1977

Dr. Priscilla C. Grew, Chairperson
State Geothermal Task Force
Department of Conservation
1416 Ninth Street
Sacramento, California 95814

Dear Dr. Grew:

In reviewing the Draft Report and the Executive Summary of the State Geothermal Resources Task Force, I find that I must dissent in part and express some concerns relating to the tone and direction of the report as well as some of its recommendations. I also believe that many of the questions spelled out in the Task Force's enabling legislation, AB 3590 (Chapter 958, 1976), have not been sufficiently answered.

As you are aware, the Legislature, through the Warren-Alquist Act, previously created the Energy Resources Conservation and Development Commission to address, among other things, comprehensive long-range energy planning and development of alternative energy resources. In spite of this clear mandate, the Task Force has failed to sufficiently tie together the present and future development of our geothermal resources, as an alternative energy source, with long-range energy planning for the state. Indeed, it seems to me that the tenor of the report is to exclude or limit, whenever possible, Energy Commission jurisdiction and involvement with the development of our geothermal resources, especially in the early stages of a project. I refer most specifically to the recommendations under Siting Procedure, Implementation, Power Plants, and Pre-Application Jurisdiction set forth in the regulatory sections of the report.

Moreover, as suggested in the draft report itself, though rejected for the most part by the Task Force (pp. 89-90): "[E]limination of the Energy Commission's broad siting authority over geothermal

(Now Pages 71-72)

plants in favor of the PUC's more limited siting function is undesirable from an energy planning perspective. The Energy Commission must consider the need for geothermal plants in the context of other energy sources such as nuclear, oil, and coal. Transferring the geothermal siting authority to the PUC would only limit the Commission's ability to condition approval of non-geothermal power plants on the use of geothermal power. Transfer of the regulatory authority of the Energy Commission to the PUC would therefore hamper the Commission's ability to plan effectively for use of geothermal power in view of the State's electrical energy needs."

In addition, the recommendations under Local Planning are seemingly designed to discourage any consultation or involvement whatever in the planning process by the Energy Commission, a position which, again, I find inconsistent with legislative intent as evidenced by the Warren-Alquist Act.

In general, the report seems to be a piece-meal, as opposed to a comprehensive, approach to solving problems concerning geothermal development. It definitely leaves the impression that the major constraints facing geothermal developers are regulatory and bureaucratic. I admit that the nature of regulations is to constrain and the bureaucratic process in many instances leaves a lot to be desired, but I have to think that the lack of development of geothermal resources to date has somewhat broader implications. Specifically, the small monetary commitment in the past by government and industries in the area of research and development has resulted in slow technological advances. Also, the dollar return on invested income in geothermal development presents itself as uncertain at this point, thus discouraging potential investment.

In short, the recommendations in the report seem to take a "band-aid" approach to solving some of the problems expressed in Task Force meetings and public hearings by geothermal developers, representatives of local governments, and private citizens. And, in general, the recommendations fail to sufficiently encourage overall future development of the resource on a statewide basis.

I would like to take this opportunity to commend members of the Task Force for the diligence with which they pursued their task. To be sure, there are parts of the report that are most informative, particularly the resource assessment section. Nevertheless, from an overall perspective, I don't think the report addresses the geothermal problem in a manner sufficient to realize a significant increase in the future use of geothermal resources throughout the state.

