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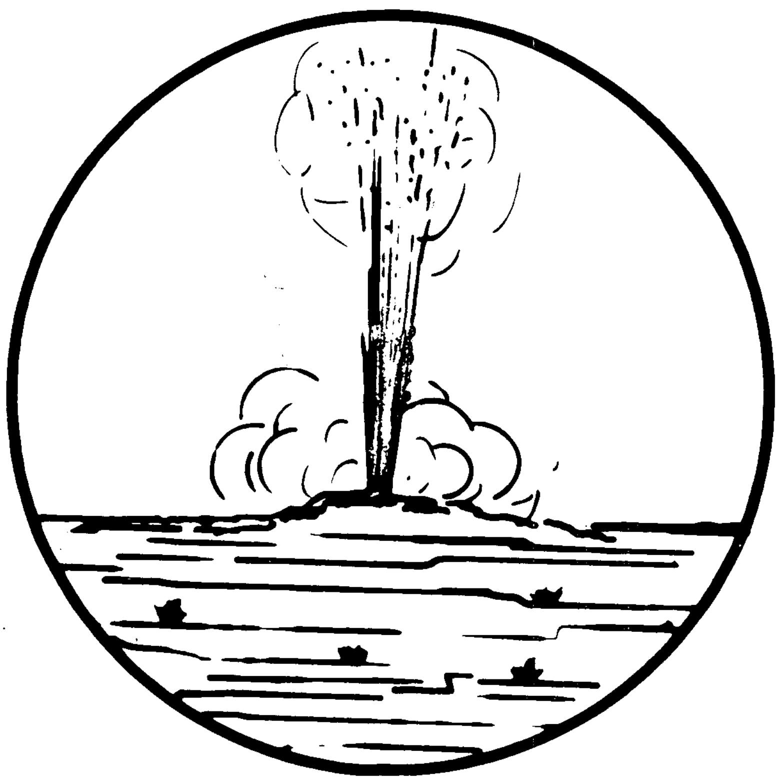
WESTERN REGIONAL

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Rulemaking for

SMALL POWER PRODUCTION AND COGENERATION FACILITIES— EXEMPTIONS FOR GEOTHERMAL FACILITIES

Docket No. RM 81-2



GEOTHERMAL

FEDERAL ENERGY REGULATORY COMMISSION
Advisor on Environmental Quality

February 1981

FERC/EIS-0019FS

WESTERN REGIONAL

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

SMALL POWER PRODUCTION AND COGENERATION FACILITIES— ELIGIBILITY, RATES AND EXEMPTIONS

FOR

QUALIFYING AND UTILITY-OWNED GEOTHERMAL SMALL POWER PRODUCTION FACILITIES

(A Rulemaking in Docket No. RM 81-2)

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February 1981

ABSTRACT: Section 643 of the Energy Security Act of 1980 directed the Federal Energy Regulatory Commission to develop rules to further encourage geothermal development by Small Power Production Facilities. This rule amends rules previously established in Dockets No. RM79-54 and 55 under Section 201 and 210 of the Public Utility Regulatory Policies Act of 1978 (PURPA). The analysis shows that the rules are expected to stimulate the development of up to 1,200 MW of capacity for electrical generation from geothermal facilities by 1995 -- 1,110 MW more than predicted in the original PURPA EIS. This Final Supplemental EIS to the DEIS, issued by FERC in June 1980, forecasts likely near term development and analyzes environmental effects anticipated to occur due to development of geothermal resources in the Western United States as a result of this additional rulemaking.

LEAD AGENCY: The Federal Energy Regulatory Commission is the sole agency responsible for this Final SEIS.

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COMMENT PERIOD: A period of 30-days will be available for commenting on this Final SEIS. Comments should be sent to the Secretary, Federal Energy Regulatory Commission, 825 North Capitol St., N.E., Washington, D.C. 20426, no later than March 23, 1981.

I SUMMARY

This is a Supplemental Final Environmental Impact Statement (SFEIS) on PURPA-Induced Geothermal Energy Development to the Draft EIS on "Rulemaking for: SMALL POWER PRODUCTION AND COGENERATION FACILITIES--QUALIFYING STATUS/RATES AND EXEMPTIONS DOCKET NOS. RM79-54 and RM79-55," June 1980.

That DEIS (hereafter referred to as the PURPA DEIS) analyzed the environmental effects that are projected to result from enactment of provisions of the Public Utilities Regulatory Policy Act (PURPA) of 1978. A purpose of PURPA is to stimulate the development of alternative energy sources, including geothermal resources, as a means of meeting national energy requirements. Under the Federal Energy Regulatory Commission's (FERC or the Commission) rules implementing Section 210 of PURPA, geothermal energy development was projected to show little progress.

This supplemental Final EIS analyzes the environmental effects of geothermal development in the western United States projected as the result of additional rulemaking in Docket No. RM81-2 changes to the PURPA by FERC.

Geothermal Development

The revised rules under PURPA are expected to stimulate the development of more than 1200 MW of capacity for electrical generation from geothermal facilities by 1995--1100 MW more than predicted in the original PURPA DEIS. PURPA-induced development is anticipated in the near term for California, Nevada, and Idaho (see Figure V-1), and may occur in other states in the West. A breakdown by location is presented in Table V-1 and shown in Figure V-1. A map indicating the extent of geothermal resource areas in the western United States is shown in Figure VI-3.

Principal Provisions of the Proposed Rulemaking

Section 643 of the Energy Security Act of 1980 authorized the Commission to develop rules to further encourage geothermal development by Small Power Production Facilities (SPPFs) by:

- Increasing the maximum size for exemption from regulation from 30 to 90 MW for geothermal SPPFs.

- Exempting utility-owned geothermal SPPFs of not more than 80 MW capacity from the Federal Power Act, the Public Utility Holding Company Act (PUHCA), and from state laws regarding rates of electric utilities and their financial organizational regulations.

- Providing avoided cost pricing benefits of PURPA Section 210 to utility-owned facilities.

Estimated Savings of Fossil Fuel Due to this Rulemaking

The following fossil fuel displacement is anticipated due to this action by 1995:*

Mountain Region	857,000 bbl/y of oil 1.19×10^{10} scf/y of gas
Pacific Region	1,214,000 bbl/y of oil 0.29×10^{10} scf/y of gas

Principal Adverse Environmental Impacts

Although geothermal resources represent a relatively clean energy source, environmental changes have occurred in various parts of the world due to development of these resources.

During the extraction process, a variety of gases may be released to the atmosphere, the most environmentally objectionable being hydrogen sulfide with its accompanying disagreeable odor. Boron, in the form of boric acid, when emitted in cooling tower drifts can harm leaf growth of local vegetation, particularly citrus crops. Other substances emitted in gaseous form, including carbon dioxide, methane, ammonia, arsenic, mercury and radon, are usually in very low concentrations. Emissions vary greatly from site to site because of the composition of the geothermal resource itself.

Surface and ground water pollution may result from disposal of excess steam condensate and water. Some of the fluid products have a high salt content and therefore may not be safely discharged to surface waters without degrading their quality. Local geologic conditions and hydrology may preclude injection of spent geothermal fluids into the ground where they could contaminate potable groundwater.

Withdrawal of geothermal fluids from the earth may cause subsidence (i.e., the sinking of land overlaying the reservoir). Reinjection of the

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* Less development may occur as a result of the decision to disallow utilities to form subsidiaries that are exempt from certain sections of the Federal Power Act and some state regulations, and to sell at the avoided cost. See IV-3.

fluids may induce seismic activity. However, such occurrences are rare, and evaluation of their potential will vary greatly from site to site.

Noise from the venting of geothermal wells has caused problems in certain areas. The long-term effects of noise in remote sites on wildlife is not well understood.

Expanded geothermal development will inevitably change the character of the land on which it occurs. Rehabilitation and recovery of the site after the useful life of a geothermal facility should be much easier and more successful than rehabilitation associated with fossil fuel power plants or nuclear reactors.

Principal Beneficial Environmental Impacts

Increased development of geothermal facilities will reduce impacts associated with fossil and nuclear fuel cycles and associated facilities, including their extraction, refining, transportation, and burning. Land disruption is anticipated to be far less extensive than that caused by surface mining of coal or uranium. In addition, the health and safety issues are minor compared with coal or nuclear power production.

Possible Measures to Mitigate Adverse Environmental Effects

Federal, state, and local control of siting and enforcement of existing environmental laws will mitigate many adverse effects of the geothermal facilities. As the number of geothermal development projects increase, technological improvements are also anticipated as a result of experience and economies of scale. For example, both the Department of Energy (DOE) and the Environmental Protection Agency (EPA) have funded development of new hydrogen sulfide (H_2S) removal systems that could reduce emissions of this substance significantly and make geothermal facilities more acceptable near populated areas. At present, the EIC copper sulfate process is the most significant government-funded measure for near-term development. These H_2S removal systems are discussed in more detail in Section VII of this report.

II AGENCIES, ORGANIZATIONS, AND PERSONS RECEIVING COPIES OF THIS FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

This Western Regional Final Supplemental Environmental Impact Statement is being circulated to the other Federal agencies for comment in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA). It is also available to State and local governments, interested parties, and the public. Recipients of the statement include:

Federal Departments, Agencies, Commissions, and Offices

Advisory Council on Historic Preservation
Agriculture, Department of
Commerce, Department of
Consumer Product Safety Commission
Council on Environmental Quality
Defense, Department of
Energy, Department of
Environmental Protection Agency
Farm Credit Administration
Federal Communications Commission
Federal Emergency Management Agency
Federal Home Loan Bank Board
Federal Trade Commission
General Services Administration
Health, Education and Welfare, Department of
Housing and Urban Development, Department of
Interior, Department of
International Boundary and Water Commission
Interstate Commerce Commission
Justice, Department of
Labor, Department of
Missouri River Basin Commission
National Aeronautics and Space Administration
National Credit Union Administration
National Science Foundation
Nuclear Regulatory Commission
Office of Science and Technology
Pacific Northwest River Basins Commission
Small Business Administration
Souris-Red-Rainy River Basins Commission
State, Department of
Transportation, Department of
Treasury, Department of
United States Water Resources Council

State Utility Regulatory Agencies

Alaska Public Utilities Commission
Arizona Corporation Commission
California Public Utility Commission
Colorado Public Utilities Commission
Hawaii Public Utilities Commission
Idaho Public Utilities Commission
Montana Public Service Commission
Nevada Public Service Commission
New Mexico Public Service Commission
Oregon Public Utility Commission
Utah Public Service Commission
Washington Util. & Trans. Commission
Wyoming Public Service Commission

State and Areawide Clearinghouses

Clearinghouses in the following States: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, listed in the Directory of Clearinghouses, Office of Management and Budget, Circular A-95, June 1979.

Parties Listed in the Service Lists for RM79-54/RM79-55 & RM81-2

All parties listed in these Service Lists which are maintained by the Secretary, FERC.

Organizations and Individuals

Sent to these parties as well as those who have requested copies of the PURPA DEIS.

American Gas Association
American Conservation Association
American Petroleum Institute
American Public Power Association
Center for Law & Social Policy
Chamber of Commerce of USA
Council of Energy Resource Tribes
Edison Electric Institute
Electric Power Research Institute
Environmental Action, Inc.
Environmental Defense Fund
Environmental Law Institute
Environmental Policy Center
Friends of the Earth
Institute for Gas Technology
Interstate Natural Gas Association
Izaak Walton League of America, Inc.
Energy Conservation Committee
National Association of Counties
National Association of Regulatory Utility Commissioners
National Audubon Society
National League of Cities
National Resource Defense Council
National Rural Electric Cooperative Assoc.
National Wildlife Federation
U. S. Conference of Mayors

Bob Blaustein
Gordon Blumquist
Bill Eastlake
Robert Goble
John Karl
William Loveless
Ron Menke
John Nassikas
Bob Oliver
David Philbrick
Roald Vendixen
Steve Vickers
Bill Williamson
Syd Willard

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IV ACTION

Rulemaking to Implement Section 643 of the Energy Security Act of 1980

The action evaluated in this Western Regional Supplemental Final EIS (SFEIS) is a rulemaking, FERC Docket No. 81-2, Small Power Production and Cogeneration Facilities, November 6, 1980, that implements provisions of Section 643 of the Energy Security Act of 1980 (ESA) by amending the Federal Power Act and the Public Utility Regulatory Policies Act of 1978 (PURPA).

Section 643(a) of the ESA is intended to clarify the authority of the Federal Energy Regulatory Commission (FERC or Commission) to classify geothermal resources as a "primary energy source" for the purpose of eligibility for use by a small power production facility (SPPF) under Section 3(17)(A) of the Federal Power Act, as amended by Section 201 of PURPA. The conference report indicates that the legislation does not intend "to cast the FERC's present regulations under Section 3(17) into doubt by reason of this amendment."

Section 643(b) of ESA contains three amendments to Section 210 of PURPA. Subsection 643(b)(1) amends Section 210(a) of PURPA. Section 210(a) requires the Commission to prescribe rules "as it determines necessary to encourage cogeneration and small power production...which rules (shall) require electric utilities to offer to sell electric energy to and purchase electric energy from qualifying cogeneration and small power production facilities." The amendment to this section adds "geothermal small power production facilities of not more than 80 megawatts capacity" to the list of technologies for which the Commission must issue rules to encourage, but not to the class of energy-production facilities to and from which electric utilities are statutorily required to sell and purchase.

The legislative history of ESA indicates that it was the intent of Congress that the Commission, under the "broad authority of Section 210 to encourage geothermal small power production," have the authority to make "some or all of the Section 210 rate benefits applicable to such facilities in the same manner as such benefits are available to non-utility owned facilities." Therefore, the Commission believes that it has the authority to require electric utilities to purchase from and sell to utility-owned geothermal SPPFs, and to price these purchases on an avoided-cost basis.

Section 643(b)(2) of ESA amends Section 210(e)(1) of PURPA to authorize the Commission to exempt "geothermal small power production facilities of not more than 80 megawatts capacity" from the Federal

Power Act, the Public Utility Holding Company Act (PUHCA), and state laws and regulations respecting the rates or the financial or organizational regulation of electric utilities, if the Commission determines that such exemption is necessary to encourage cogeneration and small power production. Because the Commission's exemptive authority under this amendment is not limited to "qualifying" geothermal SPPFs, the Commission may also exempt utility-owned geothermal SPPFs from these laws and regulations.

Finally, Section 210(e)(2) of PURPA limited the Commission's authority to exempt qualifying SPPFs to those with a capacity of 30 MW or less. Section 643(b)(3) of ESA increases the limit to "80 megawatts for a qualifying small power production facility using geothermal energy as the primary energy source..." Thus, the Commission may exempt any "qualifying" SPPF using geothermal energy as the primary energy source from the laws and regulations specified in Section 210(e)(1) of PURPA.

The Commission's proposed rules exercise the authority provided by the ESA to the maximum extent permitted. First, nonutility owned geothermal small power production facilities between 30 and 80 MW are exempted from the Federal Power Act, PUHCA, and state utility regulations. Second, utility-owned geothermal small power production facilities (up to 80 MW capacity) are exempt from these laws and regulations and can sell power to their parent company, or to non-affiliated utilities at the purchasing utility's avoided costs, as is provided for nonutility owned qualifying cogeneration and SPPFs pursuant to Commission order No. 69.

For further discussion of PURPA Section 201 and 210, refer to Sections IV and V of the PURPA DEIS "Small Power Production and Cogeneration Facilities--Qualifying Status/Rates and Exemptions Docket Nos. RM79-54 and RM79-55," which this document supplements. In addition, please refer to the proposed rulemaking in Docket No. RM81-2 (see Appendix A).

Rulemaking Alternatives

No Action

Section 644 of ESA requires the FERC to promulgate regulations to implement amendments to Section 210 of PURPA within 6 months of the date of enactment of ESA. The Commission must issue these rules, if it determines that they are necessary to encourage geothermal SPPFs.

Limitations on Rate and Exemption Benefits

In the draft EIS, the Commission stated that Section 210 of PURPA required the Commission to issue rules it determined necessary to encourage cogeneration and SPPFs. The Commission had discretion to limit the extent to which the PURPA Section 210 rate and exemption benefits are made available. As stated in the DSEIS, a limitation on these benefits would probably discourage some increments of the potential geothermal development that would occur under the proposed rules, with a proportional reduction in the regional environmental effects associated with the construction and operation of geothermal facilities.