Respectfully submitted,

OMER L. RAINS
State Senator, 18th District
Member, State Geothermal Task Force

APPENDIX II

MEETINGS, HEARINGS, AND FIELD TRIPS
OF THE
STATE GEOTHERMAL RESOURCES TASK FORCE

Date	Attendees
January 13, 1977	Members, Geothermal Task Force
February 2, 1977	Members, Geothermal Task Force; Lawrence Livermore Laboratory
February 15, 1977	Members, Geothermal Task Force; James A. Roberts, private citizen
March 10, 1977	Members, Geothermal Task Force; ERDA; U.S. Geological Survey; James A. Roberts, private citizen; U.S. Bureau of Land Management; Lawrence Livermore Laboratory; A. E. Davis & Company; California Research
March 24, 1977	Members, Geothermal Task Force; California Research; U.S. Geological Survey; A. E. Davis & Company; Lawrence Livermore Laboratory; U.S. Forest Service
April 11, 1977	Members, Geothermal Task Force; A. E. Davis & Company; California Research; Pacific Gas & Electric Company; U.S. Geological Survey; Bureau of Land Management; U.S. Forest Service
April 14 - 15, 1977	PUBLIC HEARING - Sacramento
April 22, 1977	Members, Geothermal Task Force; Bureau of Land Management; U.S. Geological Survey
April 28-29, 1977	PUBLIC HEARING - San Diego
May 12, 1977	Members, Geothermal Task Force
May 12, 1977	Members, Geothermal Task Force - Meeting with Federal Representatives: U.S. Forest Service; U.S. Geological Survey; Naval Weapons Center, China Lake; Gerold Ford, private consultant; Federal Power Commission; Bureau of Land Management; Pacific Gas & Electric Company; California Research; U.S. Fish & Wildlife Service; U.S. Bureau of Reclamation
May 19-20, 1977	PUBLIC HEARING - Sacramento
May 26-27, 1977	PUBLIC HEARING - San Francisco
June 2, 1977	Members, Geothermal Task Force

Date	Attendees
June 10, 1977	Members, Geothermal Task Force; Pacific Gas & Electric Company
June 14, 1977	TOUR OF THE GEYSERS GEOTHERMAL AREA - Members, Geothermal Task Force; Representatives from Lake and Sonoma Counties; Union Oil Company; Pacific Gas & Electric Company
June 17, 1977	BRIEFING ON HEBER DEMONSTRATION PLANT - Members, Geothermal Task Force; Representatives from Imperial County; VTN Consolidated, Inc.; Chevron Resources Company; San Diego Gas & Electric Company
July 6, 1977	Members, Geothermal Task Force
July 12, 1977	Members, Geothermal Task Force - Meeting with Federal Representatives U.S. Geological Survey; Bureau of Land Management; Bureau of Reclamation; U.S. Fish & Wildlife Service; Federal Energy Administration; Energy Research and Development Administration; Naval Weapons Center, China Lake; U.S. Forest Service
July 18, 1977	Members, Geothermal Task Force
July 21, 1977	Members, Geothermal Task Force; Pacific Gas & Electric Company; California Research
August 2, 1977	Members, Geothermal Task Force; Sierra County; Sonoma County; Mono County; Lake County; Gennis & Associates, Engineers; Pacific Gas & Electric Company; Imperial County; Union Geothermal; Senator Dunlap; Napa County
August 9, 1977	Members, Geothermal Task Force; Union Geothermal; Pacific Gas & Electric Company; California Research; Lake County Air Pollution Control District
August 17, 1977	Members, Geothermal Task Force; Union Geothermal; Pacific Gas & Electric Company; Bureau of Land Management; Aminoil USA; California Research; Wilbur Hot Springs
August 25, 1977	Members, Geothermal Task Force; Pacific Gas & Electric Company; Thermal Power; Union Oil Company; Lake County Air Pollution Control District; Lake County Board of Supervisors; Lake County Planning Department
September 15, 1977	Members, Geothermal Task Force; Bureau of Land Management; Union Oil Company of California
September 20, 1977	TOUR OF THE GEYSERS GEOTHERMAL AREA

Date	Attendees
September 27, 1977	Members, Geothermal Task Force; Napa County Citizens for Task Force
October 13 - 14, 1977	TOUR OF THE IMPERIAL VALLEY
November 9, 1977	PUBLIC HEARING - Sacramento
November 15, 1977	Members, Geothermal Task Force; Department of Energy; California Research; Union Oil Company of California; San Diego Gas & Electric Company; Pacific Gas & Electric Company
December 2, 1977	Members, Geothermal Task Force; California Research; Bureau of Land Management; Union Oil Company; A. E. Davis & Company; Pacific Gas and Electric Company; Friends of Cobb Mountain
December 9, 1977	Members, Geothermal Task Force; Pacific Gas & Electric; Union Oil Company; California Citizen Action Group

APPENDIX III

INDEX TO TESTIMONY AT GEOTHERMAL RESOURCES TASK FORCE HEARINGS

The input for this report was obtained from the oral and written testimony presented to the Geothermal Resources Task Force at its four public hearings. The persons testifying are listed in alphabetical order, followed by the date on which they testified, the number in which they appeared on that day, and the reference page in the written hearing transcription for that day.

Transcripts of the oral testimony and the written statements submitted at the Task Force hearings are available for perusal at the Resources Agency Library, 1416 9th Street, 1st Floor, Sacramento, California.

GEOTHERMAL RESOURCES TASK FORCE

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GEOTHERMAL RESOURCES TASK FORCE

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