The rulemaking alternatives that were considered included:

- Pricing sales from utility-owned facilities at less than full avoided costs

- Denying exemption from PUHCA to utility-owned facilities

- Only exempting utility-owned facilities from the Federal Power Act on a case-by-case basis.

The Commission believes that adoption of any of these alternatives would reduce the number of geothermal facilities constructed and result in a diminution of associated environmental impact.

Selected Alternative

The Commission has elected to adopt the rule as proposed with the exception that it has not made a final determination regarding exemption from the Federal Power Act and from state regulation for utility-owned facilities.

V GEOTHERMAL DEVELOPMENT RESULTING FROM THE PROPOSED ACTION

Outline of Analysis

This analysis amends Appendix G of the PURPA EIS. The objective is to determine the location and extent of geothermal development that will result from the proposed action.

The analysis consisted of the following steps: First, information contained in the PURPA EIS was reexamined and tested for currency by soliciting the opinions of utility, industry, and government sources. Based on interviews, it was determined whether the new economic incentives were effective. In particular, the following questions were addressed:

- o Does the increase in maximum size for exemption to 80 MW affect the economic viability of geothermal SPPFs?
- o Does allowance of utility ownership of qualifying geothermal SPPFs increase projected development?
- o Are avoided costs higher than originally estimated?
- o Have new designs or standardization of equipment lowered busbar costs?
- o Have breakthroughs in technology changed the location or type of geothermal reservoir that we expected to be developed?

After determining that new economic incentives did exist, the most promising locations for geothermal development were discussed with utility, industry, and government representatives. In addition, they were queried about the ramifications of raising the limit for an exempt facility from 30 to 80 MW. As a result of these discussions and our examination of published data, projections were made regarding the specific locations and extent of geothermal development that may result from the proposed action.

Results

The revised rule could stimulate the development of more than 1200 MW of capacity for electrical generation from geothermal facilities by 1995 -- 1100 MW more than predicted in the PURPA DEIS. Additional development is anticipated in California, Nevada, and Idaho (see Figure V-1). A detailed breakdown by location is presented in Table V-1.

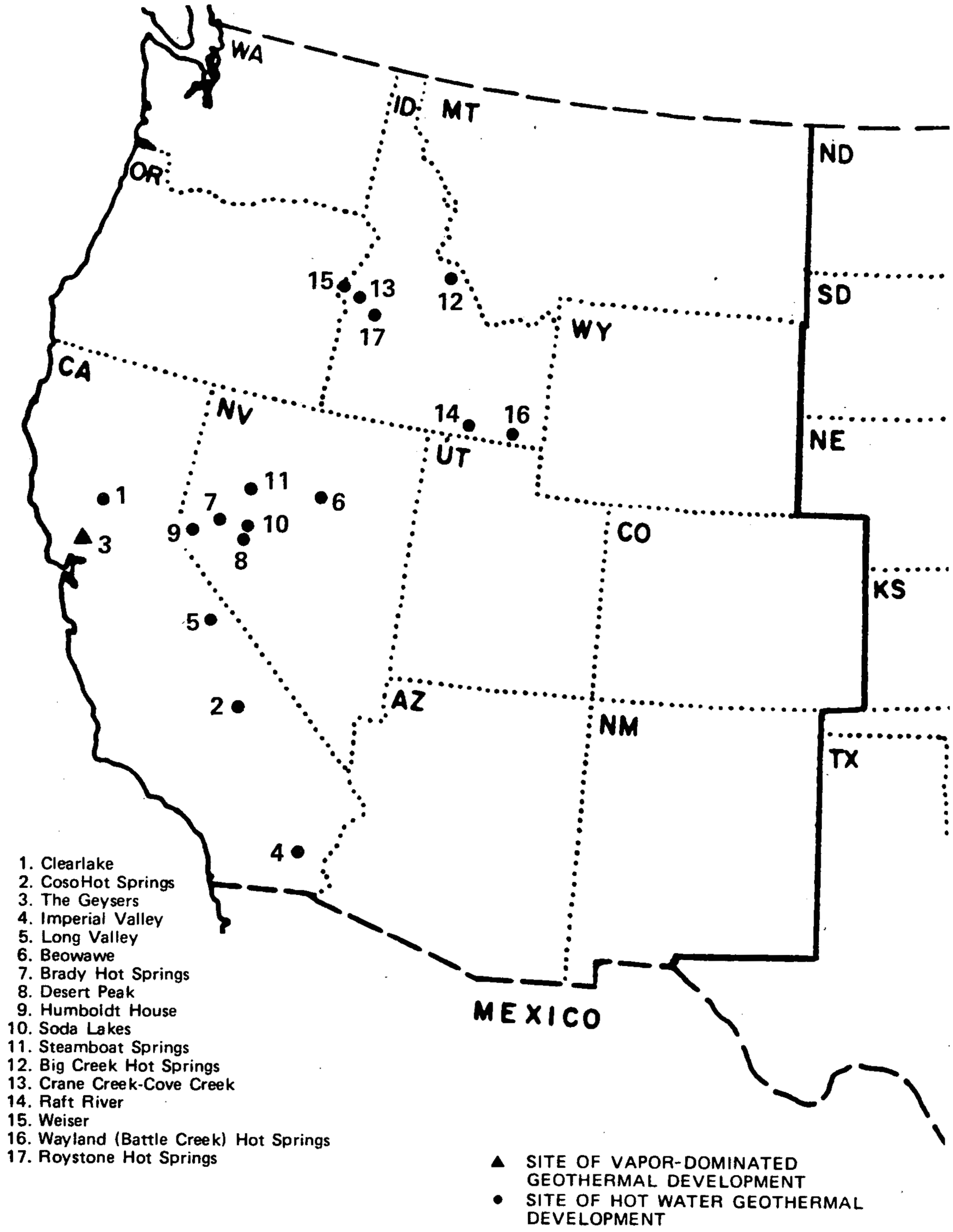

FIGURE V-1. LOCATIONS OF PURPA-INDUCED GEOTHERMAL DEVELOPMENT

Table V-1

PROJECTED LEVEL OF GEOTHERMAL DEVELOPMENT
INDUCED BY THE ACTION, BY LOCATION

State/Field Name	Number of Plants	Projected Development (MW of electrical capacity)	Average[a] Resource Temperature °C
California			
Clear Lake	2	150	190
Coso Hot Springs	1	80	220
The Geysers[b]	1	80	237
Imperial Valley	5	400	175-323
Long Valley	1	10	227
State Total	10	720	
Nevada			
Beowawe	1	80	229
Brady Hot Springs	1	80	155
Desert Peak	1	80	221
Humboldt House	1	40	217
Soda Lakes	1	80	157
Steamboat Springs	1	80	200
State Total	6	440	
Idaho			
Big Creek Hot Springs	1	15	162
Crane Creek-Cove Creek	1	15	171
Raft River	1	25	149
Weiser	1	5	130
Wayland (Battle Creek) Hot Springs	1	15	113
Roystone Hot Springs	1	5	135
State Total	6	80	
Total Development	22	1,240	

a U.S. Geological Survey, 1978.

b Dry-steam resource; all others are hot-water resources.

Avoided-cost pricing of electricity from small geothermal plants, as provided by PURPA, has become a more significant economic incentive as avoided costs have risen and this factor will stimulate the exploitation of geothermal resources. By raising the exemption limit from 30 to 80 MW, geothermal development is further stimulated by allowing development of a size unit that is more economical to produce. By granting qualifiers exemptions from regulation as utilities; and, as an indirect effect, by helping to attract capital from investors even more development is encouraged.

Detailed Approach

Effect of Avoided-Cost Pricing

Avoided-cost pricing means a utility has to pay a developer the same amount of money it would cost the utility to bring that added capacity on line (i.e., if it costs a utility 50 mills/kWh to add or replace generating capacity, the utility is required to pay that same amount to a PURPA developer).

The avoided-cost pricing provisions of PURPA will stimulate the generation of electricity from small geothermal power plants for two reasons:

(1) Avoided costs are rising to the point where geothermal electricity is more competitive.

(2) Developers, knowing that electricity can be sold at avoided cost, may choose to build a power generation plant rather than selling steam.

Avoided costs are rising to the point where geothermal electricity is more competitive. When the PURPA DEIS was prepared, avoided costs were estimated to be 50 mills/kWh in the Pacific Region. Actual avoided costs calculated by the northern California utility, Pacific Gas & Electric (PG&E), for the May 1, 1980 to July 31, 1980 quarter, averaged 51 mills/kWh (energy-only). For the November 1, 1980 to January 31, 1981 quarter, energy-only costs are projected to rise by 11.8% to 57 mills/kWh (Stearns, 1980). If an annual rate of increase in avoidable cost of 15% (about two-thirds of the current rate) is assumed, avoided costs will exceed 67 mills/kWh by 1982 for PG&E.

At these avoided costs, a hot water (150°C or hotter) geothermal resource can compete with traditional energy sources. Magma Power has contracted with San Diego Gas and Electric to provide electricity from a 50-MW plant in Imperial Valley at 65 mills/kWh in 1982 (Aidlin, 1980). Another industry source asserted that he could make a profit from a 10-MW plant if power could be sold at 60 to 62 mills/kWh (Asher, 1980). Most industry sources agreed that geothermal energy from hot water reservoirs is competitive with avoided costs in California (Harben, 1980; Holte, 1980; Lindwall, 1980; Smith, 1980). Sierra Pacific Power Company heads a five-utility combine, including firms from Oregon and Idaho, and plans to come on-line in 1982 with a 10-MW plant that is expected to produce electricity at competitive rates (Hamlin, 1980; Justice, 1980; Richards, 1980).

Hybrid facilities using warm water (150°C or cooler) geothermal resources and wood-waste to generate electricity might also become economically feasible at these levels of avoided cost. A site near Susanville, Lassen County, California, is being studied for a demonstration facility by the U.S. Forest Service, U.S. Department of Energy, California Department of Water Resources, and Geoproducts Corporation (Boren, 1980; Van Dixen, 1980; Willard, 1980). The proposed plant would produce 55 MW of electricity, using wood-waste and 121°C geothermal water (Boren, 1980). The economic feasibility of this facility has not yet been established, but total generation costs will be more sensitive to the cost of wood than warm water (75% on the cost of wood, and 25% on the cost of warm water, Boren, 1980).

As avoided costs rise, technological developments may also lower busbar costs, making geothermal power less expensive. The plant that will be tested by Sierra Pacific Power Company is a 10-MW binary facility designed around a portable module (Asher, 1980; Bordley, 1980). If this unit is successful, equipment prefabrication could result in cost savings of about 50% compared to on-site construction (Bordley, 1980).

The avoided-cost pricing provisions of PURPA are affecting development decisions. Undeveloped geothermal resources in Nevada are already perceived by their owners to have increased in value because of the passage of PURPA. Some producers speculate that PURPA could entice them to enter the power generation business -- a step they would not have otherwise considered (Aidlin, 1980; Lindwall, 1980; McQueen, 1980). As a result of PURPA, Occidental Petroleum is considering building a 75-MW generation plant on its two leases in The Geysers region of California, rather than merely selling steam as do most producers in that region (Simmons, 1980).

Under PURPA, producers can realize returns from their exploration activities more rapidly than otherwise because they are in a more favorable position in their negotiations with a utility. In the past, the development scenario generally worked in the following manner: To prove that the field was commercial, the producer would negotiate to sell steam to a small plant operated by a utility. Once commercial feasibility was demonstrated, the producer would negotiate with the utility to sell steam for full-scale exploitation of the resource (Harben, 1980). This process was often arduous and time-consuming (Asher, 1980; McQueen, 1980). For example, Union Oil Company resorted to building a demonstration plant in the Imperial Valley while trying to find a utility to operate it (Smith, 1980). PURPA offers producers the opportunity to market a more salable product -- electricity -- by affording an economic incentive for building their own plants (Aidlin, 1980). In these times of high interest rates, reducing the delay between the investment in exploration and the eventual returns will provide an important economic incentive for development of small geothermal facilities.

Effect of Exemption from PUHCA

Rather than directly owning a geothermal facility, a company sometimes find it advantageous to organize a separate corporation or partnership to own a geothermal facility. The principal advantage of this form of ownership is the ability to rely on "project financing" by the entity organized to build or acquire the generating facility. The advantages of this form of organization were described by the Securities and Exchange Commission:

> This permits the sponsoring utilities to finance the facility through issuance of long-term securities (by the entity organized to acquire or build the facility) that are not subject to the mortgage bond indentures of the sponsoring companies. It also provides flexibility with respect to the kind of security issued and the amount of debt used to finance the project. In addition, (for jointly-owned projects) the proportionate interests of the participants in the new facility can be altered as load forecasts change and new participants in the project can be admitted by a transfer of the voting securities, which avoids the delay and expense of obtaining a release under a sponsoring utility's indenture, a step that is always necessary in cases involving the transfer of an undivided ownership interest. (Holding Company Act Release, No. 21661, July 22, 1980)

An added advantage which is especially important in the development of an experimental and relatively high-risk technology such as geothermal generation, is the ability of a sponsoring company to insulate itself from the consequences of a default on the financial obligations for the geothermal facility under cross-default provisions in their own mortgage.

The companies contacted expressed a desire to avoid being regulated as a holding company if they constructed electric generating plants (Aidlin, 1980; Fernandes, 1980; Harben, 1980; McQueen, 1980; Holte, 1980; Weinberg, 1980).

Another positive effect of the rule change is related to financing of geothermal projects. The geothermal investment tax credit and the federal loan guarantee program have reduced the risk of investment in geothermal development (Richards, 1980). However, the investment tax credit may not be available to utility-owned facilities. Providing capital for geothermal power generation facilities could appeal to investors seeking tax shelters (e.g., insurance companies or banks), but only if these investors could remain immune from regulation as utilities (Falcone, 1980; Rowdzianko, 1980). Large oil companies might be willing to spend money to develop their geothermal holdings by establishing subsidiary firms to isolate their investment in risky geothermal development from the bulk of the parent company's capital; however, this approach would only be attractive if they can remain free from regulation (Harben, 1980). One utility indicated that it would have an easier time entering into development partnerships if an investor could assume an equity position in a facility and not be subjected to regulation as a utility (Holte, 1980).

Effect of Raising the Maximum Size for Exemptions

Increasing the size of the facility that can qualify for an exemption from the Federal Power Act and other laws and regulations governing utilities will stimulate geothermal development for two reasons:

(1) The higher exemption limit allows producers to develop an economically sized plant, yet still qualify for exemption.

(2) The raised exemption limit will attract more investors that can take advantage of the Geothermal Act investment tax credit and the federal loan guarantee program.

These points are explained in detail below.

Increasing facility size from 30 to 80 MW could make the difference between merely demonstrating feasibility and actually exploiting a geothermal resource economically (Asher, 1980; Rex, 1980). The cost per unit of electricity generated is 20% to 30% less in an 80-MW facility than in a 30-MW facility (Rex, 1980). Although one firm is working on a technology that would allow development in 10-MW modules (Anderson, 1980; Asher, 1980; Bordley, 1980), most producers cite 50 to 55 MW as the threshold size for an economically feasible plant (Aidlin, 1980; Lindwall, 1980; Smith, 1980). Placing two 55-MW units in one facility seems to be the preferred mode of development (Smith, 1980), but most producers believe that raising the exemption limit to 80 MW is a positive step (Aidlin, 1980; Fernandes, 1980; Lindwall, 1980; McQueen, 1980; Rex, 1980).

Smaller companies that specialize in geothermal development indicated that raising the qualifying limit would help them attract investors (Aidlin, 1980; Asher, 1980; Yamagata, 1980). Therefore, the PURPA rule change should help capital formation for geothermal development and encourage the construction of generating facilities.

Effects of Allowing Utility Ownership*

In the revised rule, the advantages of the exemption apply to utilities as well as nonutilities. The utilities can form subsidiaries that are exempt from PUHCA, as well as from certain sections of the FPA and some state regulations. In addition, they can sell electricity generated from facilities of 80 MW or less at avoided cost.

As a result, the option of utility development of a geothermal resource becomes more attractive. Utility sources felt that exemption from PUHCA was important (Holte, 1980; Weinburg, 1980; Malinowski, 1980; Barnette, 1980). The subsidiary could lease and develop the resource itself or it could enter into a partnership with other companies to develop the resource. One utility felt that partnerships between utilities and equipment manufacturers could help encourage development (Myers, 1980). Some felt that attracting capital would be easier because investors could be compensated for risk (Myers, 1980; Malinowski, 1980; Barnette, 1980). Generally, the utilities stated that development would be encouraged; however, they were uncertain whether the exemption would directly induce development. Moreover, they were uncertain of the effect it may have on their own plans to develop geothermal resources (Barnette, 1980; Malinowski, 1980; Myers, 1980; Adams, 1980). Because of these uncertainties, an attempt to isolate the utility component of the projected development is unwarranted.

Projected Location and Extent of Development

Near-term PURPA-induced development is forecast in California, Nevada, and Idaho. Avoided costs in California are becoming high enough to induce development within that state. In Nevada, Sierra Pacific reports avoided costs (for energy only) of 38.5 mills/kWh, based on oil (Richards, 1980). As oil rises in price, avoided costs in Nevada are expected to reach levels at which geothermal electricity can compete; if not, the high-demand California market is nearby. Avoided costs in Idaho are expected to be over 50 mills/kWh in 1981 (Eastlake, 1981).

No project-specific near-term PURPA-induced development was projected in Alaska, Hawaii, Oregon, Washington, Utah, or New Mexico, even though these areas are currently being explored. Over the next 15 years, demand for electricity in Alaska should remain low, and less expensive sources of power are available. In Hawaii, the good geothermal resource is on the sparsely populated Island of Hawaii, but the demand for power is on Oahu. The technology to transmit electricity long distances by undersea cable economically does not yet exist, and therefore no PURPA-induced development is forecast. Nor does technology to economically develop the geopressured resource in the Gulf States yet exist.

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* The element was not adopted in the rule. See IV-3.

In Utah, New Mexico, and California, geothermal development has occurred and will occur that is not directly attributed to PURPA. In Utah, a power plant is being built at Roosevelt Hot Springs (Harben, 1980). In New Mexico, development will occur at Valles Caldera (Lindwall, 1980). However, avoided costs should remain low in each state because of the proximity of coal deposits. One observer predicts that when new coal-fired plants have to be built, pollution control devices costing 10 to 20 mills/kWh will need to be incorporated into the cost of the plant. If so, PURPA could induce some geothermal development in those two states (Rowdzianko, 1980). For the purpose of this analysis it is assumed that this development will not occur before 1995. In California, development of a hybrid woodwaste-geothermal facility may occur in Lassen County (Boren, 1980; Van Dixen, 1980; Willard, 1980). However, PURPA played no part in inducing this proposed project (Johnson, 1980).

In the Pacific Northwest, geothermal development may occur. In Idaho, a 5 MW binary plant supported by DOE is currently operating at Raft River. Additional small binary plants may be developed at several locations, including Roystone Hot Springs, Big Creek Hot Springs, Raft River, Weiser and Wayland (Battle Creek) Hot Springs. A total of 80 MWs induced by PURPA is forecast for Idaho. In Oregon and Washington, known geothermal resources exist. Exploration is occurring and development is being encouraged (Bloomquist, 1981; Philbrick, 1981). Although development will probably occur, none is directly attributed to PURPA inducement at this time (Philbrick, 1981).

The situation in the area of the Pacific Northwest served by the Bonneville Power Administration (BPA) may change. The Pacific Northwest Electric Power Planning and Conservation Act of 1980 grants enhanced authority to BPA enabling the agency to purchase power at avoided cost. Thus, future actions by BPA coupled with PURPA may encourage future geothermal development in Washington, Oregon and Idaho.

Hybrid facilities have not yet been proven technically or economically feasible. If the demonstration plant in Lassen County is successful, hybrid facilities could potentially be built anywhere that wood resources and warm water resources are found together in commercial quantities. Northern California, Oregon, Washington, and Idaho are the most likely locations (Van Dixen, 1980), but in these areas, competition among processors to obtain wood fiber supplies is already keen, and the economics of hybrid development depend much more on the costs of obtaining wood than on water costs (Boren, 1980). The value of wood for fiber, rather than energy, the environmental constraints on timber harvesting, particularly in federal forests, and the costs of transporting low value material to a central point for generating electricity, provide substantial barriers to hybrid development. Therefore, no significant PURPA-induced hybrid development is forecast before 1995.

Projections for geothermal development to 1995 are based on utility, industry, and government contacts and published documents (USGS, 1978; Garside and Schilling, 1979). Included in these estimates are all small power generation facilities for which the decision to construct the facility could be attributed to PURPA. Because of the limitations cited above, only vapor-dominated, dry-steam systems (The Geysers) and high-temperature (more than 150°C) hydrothermal convection systems (SRI, 1980; USGS, 1978) seem likely to be developed. Eliminated from consideration were areas in states where geothermal energy is unlikely to compete on the basis of avoided costs or where sources stated that other barriers to development existed. In the states that remain (California, Nevada, and Idaho), reservoirs included in the analysis were those mentioned by parties contacted as likely sites for development. Estimated capacity for each site is assumed to be the maximum size facility that would qualify under PURPA -- 80 MW -- unless more specific information about the potential resource was available.

VI GEOTHERMAL RESOURCE

Resource Characteristics

Background

Geothermal energy is heat energy contained in the earth. The temperature difference between the earth's mantle—composed of molten rock called magma--and the earth's surface causes the heat to flow toward the surface. Where the earth's crust permits surface or near-surface water to come in contact with the hot magma, or with rock that has been heated by the magma, steam or heated water results. This steam or heated water sometimes appears at the surface, manifested as geysers, fumaroles, or hot springs (see Figure VI-1).

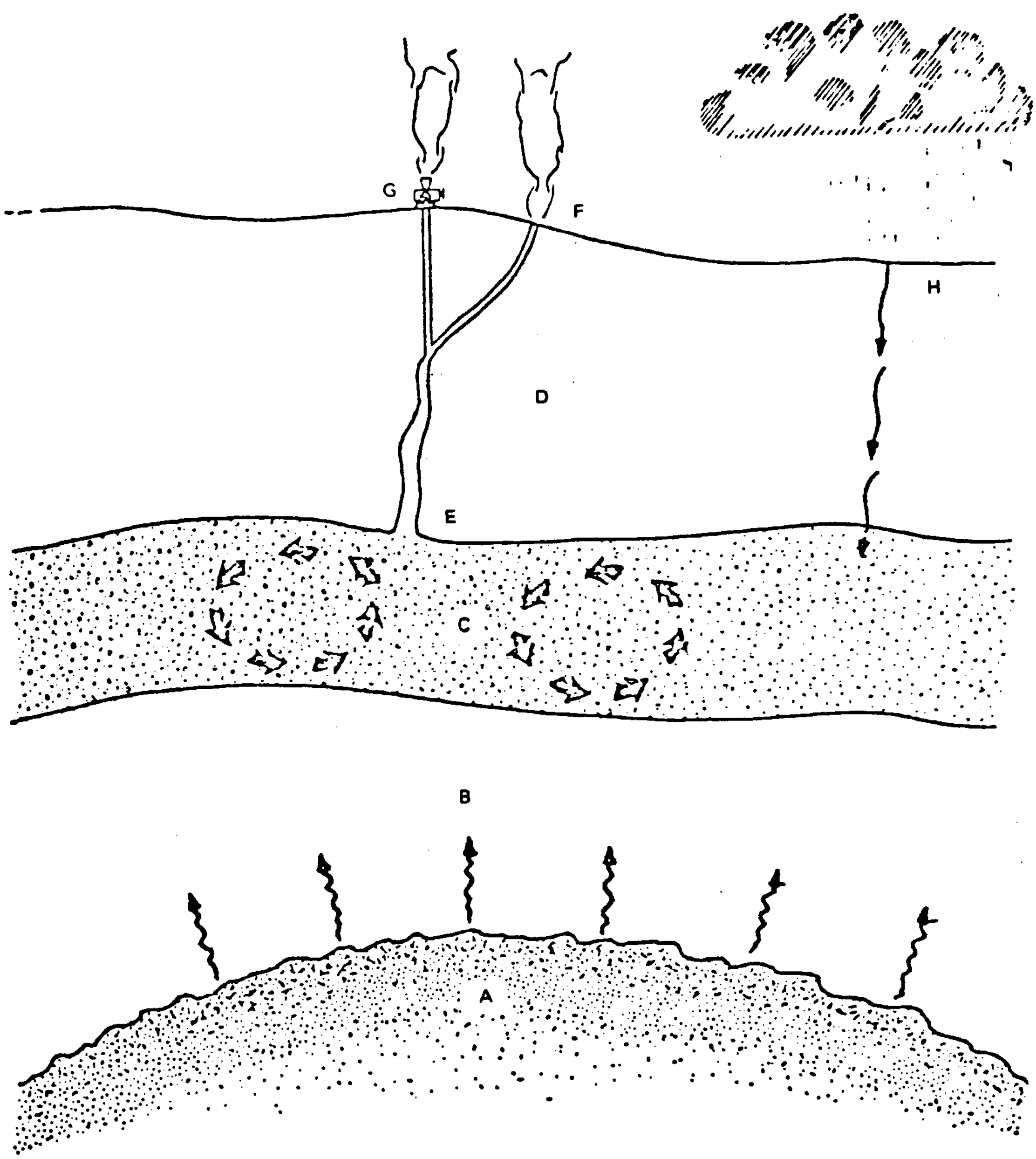
Generation of electricity from naturally occurring steam was first undertaken at Larderello, Italy, in 1904. Geothermal electricity generating stations also have been established in New Zealand, Japan, Iceland, the USSR, and Mexico. The world's largest installation, and currently the only major one in the United States, is found at the steam field known as The Geysers in Sonoma County, California.

Geothermal Hydrothermal Convection Resources

Geothermal resources are normally divided into four broad categories: vapor-dominated hydrothermal convection systems; liquid-dominated hydrothermal convection systems; hot-igneous systems (including both hot-dry-rock deposits and magma systems); and geopressured deposits. This report covers only vapor-dominated and liquid-dominated convection systems because these two system are believed to be the only ones that PURPA will induce by 1990.

In hydrothermal convection systems, heat is transferred by the convective circulation of steam (vapor-dominated) or of water (liquid-dominated). However, most hydrothermal convection systems deliver a mixture of hot water and steam at the wellhead. In vapor-dominated hydrothermal convection systems, steam with minor amounts of other gases is produced. Most liquid-dominated hydrothermal convection systems are characterized by hot springs that discharge at the surface, occasionally together with some steam. Some liquid-dominated hydrothermal convection systems, however, are capped by impermeable rocks or exist where the local water table is far below ground level and thus do not discharge at the surface.

The temperatures of liquid-dominated systems can vary dramatically. Normally, systems with temperatures above 150°C are considered good possibilities for the generation of electricity (USGS, 1979).



A	Hot Magma	E	Thin Break in Cap
B	Very Low Permeability Rock	F	Surface Geysers, Fumaroles, or Hot Springs
C	Porous Rock	G	Well
D	Low Permeability Rock	H	Rain Percolation

Source: Freeman et al., 1977

FIGURE VI-1. CROSS SECTION OF A GEOTHERMAL REGION

Chemistry of Geothermal Sources

Geothermal fluids differ greatly in their chemical and physical characteristics from resource area to resource area and even between wells within the same area. Such variations make it difficult to estimate emissions from geothermal power plants accurately.

The common contaminants from vapor-dominated sources are carbon dioxide (CO_2), methane (CH_4), ammonia (NH_3), hydrogen sulfide, (H_2S), nitrogen (N_2), and boric acid vapor. Radon gas and mercury vapor in low concentrations are also common (Griffin et al., 1974; Kruger et al., 1977). Low concentrations of arsenic have also been found in the steam from wells at The Geysers (Griffin et al., 1974). Hydrocarbons, primarily CH_4 with much smaller quantities of ethane and yet smaller concentrations of benzene, have also been reported (Nehring and Truesdell, 1978; Nehring, 1979).

Liquid-dominated sources may contain numerous dissolved chemical compounds (Shannon et al., 1978). Sodium, potassium, and chloride ions commonly are the largest constituents, and calcium is frequently also a major constitutent. Silica also appears. Gases include CO_2, H_2S, and NH_3. H_2 and hydrocarbon gases (CH_4 and smaller quantities of ethane and higher hydrocarbons) may be present, as well as minor amounts of N_2 and radon gas. Boron is commonly present in the form of boric acid, which is volatile in steam (Zerwas, 1979).

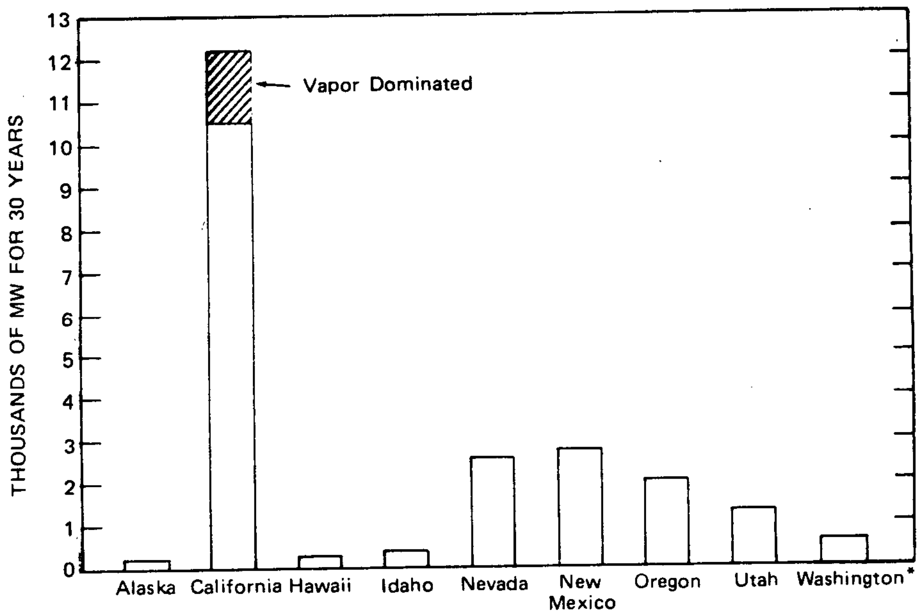
In addition to the major constituents, geothermal liquids (or brines) may also contain smaller quantities of fluoride, bromide, iodide, and sulfate ions. A wide variety of metal ions may also be present, ranging from lithium, aluminum, barium, arsenic, and strontium to heavy metals such as copper, zinc, lead, cadmium, mercury, and arsenic (Zerwas, 1979).

Energy Potential From Geothermal Resources

The nation's energy potential from vapor-dominated and liquid dominated hydrothermal resources is estimated to be the equivalent of 22,600 MW generated for 30 years (USGS, 1979). This estimate is only for identified resources; the energy potential for undiscovered resources could be considerably higher. Figure VI-2 depicts the geothermal energy potentials in several western states and Hawaii. Geothermal development may eventually take place in areas other than those described in this DSEIS. Figure VI-3 shows the areas in the western U.S. classified by the U.S. Geological Survey as having known geothermal resources as of December 1970.

Geothermal Development and Production

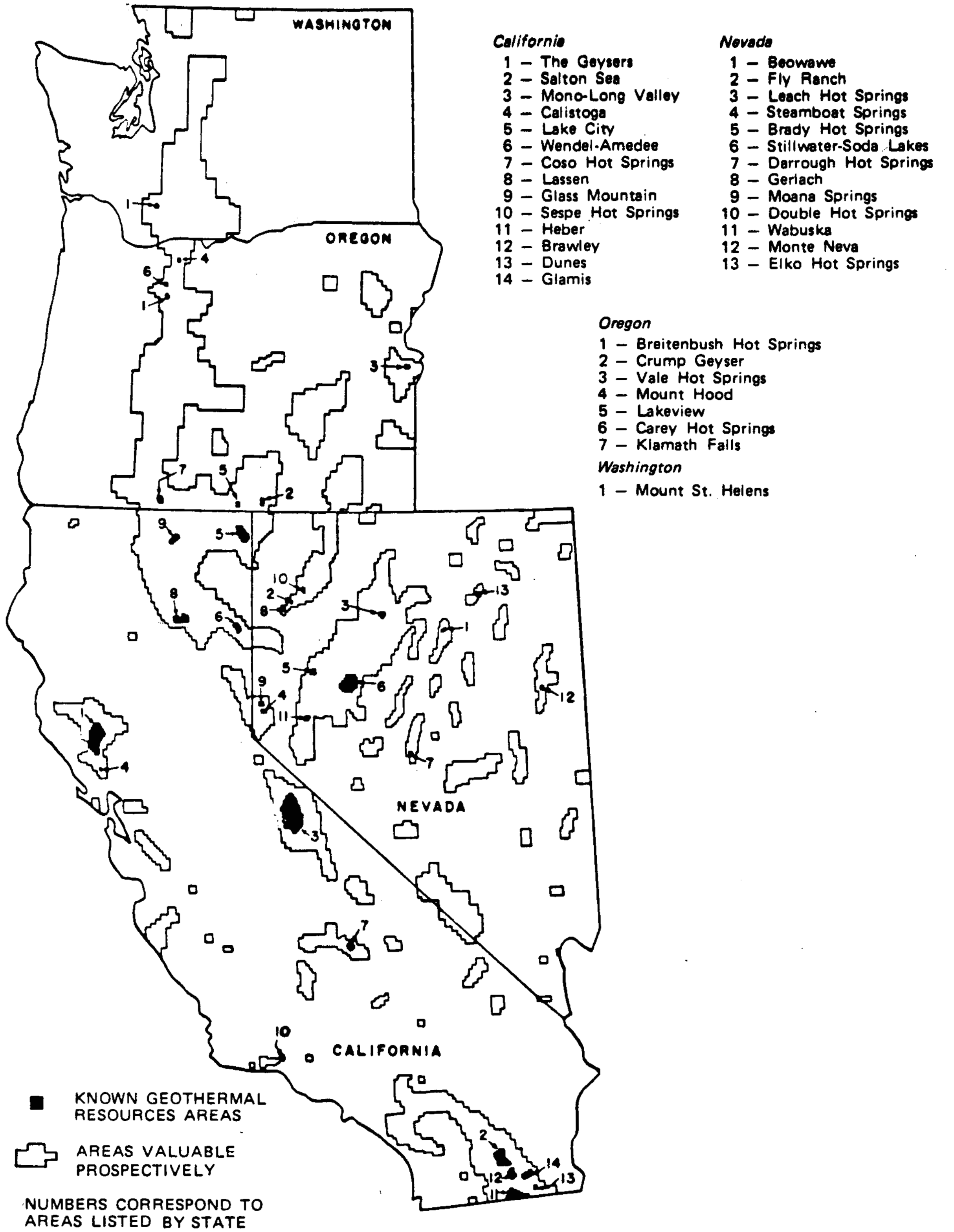
Development and production of geothermal resources are normally carried out in five phases: exploration, test drilling, production testing, field development, and power plant energy production.



Source: Adapted from LLL, no date

* Bloomquist, 1981

FIGURE VI-2. ENERGY POTENTIALS FOR GEOTHERMAL RESOURCES IN EIGHT WESTERN STATES



SOURCE: Adapted from L. H. Goodwin et al., "Classification of Public Lands Valuable for Geothermal Steam and Associated Geothermal Resources," U.S. Geological Survey Circular 647 (Washington, 1971)

FIGURE VI-3. LANDS CLASSIFIED FOR GEOTHERMAL RESOURCES (Effective December 24, 1971)

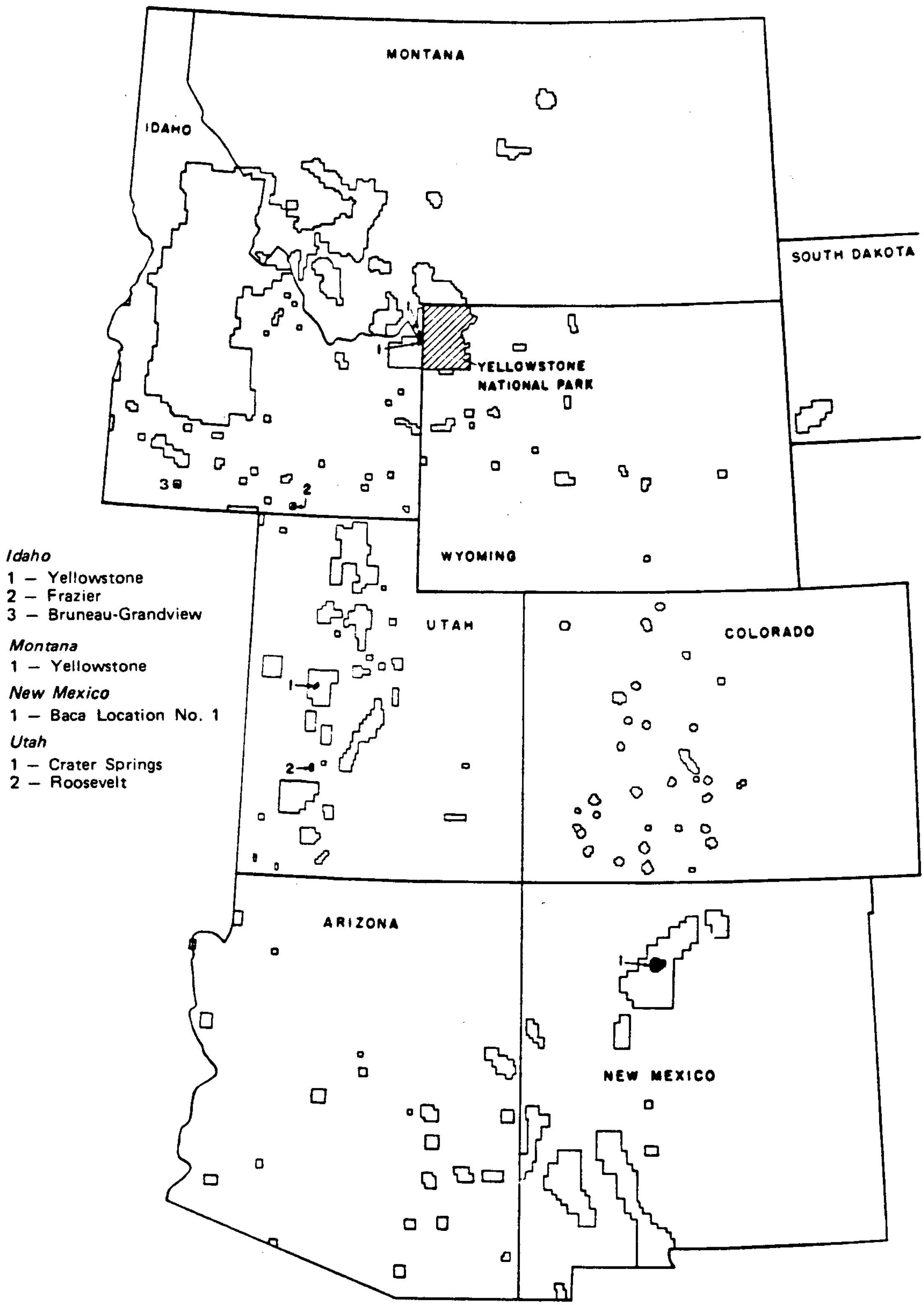


FIGURE VI-3. (Concluded)

Exploration activities typically are surface-oriented investigations, and may involve construction of temporary access roads or trails, clearing of vegetative cover for an exploration site, and movement of heavy equipment and vehicles cross-country. Test drilling generally entails using oil and natural gas rotary-drilling equipment from 15 to 60 days, depending primarily on the depth of the hole. The drilling process in geothermal areas is comparable to other well drilling, except that it is modified for entering hot ground strata and for encountering hot fluids or steam that may be corrosive.

In production testing, a well that has penetrated a potentially productive geothermal zone is first cleaned out. The flow rate, composition, and temperature of fluids and gases, as well as other physical properties of the reservoir fluids are then determined. Field development takes place after an initial well has been tested. Access roads must first be constructed. A liquid waste holding pond or sump is excavated and lined with plastic film or gunite at each potential drill site. A portable drill rig is used to drill the wells sequentially.

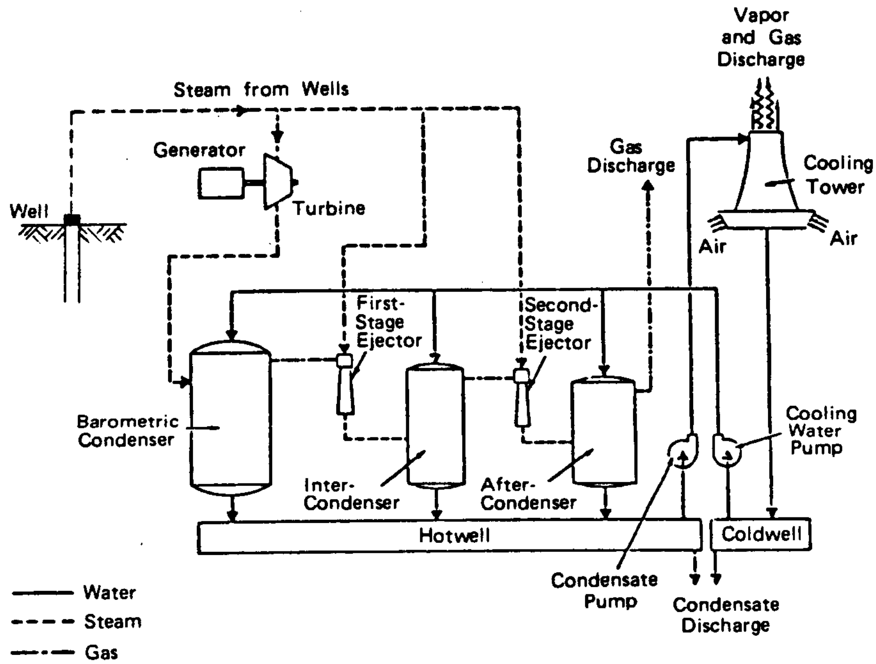
Several production wells are required to supply a power generating unit. Successful wells are "shut in," usually with only the wellhead equipment above ground while additional wells are being drilled. Insulated steel pipelines are then constructed to carry the steam from the shut-in wells to the power generation unit.

Conversion Technologies

The method selected to convert geothermal energy to electricity depends on whether the geothermal reservoir is vapor-dominated or liquid-dominated. The resource in a vapor-dominated reservoir may be used almost directly in the generating turbines. However, in a liquid-dominated reservoir, the production of electricity requires the use of a single- or multiple-flash system, a binary system, or a combination of flash and binary (Zerwas, 1979).

In the vapor-dominated system, steam travels to the power plant through a series of pipelines. At the plant, the steam directly drives the turbine and the gas ejectors. Noncondensable gases travel through the turbine, and most are ejected to the atmosphere. Some of the gases remain in the condensed water and are pumped to the cooling tower where they are released to the atmosphere. Small quantities of these gases may remain in the water, and may appear in the condensate discharge in the cold well (Zerwas, 1979). Figure VI-4 depicts a typical vapor-dominated power generation unit at the The Geysers in California.

Figure VI-5 shows the typical system for a liquid-dominated reservoir. It uses a cyclone separator to flash steam from the liquid water and to separate it for transmission to the power plant. The noncondensable gases are carried with the steam to the power plant. At Cerro Prieto (Mexico), Wairakei (New Zealand), and in Japan a



Source: Martin et al., 1978

FIGURE VI-4. SCHEMATIC DIAGRAM OF A TYPICAL VAPOR-DOMINATED GEOTHERMAL POWER PLANT conventional hot water approach using single, double, or even triple flashing of the liquid is employed (Zerwas, 1979).

A second approach for hot water reservoirs is the binary fluid cycle (see Figure VI-6), in which the hot liquid from the geothermal resource is used to heat a second fluid that then operates the turbine. A hybrid process for hot water, which involves flashed geothermal liquids to heat a secondary working fluid in a binary cycle, is also possible.

A hybrid fossil geothermal power plant combines a fossil-energy fuel together with a geothermal resource at a single location in a geothermal field*, enabling optimum utilization efficiencies of each of the resources. Hybrid plants fall generally into two categories: 1) geothermal preheat system or 2) fossil fuel superheat system. In the geothermal preheat system, geothermal fluids are run through a heat exchanger to preheat the water which is then pumped to the boiler. In doing so, steam that would have to be bled from the turbine in a standard fossil-fueled energy conversion system for feedwater heating can now be utilized in the turbine. Thus, the geothermal preheat system enables an increase in the turbine output without using more fossil fuels. In the fossil fuel superheater systems, a fossil-fueled superheater is placed in front of the turbine in a standard geothermal steam power plant. This location of the superheater reduces the amount of moisture going to the turbine and thus increases the overall turbine efficiency.

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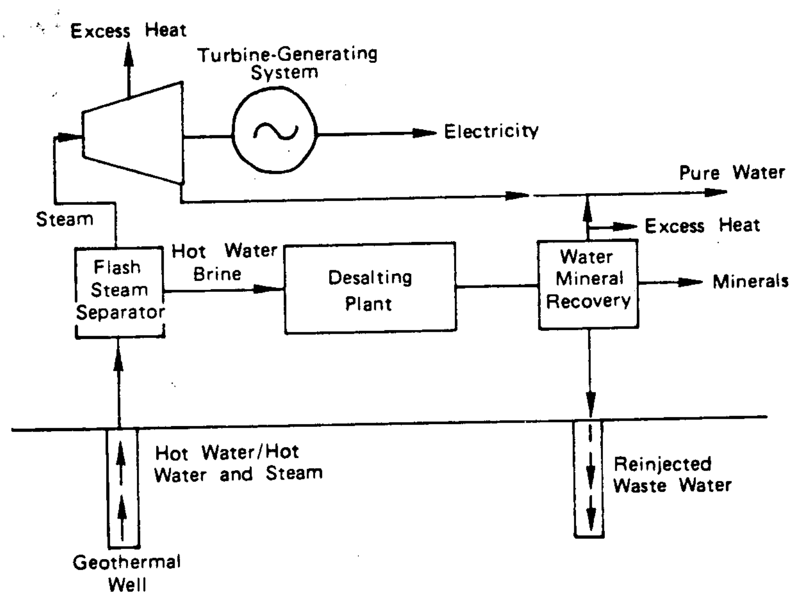
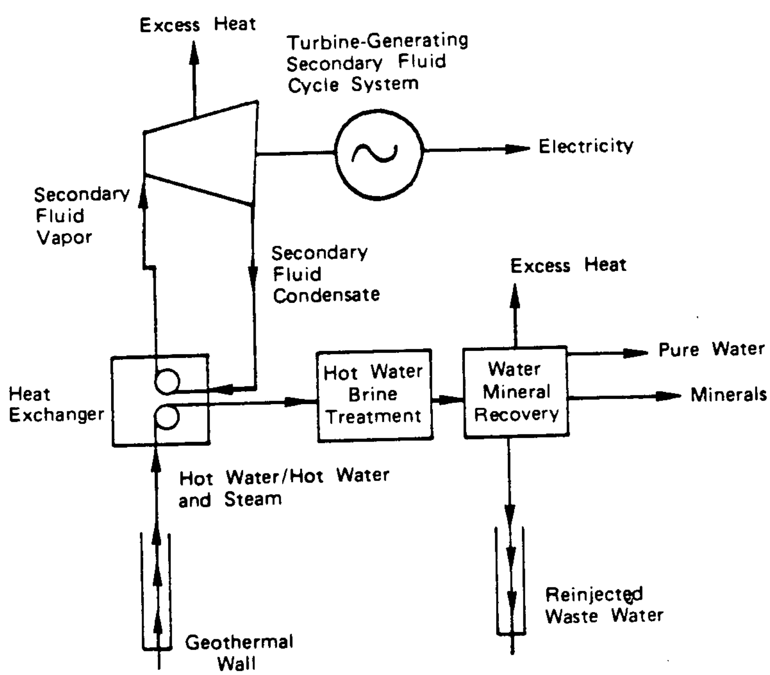
* This location is chosen because of the physical and economic impracticalities of transporting geothermal steam or hot fluid over distances exceeding about 2km.



Source: Cheremisinoff, 1976

FIGURE VI-5. FLASHED-STEAM CYCLE



Source: Cheremisinoff, 1976

FIGURE VI-6. BINARY-FLUID CYCLE

VII ENVIRONMENTAL EFFECTS OF GEOTHERMAL DEVELOPMENT

This section addresses the environmental effects normally associated with geothermal development, as well as some methods for dealing with those effects. Table VII-1 summarizes these effects for the major developmental steps. Environmental implications by resource area associated with geothermal resource development that PURPA may induce are highlighted, followed by brief geographic descriptions of areas where PURPA-induced geothermal is anticipated.

General Environmental Implications of Geothermal Development

Air Quality

Although air quality impacts anticipated to result from a single 80 MW geothermal facility would usually be minor on a national or regional basis, local effects may be significant because of highly site-specific factors. In addition, the cumulative effect of emissions from several facilities in the same geographic area may create significant air pollution concerns. The complex geochemistry of the geothermal resource itself is exemplified by the variation in concentration of noncondensable gases from wells within each resource area and also by the changes that take place over time (U.S. DOE, 1980). Such variations make it difficult to estimate emissions of gases from geothermal facilities accurately (see Tables VII-2 and VII-5, VII-6). Noncondensable gases are principally emitted by condenser gas ejection, cooling tower exhaust, power plant by-passing during shutdown, and well venting (U.S. EPA, 1978).

Hydrogen sulfide (H_2S) appears to be the most troublesome of the gases because of its objectionable odor, even at very low concentrations (Bowen, 1973). H_2S released at the well head during drilling or within the power-generating facility itself may be in high enough concentrations to cause discomfort (see the Health and Safety section of this chapter). However, no evidence exists that H_2S occurs in ambient concentrations at levels that could cause or contribute to the endangerment of public health and welfare. To date, no National Ambient Air Quality Standard (NAAQS) has been established for H_2S, although it is a pollutant subject to regulation. The EPA is currently considering a New Source Performance Standard (NSPS) for geothermal electric generating facilities (Hedeman, 1981).

NAAQS for other noncondensable gases, such as ammonia, radon and mercury, may be developed. Although the option is available, it does not presently appear likely that any of the gases emitted from geothermal facilities will be regulated by the effects-based ambient air quality criteria and ambient standards, nor by the hazardous air pollutant

Table VII-1
ENVIRONMENTAL MATRIX FOR GEOTHERMAL DEVELOPMENT

ASPECTS OF THE ENVIRONMENT	EXPLORATION	PRODUCTION DRILLING AND TESTING	PARALLEL FIELD DEVELOPMENT OPERATIONS	PLANT CONSTRUCTION	FULL-SCALE OPERATIONS
	• Mapping/field studies • Drilling pad construction • Test drilling (shallow and small diameter) • Temporary roads/traffic • Equipment operation	• Well drilling and construction (production and reinjection) • Well stimulation • *Accidental blowouts* • Well testing/venting, ponding/reinjection	• Land clearing and roads/ vehicular traffic • Gathering systems • *Equipment activities* • Service living quarters • Water, sewage, temporary electricity, and other supporting services	• Structures and improvements • Vehicular traffic/equipment • Activities • Special construction activities (e.g., blasting) • Electric transmission systems • Supporting services (e.g., water, electricity)	• Cooling towers • Venting (during short-term outages) • Well-head bleeding • Reinjection • Recharge, stimulation, and redrilling • *Corrosion and scale control* • Gaseous, liquid, and solid wastes • Work force movement • Abandonment
Air Quality	H	L/H	L	L	L/H
Water Resources	L	L/H	L/M	L	L/H
Wildlife and Vegetation	L	L/M	L/M	L/H	L/M
Geology and Soils	L	L/M	L/M	L/M	L
Noise	H	M/H	M	M	L/M
Social, Economic and Cultural	L	L/M	L/H	L/H	L/H
Health and Safety	L	M	L	L	L/H
Land Use	L	L	L/H	L/H	L

H = High potential impacts; long-term *and/or great intensity*

M = Moderate potential impacts; major short-term and/or overshadowed effects

L = Low/negligible potential impacts; minor and/or short term

SOURCE: Adapted from "A Technology Assessment of Geothermal Energy Resource Development" NSF/RANN, April 15, 1975.

Table VII-2

MAJOR NONCONDENSABLE GASES FROM GEOTHERMAL WELLS

	Typical Emissions (g/MWh)	Significant Environmental Effects	Applicable Environmental Regulations	Control Likely
Carbon dioxide	80,000 - 100,000	None	None	No
Ammonia	400 - 2,000	None	Occupational standards only	No
Methane	300 - 3,000	None	None	No
Hydrogen sulfide	50 - 1,200	Odor; high concentrations are occupational hazard	State ambient standards and proposed emissions limits	Yes
Mercury	0.09 - 0.7	Toxic	Federal standards	Possibly
Radon	40,000 - 50,000	Radiation hazard	Federal standards	Possibly
Trace metals	—	Toxic	--	Unknown

provisions of the Clean Air Act (EPA, 1978). The states, however, through their State Implementation Plans still retain the option of imposing more restrictive limitations.

Where geothermal electric generating facilities are proposed in Air Quality Attainment Areas and it is determined that a facility will emit more than 250 ton/y of any pollutant subject to regulation, a review under the Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act will also take place. The effect of PSD and visibility regulations on geothermal development is uncertain. Aside from the local vapor plume, no primary pollutants are emitted that affect visibility. Therefore, it may be assumed that visibility regulations protecting Class I areas will have little effect on geothermal facilities.

The Clean Air Act provides for regulation of emissions of radioactive substances, cadmium, and arsenic--all of which may be found in geothermal fluids. Emissions of these substances from geothermal facilities are likely to be regulated if they are found to be in environmentally significant quantities (EPA, 1978).

Treatment technologies have been developed specifically for controlling H_2S emitted from geothermal facilities. H_2S, as mentioned previously, is unique among geothermal air pollutants in that its control has been principally forced by its odor, rather than by health effects (EPA, 1978). Five candidate processes exist for removal of H_2S from power plant effluent:

- The EIC Corporation copper sulfate ($CuSO_4$) process
- The Stretford process
- The Dow Oxygenation procedure
- The iron catalyst method
- Scrubbing with spent geothermal fluids (U.S. DOE, 1980; EPA, 1978).

Removal procedures vary from site to site and are based on the composition of the geothermal resource.

The EIC process in which steam or noncondensable gases are reacted with a solution of $CuSO_4$ to form insoluble copper sulfides has been tested by Pacific Gas and Electric Company at The Geysers. Investigations are now under way to devise techniques for commercial separation and recovery of the residual ammonium sulfate $(NH_4)_2SO_4$ and boric acid. Research is now being carried out at SRI International under EPA and DOE funding on the electrolytic reduction of H_2S in brine solutions, this may prove to be another technique for direct abatement in the liquid resource (U.S. DOE, 1980; EPA, 1978).

Because nearly all of the H_2S abatement methods will produce a waste sludge by-product, a cross-media environmental impact of concern results. If the brine scrubbing techniques produce economically recoverable heavy metal compounds, a benefit rather than a negative impact would result. Until economical recovery becomes feasible, however, suitable sanitary landfill disposal sites will be required to dispose of the sludges.

Various emission limits for H_2S released from geothermal wells have been proposed or are being considered. These limits would apply to all wells and range from 50 g/MWh proposed by the State of California in Sonoma County, California, to 400 g/MWh being considered by the EPA. Uncontrolled emissions from existing geothermal wells in the western United States range from 160 g/MWh to 1200 g/MWh (White, 1978; Ermak et al., 1979). Depending on the H_2S content of the well, control of as much as 96% of the H_2S could be required if the most stringent control measures were adopted.

Even the most stringent emission control technique, however, is inadequate for preventing the violation of some state ambient H_2S standards, particularly that of New Mexico, which is 0.010 ppm (0.014 microgram/m^3), near the odor threshold. Nevada has no H_2S standard at this time.

Enforcement of a state's ambient standard will be at the discretion of the state or local air quality control agency. The degree of enforcement will probably depend on complaints of odor from local residents. The larger the geothermal field, the more control may be required to reduce odor.

Water Resources

Geothermal development raises three primary concerns related to water resources: (1) Water pollution may result from the disposal of fluids withdrawn from subsurface geologic reservoirs following their use for testing wells or generating power. (2) Large-scale withdrawal and disposal of geothermal fluids may alter the surface and subsurface hydrology of a development area. (3) Geothermal development may deplete local water supplies in the largely arid American West.

Water Pollution

The pollution problems associated with vapor-dominated geothermal systems are generally more manageable than those associated with hot-water systems because the condensate from the geothermal steam is often relatively low in pollutants. However, water pollution can occur during any stage in geothermal development, whether field exploration and testing, production well drilling, construction, or power plant operation.

Sources of Pollution. Muds used during the early stages of well drilling may contain substances harmful to water quality. To prevent the contamination of surface waters, these substances, together with rock dust and the wastewater used in the drilling operation, must be isolated. At many existing developments, sumps with an impermeable lining or steel tanks have been used to store drill cuttings and waste fluid during drilling operations. Nontoxic wastes may be permanently disposed of in a sump if it is protected from erosion; however, toxic wastes must be transported to an approved waste disposal site.

Well blowouts could also create water pollution. The California Division of Oil and Gas requires that blowout prevention equipment be used during the drilling of all geothermal wells.

Erosion and sedimentation associated with the construction of drilling pads, roads, transmission lines, and power plants can degrade the quality of nearby surface waters unless careful monitoring and runoff prevention control measures are implemented.

The most serious water pollution problems are likely to develop during power plant operation. In dry steam geothermal plants, relatively pure steam passes through turbines, is then condensed by contact with cooling water, and is finally evaporated in a cooling tower. Because the cooling tower evaporation rate is slower than the rate at which the steam is fed into the turbines, some of the steam condensate must be removed in another fashion. On the average, 80% of the steam is evaporated through the cooling towers, leaving 20% as blowdown water.

Of the various disposal methods for blowdown water, reinjection to the geothermal reservoir is considered to be the most advantageous because the pollutants in the water do not come into contact with relatively pure surface waters and groundwaters. To ensure that no connection is established between shallow groundwater and deepwater reservoirs, reinjection wells must be carefully encased to prevent the leakage of geothermal condensate to shallow aquifers.

Hot-water systems pose far more difficult water pollution problems than steam-dominated ones because wastewaters from testing and production are more abundant, more water pollutants are contained in the geothermal fluid, and large amounts of cooling water are used. At a typical hot-water plant, more than 75 million liters (20 million gallons) of wastewater per 100 MW of generating capacity are disposed of each day from the condensed effluent and from the excess water that is not flashed to steam. This may be compared with the much smaller quantity of 28 million liters (1 million gallons) per day that is disposed of at The Geysers in California (a vapor dominated resource) for each 100 MW of electricity generated (Berman, 1975).

EPA is presently developing Effluent Guidelines and National Standards of Performance under Section 304 and 306 of the Clean Water Act for surface water discharges from geothermal facilities. These guidelines and standards will eventually provide firmly based effluent limitations and thus establish NPDES permit requirements (EPA, 1978). In the interim the principal base for control is the receiving water standards (40 CFR 120) presently in place, which are periodically updated and revised. The water quality standards are established by the states in concert with EPA.

Waste Disposal

Given the variability in the amount and type of dissolved solids in geothermal fluids, several methods for disposing of wastewater from drilling and power plant operations have been tested and used. They include direct release to surface water bodies, evaporation, surface spreading to shallow aquifers, desalination with subsequent water reuse, and reinjection to the producing reservoir by use of deep wells. The selection of a disposal method depends on local hydrological conditions, the quality of the wastewater, and environmental regulations.

Hydrology

No evidence exists that geothermal development at any operating facilities has altered the area's surface hydrology significantly. However, continued withdrawal of geothermal fluid could reduce the amount of water in the deep steam reservoir, thereby possibly changing the temperature, chemical characteristics, and rate of flow of nearby thermal springs. Drilling of shallow temperature measuring and observation holes during the exploratory phase of development may create a potential route for mixing shallow and deepwater aquifers. In addition, the dewatering process employed at deep excavations and large-scale extraction and reinjection of hot-water geothermal fluids may change the subsurface hydrologic system. Effects such as alterations in groundwater recharge rates, reduced flow to small streams and springs, and drying up of domestic and commercial wells may result.

To prevent alteration of the hydrologic balance of the area, most of the withdrawn fluid must be restored through reinjection. Reinjection wells must be carefully enclosed to prevent leakage of geothermal brines to shallow aquifers.

Subsurface disposal of geothermal waters is regulated by the EPA's Underground Injection Control (UIC) regulations and by state drinking water programs developed pursuant to the Safe Drinking Water Act, as well as by the U.S. Geological Survey's Geothermal Resources Operational Orders which provide for strict regulations for drilling on public lands to protect groundwater. The regulations prescribe detailed standards to be met during all phases of geothermal development activities (40 CFR 146). EPA with the states is presently involved in determining permissible uses for areas designated as primary sources of drinking water. Limitations to developers of geothermal facilities may occur in especially critical areas where open systems are employed (binary systems would probably not be so limited). The draft order to develop state groundwater designations appeared in the Federal Register, November 24, 1980, however, it is not yet a part of the UIC regulatory framework.

Reinjection can also help to maintain the long-term productivity of the geothermal resource. Computer simulation of resource behavior is needed to identify the most effective long-term production strategy (including the rate and method of withdrawal and reinjection) for both hot-water and geopressured reservoirs.

Water Supply

Geothermal power production may also require the use of water for cooling purposes. At The Geysers and other vapor-dominated systems, water in the form of condensed steam eliminates the need for an external source of water. A similar cooling system can be used in a flash turbine hot-water plant. However, in a binary fluid system, the geothermal hot water is reinjected directly to the geothermal reservoir once it has passed through a heat exchange device. Thus, it is unavailable for cooling the chlorofluorocarbon or isobutane used to drive the turbine, and an external source of water is needed. If 100 percent injection is required (as it is in Imperial County, California), then even flashed steam plants will require a source of water to make up the required volume of injected fluid.

Cooling Alternatives

The cooling water can be provided to a geothermal site by (1) a once-through cooling system, in which external water, frequently from a river or lake, is used once for cooling and then discharged to its source; (2) an evaporative or wet cooling tower, in which the external water is evaporated to the atmosphere; or (3) a dry cooling tower, in which the fluid is cooled by air and continually circulated in a closed system. The water requirements of these systems may vary widely. Once-through systems and wet cooling towers require substantial amounts of water; dry cooling towers require very little. The environmental impacts of these systems also vary substantially.

A once-through cooling system is used at Wairakei, New Zealand; however, the potential for thermal pollution of surface water limits the applicability of this approach in the United States. Preliminary designs for a 10-MW demonstration binary power plant with an evaporative cooling tower indicate that about 1310 l/min (346 gal/min) of makeup water is required, of which about 20% is blown down and reinjected to the reservoir. At this rate, for an 80-MWe plant, 25,000 l/min (6,640 gal/min) or 13.1 x 10^6 m^3/y is required. This amount is substantially greater than that needed by alternative power generation systems because the thermal efficiency of a geothermal plant is low. Such large quantities of water may not be available in many locations in the predominantly arid western states, or may preempt scarce water resources needed for other purposes.

Solid Waste

Safe disposal of solid wastes resulting from geothermal operations is important from an environmental standpoint due to potential toxicity and the large volumes which may be produced as development proceeds. Composition of the waste products will vary according to physical and chemical characteristics of the geothermal resource, type of energy conversion process, type of cooling water consumed and method of H_2S abatement. Disposal of solid wastes from geothermal facilities to sanitary landfill sites is presently regulated by states and may come under federal requirements pursuant to the Resource Conservation and Recovery Act, as amended.

The principal solid wastes accumulated are drilling muds and formation cuttings. Debris from the well drilling activities is captured and accumulated in reserve pits and tanks. When drilling is completed the wastes are dewatered by evaporation and removed to an approved disposal area.

Separation of precipitated solids from spent geothermal fluids is generally considered necessary to prepare for reinjection. Solids consist primarily of silica and heavy metal sulfides. Methods for separation and precipitation are still being refined. Solids will also result from scale buildup and it can be expected that physical methods will be employed to periodically remove scale from critical locations in the facility. Solid wastes due to removal of H_2S are discussed in the previous section on Air Quality. It is expected that most wastes will be disposed of on site (U.S. Doe, 1980).

Suggested methods for handling geothermal solid wastes which contain hazardous substances are containment and isolation from possible leaching to ground or surface water, or treatment of leachate to remove hazardous elements and any materials that, if discharged would violate water quality standards (EPA, 1978).

Vegetation and Wildlife

The general effects of geothermal energy development on biological resources, which are discussed in Leitner (1978a, 1978b) and Suter (1978), are summarized here. Direct loss of habitat as a result of the construction of facilities such as wells, roads, pipelines, and power plants has been well-documented at The Geysers in California. As a rule, less than 10% of a typical 160- to 400-hectares (400 to 1000-acre) leasehold is actually cleared of vegetation. This loss of habitat could be significant if the habitat of a rare, threatened, or endangered organism were involved or if such critical areas as riparian corridors or big-game migration routes were affected.

Removal of vegetation and disturbance of the soil mantle during construction activities can result in accelerated erosion. The deposition of eroded sediments in streambeds can in turn lead to adverse effects on fish spawning and nursery habitat.

Discharge or spills of geothermal fluids, steam condensate or drilling wastes into surface waters can seriously affect aquatic life. These materials often contain small quantities of potentially hazardous substances such as NH_3, H_2S, heavy metals, or fluoride.

Certain species of native trees and shrubs near the geothermal power plants at The Geysers have shown symptoms of stress and serious damage. Studies indicate that small amounts of boron, in the form of boric acid, present in the geothermal steam are involved. Power plant cooling water at The Geysers is derived from condensed steam, and some of the boric acid that carries over into this condensate escapes from cooling towers in drift droplets. It is not clear whether this will occur at other geothermal sites. It should be pointed out that if boric acid is emitted at other geothermal sites, resulting in vegetation damage, this should be considered a potentially significant environmental impact (Hedeman, 1981).

Finally, it is likely that the noise, disturbance, and human intrusion that accompany geothermal development adversely affect wildlife use of adjacent habitat. Species such as nesting raptors and some predators may be particularly sensitive to these factors. Most species, however, seem to adapt to the noise and disturbance.

Geothermal facilities should be sited to avoid loss or disturbance of important wildlife habitats such as the state and federal refuges, wetlands, or desert areas with rare or endangered species. Proper baseline information should be generated to avoid siting in sensitive areas such as those previously mentioned. If this is done, no significant impacts on terrestrial biota should occur. However, accidental spills of geothermal fluids that reach surface waters could have serious effects on aquatic life. If such accidents occur, operators could compensate for any habitat loss by making wildlife habitat improvements on adjacent lands for the duration of the development project.

Geology and Soils

Geothermal energy development can result in changes that may be of concern in the geologic environment. Most changes are likely to be associated with the production and use of geothermal fluids, rather than with the initial exploratory phase of development.

In most cases, geothermal fluids extracted from a reservoir will eventually be reinjected. Reinjection could cause local changes in pressure within the reservoir that might induce seismic activity because many geothermal areas are located on or near fault zones. However, it is extremely unlikely that major seismic events could be triggered in this way. Experience with fluid reinjection in a number of nongeothermal situations has shown that induced seismicity can be minimized or prevented by regulating injection pressures.

Land surface subsidence has occurred during fluid production at geothermal fields in several locations. Permanent and non-recoverable subsidence results from slow and long-term removal of fluids and from the compression of aquitards--such as clay, silty materials or shale--above or below a reservoir. Recognition of this factor in some situations may be pertinent to the scheduling of reinjection operations. Reinjection of fluids serves to maintain the pressures within the reservoir. However, if vertical displacement does occur at a substantial rate, manmade structures in the area of subsidence could be damaged.

Construction of wellsites and roads at The Geysers steam field led to serious landslides and accelerated erosion during the 1960s and early 1970s. These occurrences were due in large part to the steep slopes, heavy rainfall, and particular geologic and soil properties of this region. Subsequent careful site selection and engineering design have minimized these problems. Similarly, problems may occur at other sites whose conditions are similar to those at The Geysers, but they would not be expected as a general feature of geothermal development.

Noise

A number of significant noise sources are associated with developing and using geothermal resources. They include the sound generated by heavy earthmoving and construction machinery, stationary diesel-powered engines and compressors used in well-drilling; the turbines, gas ejectors, and cooling towers at the power plant; and the unmuffled venting of geothermal fluids to the atmosphere.

If sensitive receptors such as residences, schools, hospitals, or outdoor recreation areas are located within 1 to 5 km (1 to 3 miles) of a geothermal development, site noise may lead to public annoyance and complaints. Although many local jurisdictions near KGRAs have no established noise standards, community pressure can result in adoption of stringent controls.

Siting geothermal facilities to utilize natural topographic barriers and vegetation can reduce noises to acceptable levels. Noise control technology to muffle or reduce noise emissions at the source is also available for most geothermal industry operations.

Economic, Social, and Cultural Factors

Economic Effects

The economic impacts discussed here, consisting of effects on employment and income, are divided into permanent effects due to permanent new employees in a geothermal development region and temporary effects due to those temporary workers who primarily construct and drill the geothermal facilities. This study assumed an upper-bound case: Jobs and income created are net (no job switching), and all workers reside within the county where the development takes place. Also assumed is an average annual wage of $20,000 and income and employment multipliers of 2, which we hve used in computing total income and employment changes due to respending of direct income throughout the regions in question.

The following tabulation shows the net jobs and income created as a result of the 1200 MW of projected geothermal energy development:

	Direct	Total
Permanent employment and income generated by geothermal development		
Employment	200	400
Income (millions of dollars)	$4	$8
Temporary employment and income generated by geothermal development		
Employment	2,033	4,066
Income (millions of dollars)	$41	$82

The permanent income and employment changes will continue for the service life of a geothermal project, whereas the temporary changes will occur only during the initial construction phases of the project. On project completion, temporary workers will either leave the region or compete for existing jobs.

Social Effects

Social effects may be caused either by the influx of new residents into a developing area or by secondary effects of the physical development on present residents of the communities. It is assumed that new workers do not come from within a region, in which case, population impacts would be minimal. Rather, they are assumed to come from outside. This assumption allows an estimation of the potential maximum impacts.

Population Impacts. Given a family size of 3.5 for each new worker, the permanent population increase within the developing regions will be 1,400, or about 80-90 per plant location. The temporary population increase will be around 14,000, or about 800-900 per site. Some small communities and rural areas will experience some disruption by the added population, especially during the construction phase due to the large temporary work force. In general, the changes are relatively small and can be absorbed without major problems occurring in most areas.

Housing and Public Services. The long term, permanent population increases will result in few impacts on housing and public services during the lives of the projects. However, in individual areas that depend on market conditions, temporary insufficiency of housing and public services will most likely be experienced during project construction. Impacts on community infrastructures could be mitigated by contributions from geothermal developers on a cost-incurred basis for increased public service requirements, including schools, to the extent funds are not available through taxes or other public funds produced as a result of these communities, the construction population, or the plant itself.

Transportation. In some areas of geothermal development, transportation effects are likely to take place because of heavy equipment and commuting traffic. These impacts will be most intense during the construction phases of the facilities when large pieces of equipment are being moved in by heavy-duty vehicles. Roads not designed or constructed to handle such heavy-duty traffic may become congested and suffer accelerated deterioration. Noise, dust, and smoke, as well as hazards for persons living near the transport routes, will be increased.

Once the construction phase is completed, traffic flows will markedly decrease and become more regular. Some additional permanent traffic may also be induced as support businesses establish local offices or outlets to serve the development.

The adverse effect of increased usage of heavy equipment can normally be mitigated by requiring equipment to have properly working mufflers to abate excess noise and to be maintained in good operating condition to reduce air emissions. Geothermal developers could be required to upgrade roads and maintain them. Dust can be controlled by regularly watering down the roads receiving heavy traffic. When water is a scarce commodity in a region, other accepted but more costly options are available. Hazard areas can be marked.

Cultural Impacts

Aesthetics. Aesthetic effects at a geothermal development site include visual, odor, and noise impacts. The major sources of visual impacts are the wells, pipelines, generating facilities, cooling towers, and transmission lines that will be constructed at and around a geothermal site.

The extent to which a geothermal facility measurably affects a locale will vary markedly. In some instances, careful siting within an area may be all that is necessary. In other instances, the entire area may prove unsuitable for geothermal plant siting.

Visual impacts are normally hard to evaluate because the natural scenic value of the area must be judged, as must the desirability of altering that value; the size of the area affected must be estimated, as must the effect on the existing landscape; and the degree of scenic disruption must be analyzed. If geothermal developers are required to take visual impacts into account during planning and design, to the extent practicable, structures can be designed to meet existing applicable architectural standards. Thus the plant facilities could be made to blend harmoniously with the surrounding environment and have a reasonably pleasant appearance (U.S. Department of Interior, 1973). As an example, in the Coso region, a layer of earth will cover each power plant, both providing a protective hardening and serving to mitigate the visual impact of the plant.

The major source of offensive odors associated with geothermal development is H_2S, which may have a smell characteristic of rotten eggs. Depending on local meteorological conditions and terrain, this odor may be perceptible a considerable distance from the facility and if strong enough acts as a deterrent to recreational or normal activities. Experience around paper plants that also produce H_2S has shown that local populations generally adapt to the odor, whereas visitors find it unpleasant. Five candidate processes are available to remove H_2S and thus reduce odor problems. Work in H_2S reduction technology is continuing (U.S. DOE, 1980).

The major noise sources are those associated with construction which is of relatively short duration; and those associated with operation--primarily the cooling tower, steam jet gas ejector, and turbine generator. Except for venting wells, which produce loud noise, of short duration, these facilities operate fairly constantly during the life of the plant and therefore become a background sound that becomes a "normal" part of the environment. The muffler systems employed on new wells reduce noise. Because noise falls off rapidly as a function of distance from the source and because most proposed sites are in isolated or rural locations, noise is not expected to be a major problem.

Archaeology/Historic Sites. Archaeological sites are found either on or in the vicinity of many of the proposed geothermal facilities. However, because of geothermal and other development activities in locales such as The Geysers and the Imperial Valley in California, and Steamboat Springs and Soda Lake in Nevada, the sites have already been heavily disturbed. Where sites have not been adequately surveyed and where a State Historic Preservation Officer (SHPO) determines a high probability of archaeological sites exists, it is advisable that an archaeological resource inventory be conducted before site exploration begins.

If a potential archaeological site is found, work should stop and test pits should be dug by archaeologists to determine the significance of the site. If it is not significant, work can proceed. If it is significant, the site should be avoided. If avoidance is impossible, the site may have to be fully explored, documented, and possibly excavated and curated, which can be a very costly and time-consuming process.

Buildings or other structures at an historic site should be examined by an historical architect before any actions are taken that might adversely affect them. Proper mitigation measures for a structure varies. It may be moved, reinforced, or in some cases, torn down after a photographic record and measured drawings have been made. If the structure is torn down, its foundation and the immediate vicinity should be excavated; the procedure outlined above should be followed if artifacts are present.

For the most part, historic sites are located outside the geothermal areas of concern here and as such are not likely to be directly affected. The only exception to this is Steamboat Springs.

Health and Safety

Health and safety issues fall within the purview of federal, state, and local occupational safety and health regulations and are not basically environmental issues. Several types of hazards are of some environmental interest and are briefly discussed.

Hydrogen Sulfide. H_2S is the most significant potential occupational health problem in the geothermal industry (Zerwas, 1979). The gases accompanying geothermal fluids almost invariably contain H_2S. At low concentrations, H_2S constitutes an odor nuisance. In low concentrations, H_2S may also cause headaches, fatigue, irritability, insomnia, and gastrointestinal disturbances. In a somewhat higher concentration, the gas acts as a nervous system stimulant, causing excitement and dizziness (Milby, 1962). Systemic H_2S poisoning can result in respiratory failure and asphyxia (Zerwas, 1979).

The greatest danger to personnel from H_2S occurs during well drilling operations. During drilling pockets of H_2S may be encountered, and the pressure of the drilling "muds" may be insufficient to contain the gas from escaping. Available mitigation measures include equipping the drilling rigs with alarms that indicate when H_2S levels reach a potentially hazardous level. Additionally, cyclone mufflers can scrub some of H_2S out of the steam. Injecting solutions of sodium hydroxide and hydrogen peroxide in the line in front of the muffler has removed H_2S successfully (Zerwas, 1979).

Radon. The emission of radon at The Geysers power plant has been studied in detail by Anspaugh (1978), who concluded no effect from radon emission is discernible on the general environment of the power plant or on downwind communities.

Arsenic. Arsenic is a frequent component of geothermal fluids (Weres et al., 1977; Crecelius et al., 1976). Although the arsenic releases are quite small compared to H_2S, arsenic is an elemental poison. Because arsenic is also a carcinogenic agent, any potential contact should be minimized in areas where arsenic levels are fairly high.

Mercury. Mercury is almost always found as a trace element in geothermal fluids. Klusman et al. (1978) stated that mercury deposits are characteristic of geothermal fluids. However, mercury appears to be a marginal contaminant; on a per megawatt basis, emissions of mercury from geothermal power plants are comparable to releases from coal-fired power plants (Robertson et al., 1977).

Particulates. The most obvious particulates encountered in geothermal fluids include boric acid, silica, and rock dust. Whereas rock dust is relatively innocuous to human health and safety, boric acid can cause reversible or irreversible changes not serious enough to cause death (EPA, 1978). Silica can cause silicosis in workers exposed over long periods.

Noise. The noise from construction, drilling, and machine operations associated with geothermal power development is generally at levels that can adversely affect the hearing of the workers involved.

Land Use

Land ownership where PURPA-induced geothermal activities may take place is shared among federal, state, and private sectors. Site-specific environmental assessments and related Environmental Impact Statements will be undertaken by agencies as determined by the CEQ to have lead responsibility under NEPA. On federally-owned lands, the agency charged with management would be presumed to be the one to conduct an environmental review. EISs on site-specific projects on private and state lands will be prepared by the FERC and other federal agencies, such as those providing financial assistance or with certain regulatory responsibilities. Distribution of the lands described in this DSEIS is presented in Table VII-3.

Land use in the vicinity of geothermal developments will most likely be changed by the construction of roads, ponds, drill sites, wells, aboveground pipelines, power lines, power plants, and by-product facilities associated with industrial development, because most of the existing land uses are agricultural, recreational, or desert. Mitigating measures to reduce adverse impacts on land use from geothermal developments include actions such as land-use planning, environmental evaluations, and sound engineering and construction processes.

Some geothermal resource areas are beneath Department of Defense (DOD) lands and adjacent to DOD installations and operations, particularly in California, Nevada and Idaho. To assure that future geothermal development activities do not encroach on or adversely affect DOD operations, FERC will work closely with DOD staff.

Table VII-3

LAND OWNERSHIP OF ANTICIPATED GEOTHERMAL DEVELOPMENT
(PURPA-Induced)

Site		Federal Acres	State and Private Acres	Total KGRA Acres
(California)				
Imperial Valley	(1)	89,641	171,263	260,904
Coso Hot Springs	(1)	43,330	8,430	51,760
Mono-Long Valley	(1)	392,096	63,160	455,256
The Geysers/ Clearlake	(2)	85,107	290,923	376,030
(Nevada)				
Steamboat Springs	(3)	4,450	4,450	8,914
Brady Hot Springs	(3)	59,358	39,150	98,508
Beowawe	(3)	16,530	16,600	33,225
Desert Peak	(2)	52,176	46,332	98,508
Humboldt House	(2)	801	0	801
Soda Lakes	(2)	116,872	108,388	225,260
(Idaho)				
Raft River	(3)	25,110	5,099	30,209
Crane Creek-Cove Creek	(3)	3,240	1,102	4,342

(1) California Institute of Technology, "Geothermal Energy Resources in California," California Energy Resources Conservation and Development Commission Research and Development Division (June 30, 1976).

(2) USGS, "Federal and Non-Federal Acreages in KGRAs in the Pacific Region," area geologist, Office Memo (August 13, 1979).

(3) Williams, F., "Site-Specific Analysis of Geothermal Development--Data Files of Prospective Sites, Vol. III," SRI International (February 1978).

The generally accepted estimated economic life of a geothermal electric generating facility, including field, power plant, and transmission system is 30 years. However, the 93rd Congress' Energy Report states that carefully managed wells should operate for 100 years or more, and if the wells' waste water is recycled back into the ground, it might be able to operate indefinitely.

Should a geothermal electric generating facility be deemed no longer functional, all lands cleared for the activities associated with the facility could be restored to the original state in accordance with federal, state, and local requirements. The wells are capped in accordance with state regulations and all foundations and equipment would be removed and either recycled or disposed of according to solid waste regulations.

Although geothermal development may have a negative effect on certain land uses, some may view it as having a positive value because it may afford greater public access to remote or isolated areas. Creation of new routes or improvement of existing roads can open new areas to multiple-use development. Such routes also can serve as fire breaks or facilitate fire protection in areas subject to grass, brush, or forest fires (U.S. Department of Interior, 1973). Close attention must be paid on federal land regarding land use when development takes place near Roadless Area Review and Evaluation (RARE II) and designated wilderness study areas. Once roads are near these areas, spillover into the set areas that have been set aside to protect their pristine nature becomes much easier.

Fuel Displacement

Fuel use will be directly affected by the PURPA-induced geothermal development occurring in California, Nevada, and Idaho. Geothermal power production facilities will obviate the use of fossil or other fuels and will allow electric utilities to defer new capacity.

The following displacement in fossil fuels were projected by 1995 by running the EEPAM3 model developed for PURPA-DEIS:*

Region	Fuel Type	BTU's x 10^{12}/y	Unit Saving per year
Mountain	Oil	48	857,000 bbl
	Gas	12.3	1.19×10^{10} scf
Pacific	Oil	6.8	1,214,000 bbl
	Gas	3.0	0.29×10^{10} scf

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* These figures reflect utility-owned facilities which are not included in the adopted rule. Therefore, these projections may be high.

Table VII-4

ENVIRONMENTAL EFFECTS MATRIX FOR PURPA-INDUCED GEOTHERMAL DEVELOPMENT

Environmental Aspects	Locations of Projected PURPA-Induced Geothermal Development										
	California					Nevada					
	Clear Lake	Coso Hot Springs	The Geysers	Imperial Valley	Long Valley	Beowawe	Brady Hot Springs	Desert Peak	Humboldt House	Soda Lakes	Steamboat Springs
Air quality	H	M	H	H	H	L	L	L	L	L	H
Water resources	L	M	L	H	M	M	M	M	M	M	M
Vegetation and wildlife	M	L	M	L	H	L	L	L	L	L	L
Geology and soils	M	L	M	H	L	L	L	L	L	L	M
Noise	M	M	M	L	M	L	L	L	L	M	H
Social	L	L	L	L	L	M	M	L	L	L	L
Economic	L	L	L	L	L	L	L	L	L	L	L
Cultural											
Archeological	?	H	?	?	H	L	M	?	M	?	H
Aesthetics	H	M	L	L	H	L	L	L	L	L	H
Land Use	M	H	M	H	H	L	L	L	L	L	H
Health and Safety	L	L	L	L	L	L	L	L	L	L	L

H = Issue of high concern. Full mitigation is difficult to achieve.
M = Moderate issue of concern. Mitigative solution is normally available.
L = Low/negligable issue of concern. Mitigation readily available or unnecessary.
? = Unknown or data not available

For the purpose of this analysis the new geothermal capacity is anticipated to displace existing oil and gas capacity. New baseload capacity is assumed to develop unaffected by the geothermal rule changes.

Environmental Characteristics of Projected Geothermal Development Areas

Development of geothermal resources has been projected in areas identified in Chapter V as the result of PURPA and the Commission's proposed rules. Area-specific environmental information is provided to the extent available on these locations. The tables provided on the vapor dominated system and flash injection system were developed from data on two specific areas, The Geysers and the Imperial Valley, respectively. While the findings displayed are specific for these two areas, they are also relevant to the general environmental issue, impacts and concerns found in other areas of similar geothermal resources. Since The Geysers is the only vapor dominated area, the other 16 development areas in California, Nevada, and Idaho share environmental characteristics with those shown for the Imperial Valley.

Table VII-4 depicts the environmental effects identified for the development areas in California and Nevada. The table was derived from consultation with experts and review and analysis of the available literature and Appendix B; it succintly indicates potential environmental effects for each area and provides a comparison between areas. Related to the long-term environmental effects from geothermal development is the status of geothermal environmental control technology and mitigation measures. The Department of Energy periodically evaluates these factors and projects the risks and impacts associated with development and commercialization of geothermal resources in its Environmental Readiness Document series. Appendix 2 presents these data in terms of the likelihood of a finding adverse to development, the degree of program delay resulting from that adverse finding, and associated mitigation costs (DOE, 1978). By comparing the readiness status of various components of the geothermal energy system with the expected level of concern at projected locations it is possible to determine if serious environmental problems can be eliminated or satisfactorily mitigated.

The overall probability of environmental concerns and constraints playing an adverse or significant role in geothermal development is low to medium. The probability of development delays due to adverse findings is also in the medium range (0.4 - 0.6 probability of occurrence).

The problem of H_2S emission has already been discussed. It is unlikely that H_2S emission will cause significant ecological or health effects, but its odor does present a major nuisance that is often unacceptable to the public. Noise associated with many geothermal operations, particularly the venting of wells tapping vapor-dominated reservoirs, appears to be a significant problem at one location.

For liquid-dominated reservoirs, there are related problems of spent fluid disposal, land subsidence, and enhanced seismicity. It is expected that the disposal of spent geothermal fluids can be achieved by injection into the reservoir, and that this will also eliminate the potential problem of land subsidence that has been observed at many sites after fluid withdrawal.

Mineral scaling and precipitation problems associated with injection may prove to require chemical treatment and/or settling ponds. Even if injection is successful, the process itself might produce an enhanced level of seismic activity, or the thermal strain from use of the reservoir might cause seismic events. If the injection process is successful only because of the removal of compounds such as silica, a large-scale solid waste disposal problem may result.

Socioeconomic problems, particularly issues of compatible land use and general problems of resistance to large-scale developments, will be highly site-specific and will range from negligible to severe depending upon the size, diversity, and attitudes of the affected local communities.

Well blowouts have occurred at several locations; the results have not caused major damage because of the isolated locations, but such events could be much more serious in other locations. Many proposed power plant designs are of the binary type with working fluids such as isobutane and propane. Technology to ensure containment of such explosive fluids under geothermal working conditions is essential.

One barrier to large-scale expansion of the use of geothermal energy is competition for available resources, such as water for cooling and for fluid injection. If injection of most of the withdrawn water is required, then a supplementary source of cooling water will be required. As many hydrothermal reservoirs are in regions of limited water availability, this lack of water resources could result in a delay or could halt further development. The likelihood of water use conflicts is very site-specific and ranges from high to low.

The research necessary to resolve environmental concerns is being conducted concurrent with the development and demonstration of the technology itself.

The Geysers, California

The Geysers is located in northeastern Sonoma County in the remote and relatively isolated Mayacmas Range. The land in the region is generally rough, mountainous, and sparsely settled. The principal commercial and industrial enterprises are hunting and recreation, mining, and geothermal power (PG&E, 1973), with no major agricultural enterprises.

Environment and systems characteristics of The Geysers are shown in Table VII-5. The first column provides basic information on the

Table VII-5
GEOTHERMAL–VAPOR DOMINATED SYSTEM

ENERGY SYSTEM:

SIZE
- 110 MWe
- 15% conversion factor
- 75% capacity factor
- produces 2.47 x 10^{12} Btu per year
- unit 12 of Pacific Gas and Electric Geysers generating system

DESCRIPTION
- Steam is purchased from the Geysers field and is used to drive a turbine generator with condensate water used for cooling. No abatement procedures are used at the generating plant; however, the steam distribution system includes a centrifugal axial separator. Furthermore H_2S abatement measures are planned for implementation beginning with unit 13.

COMPONENTS
- production wells
- gathering system
- steam distribution system
- turbine-generator
- condensers
- heat rejection system
- gas ejector system
- electrical system and controls
- waste purification

ENVIRONMENTAL CONCERNS
- hydrogen sulfide (H_2S) is toxic, has odor – but control technologies are available
- high noise levels
- disposal of excess steam
- emissions highly site, reservoir, and time dependent
- conflicts with existing community lifestyles

RESOURCES USED:
(Per 10^{12} Btu Produced)

FUEL	
steam	6.7 x 10^{12} Btu's
LAND(1)	
permanent	31.2 – 62.4 acres
undisturbed	249.6 – 280.8 acres
WATER	Acre-Feet
water vapor input	1,960
water vapor discharged to air	1,640
water reinjected to wells	320
COSTS(2)	Dollars
construction (1978)(1)	11,180,000
operation and maintenance (1976)	175,000
annual cost of steam (1978)	3,807,000–5,272,000
abatement costs(3) (1976)	
peroxide system	
capital	401,000–490,000
operation and maintenance	126,000–454,000
ozone system	
capital	710,000–1,560,000
operation and maintenance	129,000–211,000
geothermal field construction	NA
geothermal field operation and maintenance	NA
PERSONNEL	Workers
construction (man-years)	
generating plant	57.43
well-field	NA
total	NA
operation and maintenance	
generating plant	NA
well-field	NA
total	4.97

RESIDUALS AND PRODUCTS:
(Per 10^{12} Btu Produced)

AIR POLLUTANTS(4)	Tons	(6)
carbon dioxide	250–26,000	(11,160)
ammonia	16– 1,800	(660)
methane	13– 1,500	(660)
hydrogen sulfide	5– 1,500	(764)
arsenic	NA	(8x10^{-4})
boron	NA	(1.7)
mercury	NA	(5x10^{-5})
hydrogen	6–120	(83)
water vapor	NA	(2.9x10^{6})
nitrogen, argon	4–410	
WATER POLLUTANTS(5)	Tons	
carbonates	81–210	(249)
ammonia	62–104	(86)
SO_2	NA	(1.2)
sulfate	87–260	(76.2)
sulfur	NA	(4.9)
nitrate	<0.04	(0.06)
chloride	<2	(2.0)
calcium	NA	(3.1)
magnesium	NA	(0.6)
silicon	NA	(2.2)
boron	44–89	(10.0)
total solids from evaporation	NA	(107.7)
organics and volatile solids	NA	(120.0)
water	NA	(=320 acres-feet)
RADIATION(4)		
Air	Curies	
Rn-222	41	
HEAT	Btu's	
waste heat (discharged to air)	5.4 x 10^{12}	
NOISE	Decibels(A)	
well drilling	75–80 at 50 feet	
mud drilling (60 days/well)	85–120 at 25 feet	
air drilling (30 days/well)		
well cleaning; open well (3-6 days)	118 at 50 feet	
well testing: open well (14 days)	118 at 50 feet	
rock muffler	89 at 50 feet	
well bleeding (variable)	65–86 at 5 feet	
well blowouts (infrequent)	118 at 50 feet	
construction of plant		
construction operations (1-2 years)	70–90 at 50 feet	
plant operation (20-30 years)		
muffled steam line vent (intermittent)	90 at 100 feet	
jet gas ejector (continuous)	84–117 at 5-10 feet	
steam line separator (continuous)	80 at 25 feet	
steam line breaks (brief, infrequent)	100 at 50 feet	
cooling tower (continuous)	80–90 at 5-10 feet	
turbine generator building (continuous)	70 outside	
ENERGY		
electricity	2.93 x 10^{8} kWh	

(1) Data values represent life-cycle values divided by annual energy output, measured in 10^{12} Btu.
(2) Construction and operation and maintenance costs are for the plant only.
(3) Costs projected to achieve 99% H_2S abatement at the Geysers. To be installed on all units beginning with unit 14. Does not include cost of retrofitting.
(4) Site specific for the Geysers field. Assumes no abatement measures.
(5) No treatment involved, reinjected through wells.
(6) Values in parentheses indicate actual emissions from the Geysers field operations as presented in Carstea, 1977.

SOURCES: Personal communication with D. J. Cossette of Pacific Gas and Electric, Comments of Dr. Lynn Anspaugh, Lawrence Livermore Labs, 1978.
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Table VII-6
GEOTHERMAL-FLASH INJECTION SYSTEM

ENERGY SYSTEM:

SIZE:[1]
- 50 MWe (net) power output
- 10.1×10^6 lb/hr brine flow rate (fuel) to plant at 338°F/115 psia
- 13 production wells
- 6 reinjection wells
- 8.69×10^{16} lb/hr brine/cooling water flowrate reinjected at 220°F/315 psia
- 10 acres plant site
- 30 years plant life
- .75 capacity factor
- 1.121×10^{12} Btu annual power output
- 8-11% thermal conversion efficiency for 375°F brine[2]

DESCRIPTION
- Geothermal brine is drawn through production wells and transported to the power plant. Steam is produced from the brine by reducing the brine pressure below its vapor pressure. This process, known as flashing, is performed twice. The excess brine is reinjected through reinjection wells. The noncondensable gas portion of the steam is treated with an H_2S scrubbing process and is released to the atmosphere (estimated H_2S removal of 99%). Condensate steam is used for cooling with excess condensate employed for continuous blowdown and reinjected with the excess brine.

COMPONENTS
- production wells and islands
- reinjection wells and islands
- distribution system
- steam system
- brine system
- cooling system
- H_2S scrubber

ENVIRONMENTAL CONCERNS
- releases of noncondensable gases
- high noise levels
- potential groundwater contamination
- land subsidence
- increased seismic activity
- alteration of runoff patterns
- habitat disruption
- all factors are highly site specific

RESOURCES USED:
(Per 10^{12} Btu Produced)

FUEL	Source	
geothermal brine, 338°F, 115 psia[1]	(1)	2.958×10^7 tons

LAND[a]	Source	
wells and islands	(2)	3.57 acres
plant size	(2)	8.9 acres

CHEMICALS	Tons
alkali for scrubber	NA

COSTS[b][1]	Dollars (1976)
well field[a]	
surface equipment	5,352,000
wells	7,136,000
engineering services	1,070,000
Subtotal	13,558,000
plant construction[a]	
turbine-generator	5,986,000-9,064,000
other mechanical	4,585,000
piping and instrumentation	4,112,000
electrical	2,828,000
civil/structural	3,381,000
engineering services	2,426,000-2,881,000
Subtotal	23,318,000-26,851,000
Total[a]	36,876,000-40,409,000
well field operation and maintenance	1,320,000
plant operation and maintenance	466,000-537,000
Total	1,786,000-1,857,000

PERSONNEL	Workers
field construction	NA
field operation	NA
plant construction	NA
plant operation	NA

RESIDUALS AND PRODUCTS:
(Per 10^{12} Btu Produced)

AIR POLLUTANTS[3]	Tons
hydrogen sulfide[c]	19.4
ammonia	98.8
methane	580
carbon dioxide	35,500
arsenic	NA
boron	NA
mercury	0.1
hydrogen	NA
nitrogen, argon	NA
water vapor	4.3×10^6

WATER POLLUTANTS[d][3]	Tons
carbonates	NA
ammonia	NA
SO_2	NA
sulfate	NA
sulfur	NA
nitrate	NA
chloride	NA
calcium	NA
magnesium	NA
silicon	NA
boron	NA
dissolved solids	NA
water (tower blowdown)	1.76×10^5
total brine	2.53×10^7
total suspended solids[e]	NA
nutrients[e]	NA

RADIATION[3]	
Air	Curies
Rn-222	7.3
other radionuclides	NA

NOISE[4]	Decibels
well construction	intermittent high intensity
well operation	intermittent high intensity
plant construction	medium intensity
plant operation	low intensity

ENERGY PRODUCT	kWh
electricity	2.93×10^8

NOTE: Allowance for contingency is not included in costs.

(a) Data values represent life-cycle values divided by annual energy output, measured in 10^{12} Btu.
(b) Capital costs include installation, personnel, etc.
(c) Without sulfur removal system
(d) Reinjection
(e) Construction related, result of altered runoff patterns.

SOURCES: (1) Bechtel Corporation, Advanced Design and Economic Considerations for Commercial Power Plants at Heber and Niland California, 1977.
(2) Ermak, D. L., 1977. "Potential Growth of Electric Power Production from Imperial Valley Geothermal Resources," UCRL-52252.
(3) Knox, J. B., and R. C. Orphan, ed., Program Report - FY 1977, Atmosphere and Geophysical Sciences Division Physics Department, UCRL-51444-77, Lawrence Livermore Labs, 1977.
(4) Environmental Protection Agency, Western Energy Resources and The Environment: Geothermal Energy, 1977.

geothermal systems and resources. The second column presents information on the resources required for the operation of the system, while column three describes the environmental impacts, residuals, and energy products.

Air quality is the most prominent issue at this location, but as shown in Appendix B, is amenable to control.

Clear Lake, California

Clear Lake is also located in northern Sonoma County in the Mayacmas Range. The land in the region is generally rough and mountainous with a substantial resident and tourist population in a number of small resort communities. Air quality and cultural issues appear to be of greatest concern, however, the likelihood of adverse effects on development are medium and low, respectively. (See Table VII-6 for general geothermal characteristics.)

Coso Hot Springs, California

Of the 51,760 KGRA acres at the Coso geothermal site, the majority are owned by either the U.S. Bureau of Land Management (BLM) or the U.S. Navy. The rest is either state or private property. The area is in the Mojave Desert, with the highest elevations in the north and a gradual southwest slope. The land is used for recreational, military, and agricultural purposes; however, agriculture is declining because of a lack of irrigation water (Williams et al., 1978). Coso's population is mainly rural, with the largest town in Inyo County having a population of fewer than 10,000. (See Table VII-6 for general geothermal characteristics.)

Cultural and land use concerns rank as the most important issues facing geothermal development in the Coso area, but both issues are amenable to resolution with low probabilities of adverse effects on development.

Imperial Valley, California (Heber, Salton Sea, Brawley, East Mesa)

The Imperial Valley in Imperial County is a flat, irrigated, agricultural region that extends into desert shrubland in the East Mesa area of southeastern California. It is basically a rural area with small population centers (Williams et al., 1978). Environmental and geothermal characteristics are detailed in Table VII-6.

Existing county land use plans and the locations of state and federal wildlife refuges could significantly restrict the spatial development of geothermal energy. The three sources of land use restrictions are (1) county zoning ordinances, (2) the county's Ultimate Land Use Plan, and (3) proposed county regulations governing geothermal operations, plant permitting, and plant siting within the county. Restricted areas comprise city boundaries and recreational zones. The

Ultimate Land Use Plan excludes geothermal development in urban, rural, residential, recreational, preservation, and special public areas. Finally, restrictions require minimum distance between plant and community boundaries, schools, hospitals, and feed lots (Layton and Ermak, 1976).

Long Valley, California

Long Valley, located east of the Sierra Nevada Mountains in Mono County, is a rural area that is supported primarily by recreation and tourism, as well as by mining and agriculture (Williams et al., 1978). Air quality, vegetation and wildlife, cultural, and land use concerns are very important in this area and could act as serious detriments to development. The probability of these concerns actually adversely delaying development are in the medium to low range.

Steamboat Springs, Nevada

Steamboat Springs is in the shrub/grassland area of mountainous northwest Nevada. Nearby, extensive meadows have been used for agriculture and are now rapidly being converted into large housing tracts at the southern edge of the Reno metropolitan area. Numerous historical and archaeological sites, including petroglyphs and open aboriginal camps, make the area a designated historical site (Williams et al., 1978). See Table VII-6 for general geothermal characteristics. Air quality, noise, cultural and land use concerns for the major constraints to development in Steamboat Springs.

Nevada (Beowawe, Brady Hotsprings, Desert Peak, Humboldt House, Soda Lakes)

These sites are found in a sparsely populated rural desert region in northern Nevada. Mining, ranching, irrigated agriculture, and recreation are the major industries. (See Table VII-6 for general geothermal characteristics.) Environmental concerns are either moderate or low at all of these locations, and would not appear to be significant deterrents to development.

Raft River, Idaho

The Raft River site is located in Cassia County in the southeast portion of the state close to the Utah border. Approximately 25,000 of the 30,000 acres within the KGRA are federally-owned. The natural landscape which is generally flat with small gullies and ridges has been altered considerably for farming. Although the area is almost exclusively agricultural and has a population density of less than one person per square mile (Williams et al., 1978), there does not appear to be significant opposition to development. Geothermal related activities, however, may cause local boom and bust problems.

Weiser and Crane Creek-Cove Creek, Idaho

These two potential development sites, located in Washington County in west-central Idaho among low mountains with sagebrush steppe vegetation, are surrounded by grassland, grazing lands, and irrigated croplands. Because of environmental concerns, the Bureau of Land Management has rejected two noncompetitive lease applications for federal lands in the area.

Wayland (Battle Creek) Hot Springs, Idaho

This potential development area is located in the southeast corner of Idaho within Franklin County. The primary industries in the county are irrigated agriculture, stock yard operations, recreation, and phosphate mining. The county contains important wildlife habitat and natural areas. Second home subdivisions have affected local water quality.

Big Creek Hot Springs, Idaho

Big Creek Hot Springs is located west of the town of Salmon in Lemhi County. The area is characterized by sensitive soils, abundant aquatic habitat, wilderness areas, and many forests. Local industries include forestry, livestock, dry-farming, irrigated agriculture, and recreation. Some mining activity also occurs in the area.

Roystone Hot Springs, Idaho

Roystone Hot Springs is on the border of Gem and Boise Counties in west-central Idaho. This region of Idaho, characterized by lands that range from high deserts and arid canyons to rugged mountains, is experiencing a rapid rate of population growth and changes in land use. Sensitive soil conditions and waterfowl habitat surround these potential geothermal resources.

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APPENDIX A

SIGNIFICANCE OF CONCERN OF HYDROTHERMAL ELECTRIC AND DIRECT HEAT

Source: ENVIRONMENTAL READINESS DOCUMENT
Hydrothermal Electric and Direct Heat
Commercialization Phase III Planning
September 1978
U. S. Department of Energy
Assistant Secretary for Environment

Appendix A. SIGNIFICANCE OF CONCERN OF HYDROTHERMAL ELECTRIC AND DIRECT HEAT

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
Column Content Concern statement as provided in Appendix A	Present Knowledge of: - severity of hazard - adequacy of control	Years of required research (as in Appendix A)	Estimate of probability of adverse finding (high, medium, or low) and character of likely adverse finding	The total cost (direct and indirect) of controls that may be required in the event of adverse finding	Period of program delay that may result from adverse finding	Assessment of risk of proceeding with technical development schedule in light of state-of-environmental knowledge, research schedule, and uncertainty of research outcome
1. Release of Airborne Effluents Hydrothermal fluids typically contain a number of compounds such as CO_2, NH_3, As, H_2S, CH_4, Rn, Hg, and B. These and other chemicals such as salts in cooling tower drift may be released to the atmosphere; impacts may occur on local ecosystems and on human health.	a) H_2S is of particular concern because of unacceptable odor (above 5ppb) and toxic effects (above 20 ppm). Abatement systems now used at The Geysers cannot comply with California H_2S standards; new systems with improved capability and reliability are just approaching demonstration phase. Long-term accumulation and effects of Hg, B, As, and H_2S on ecosystems are unknown. Methodology does not exist for predicting atmospheric transport of H_2S in rough terrain. This is needed for siting power plants. b) Data concerning long-term accumulation and effects from Hg, B, As, and H_2S on ecosystems are limited. Currently, there are no controls being deployed for these pollutants.	3	a) Medium - Optimum utilization of geothermal regions is limited by H_2S abatement constraints. Systems in commercial operation now are not satisfactory. Future well head abatement systems, use of dry cooling towers, and injection with a binary system will require unproven technology with a significant cost penalty. Also, it is unlikely in the future to have adequate abatement during well drilling, well bleeding, or bypassing for vapor dominated resources or during flashing of hot water resources. Development of predictive atmospheric modeling capability for rough terrain will maximize dispersion of H_2S by selective power plant siting. b) Medium - Current characterization of effluents indicate a build-up of Hg, B, and As. While these pollutants are not regulated and have not hindered siting to date, innovative techniques may be needed for clean-up if they are regulated.	a) For H_2S cleanup, the following increases in levelized busbar energy cost will be incurred above those for surface condensers and Stretford process: • Well-head abatement, 1-5% (1) • Dry Cooling, 10-15% (2) • Injection with binary system, 20-25% (3) b) For Hg, B, and As cleanup 5-10% increase in levelized busbar cost. (4)	Delay in the Geysers area will be significant. Delay in hot water resources will depend if flash steam design is used.	Medium if H_2S abatement systems are proven in field applications. Impact of Hg, B, and As cleanup will depend upon regulations and proven technologies.

* LOW = 0.1-0.3 probability of occurrence
MEDIUM = 0.4-0.6 probability of occurrence
HIGH = 0.7-0.9 probability of occurrence

** These are order of magnitude cost estimates

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4. Imputed using subjective evaluation.

Appendix A. (Continued)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
Column Content Concern statement as provided in Appendix A	Present Knowledge of: - severity of hazard - adequacy of control	Years of required research (as in Appendix A)	Estimate of probability of adverse finding (high, medium, or low) and character of likely adverse finding	The total cost (direct and indirect) of controls that may be required in the event of adverse finding	Period of program delay that may result from adverse finding	Assessment of risk of proceeding with technical development schedule in light of state-of-environmental knowledge, research schedule, and uncertainty of research outcome
2. Release of Waterborne Effluents Large volumes of spent geothermal fluids and cooling tower blowdown will be generated. They may contain dissolved volatile compounds and large quantities of dissolved solids. The concern is for long-term disposal of such fluids so that beneficial sources of water are protected.	Most high temperature resource fluids contain moderate to high levels of salts and trace heavy metals (Hg, B, As). Experience in Imperial Valley dictates that salts will have to be filtered out before reinjection to avoid plugging of reservoir matrix. Pre-treatment before injection will leave residuals requiring surface disposal. Safe disposal of high saline fluids under pressure has not been demonstrated. Moderate to low temperature fluids (non-electric applications) probably will present minimal hazard.	Because of the large volume of waste and uncertainties surrounding plugging R&D will be substantial (5 years).	Medium - Safe disposal of brine in Imperial Valley will be required to protect agricultural developments. In most cases geothermal fluids cannot be dispensed into surface or groundwater systems if total dissolved solids (TDS) exceed 1000 ppm. Plugging from injection may be resolved by pretreatment, usually for silicates. Another option is evaporative ponding of the waste. Innovative treatment, such as reverse osmosis, could result in a secondary use of the water. All of these advanced systems will have an accompanying solid waste disposal problem.	The levelized busbar costs will increase above injection by: • Injection with treatment about 9% (1) • Ponding about 1% (1) • Reverse osmosis about 22% (1) Note: Above costs do not include solid waste disposal.	Delay in Geysers would be minor because low TDS fluids present little, if any, problems for disposal. Delay in Imperial Valley could be significant if high salt content fluids cannot be injected.	Moderate for most non-electric and low saline applications. Significant for high saline applications because there is a need to establish that fluid can be injected at high rates over long periods of time. Also, EPA standards for safe drinking water may preclude injection into potential water aquifers, and Resource Conservation and Recovery Act may limit ponding.

** LOW • 0.1-0.3 probability of occurrence
MEDIUM • 0.4-0.6 probability of occurrence
HIGH • 0.7-0.9 probability of occurrence

*** These are order of magnitude cost estimates

Reference

1. Private communication, D. [illegible], [illegible], with [illegible] Walter, [illegible], 7/5/78.

Appendix A. (Continued)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
Column Content Concern statement as provided in Appendix A	Present Knowledge of: - severity of hazard - adequacy of control	Years of required research (as in Appendix A)	Estimate of probability of adverse finding (high, medium, or low) and character of likely adverse finding	The total cost (direct and indirect) of controls that may be required in the event of adverse finding	Period of program delay that may result from adverse finding	Assessment of risk of proceeding with technical development schedule in light of state-of-environmental knowledge, research schedule, and uncertainty of research outcome
3. Noise Uncontrolled noise levels associated with exploration and drilling, well venting, and operational processes can reach levels as high as 120dBA near the plant and may have deleterious effects on human health, animal husbandry and perhaps rare and endangered species' breeding habits.	Most noise pollution will be associated with vapor dominated resources and well venting and bleeding operations during air drilling phases. Adequate noise abatement techniques for drilling and well flow testing need to be developed. Moderate impact on wildlife habitat can be expected. Auxiliary drilling equipment will need to be acoustically shielded. Present muffling systems are moderately successful but are costly.	1-2	Low - Adequate controls can be developed for well drilling and well venting tests in vapor dominated resources. Need further R&D on long-term effects on wildlife habitats and drilling operations within nearby community boundaries. Noise from development of hot-water resources will be less and controllable.	Noise abatement systems will have an additional levelized bus-bar cost of less than 1%. (1)	Major delays could be associated with expansion of the Geysers to 2000 MWe. Delay is moderate for Imperial Valley.	Low risks if economical and reliable systems, using present day technology, can be demonstrated for air drilling and plant venting/bleeding.

LOW = 0.1-0.3 probability of occurrence
MEDIUM = 0.4-0.6 probability of occurrence
HIGH = 0.7-0.9 probability of occurrence

** These are order of magnitude cost estimates

Reference

1. Private communication, D. Boehm, DOE, with P. Leitner, St. Mary's College, 7/5/78.

Appendix A. (Continued)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
Column Content Concern statement as provided in Appendix A	Present Knowledge of: - severity of hazard - adequacy of control	Years of required research (as in Appendix A)	Estimate of probability of adverse finding (high, medium, or low) and character of likely adverse finding	The total cost (direct and indirect) of controls that may be required in the event of adverse finding	Period of program delay that may result from adverse finding	Assessment of risk of proceeding with technical development schedule in light of state-of-environmental knowledge, research schedule, and uncertainty of research outcome
4. Subsidence The removal of large quantities of hydrothermal fluid may result in subsidence. The importance of subsidence will be site-specific; at locations such as The Imperial Valley where the geothermal reservoirs are overlain with agricultural land, subsidence impact could be significant.	Current mitigation strategies are based upon oil field and ground water extraction experiences. Little actual experience exists in management of subsidence in geothermal fluid withdrawal-injection. Most plans call for injecting into strata different from where fluid is initially extracted. The prevention of subsidence under these conditions is not clearly understood, nor are the factors that control subsidence in general. Once subsidence occurs, the effects may be reversed, but at significant cost.	3	Medium - The efficacy of subsidence prevention by injection of spent fluids has not been demonstrated.	If injection is used for liquid waste, no incremental costs. If ponding is used and some form of injection is needed to control subsidence, then an additional levelized busbar cost of up to 20% could be incurred.(1)	Delays in Imperial Valley could be significant if process is proven infeasible or unsuccessful. Delays are not foreseen for Geysers area.	Significant for Imperial Valley due to sensitive agriculture and uncertainties surrounding plugging of injected fluids. The Geysers would be unaffected.

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MEDIUM = 0.4-0.6 probability of occurrence
HIGH = 0.7-0.9 probability of occurrence

** These are order of magnitude cost estimates

Reference

1. Private communication, D. Boehm, DOE, with Ron Walter, PNL, 7/5/78.

Appendix A. (Continued)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
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5. Enhanced Seismicity The withdrawal and/or injection of hydrothermal fluids may enhance the frequency or magnitude of seismic events.	Evidence for inducing seismic events exists from high pressure injection at Rocky Mountain Arsenal, Colorado. It is unlikely that low pressure injection associated with geothermal fluid disposal will induce seismic events. Observations in Imperial Valley where limited injection has taken place, indicate no observable correlation between seismic phenomenon and injection. Need more data for various geological formations and long-term high flow rates of injection. It is postulated that reservoir cool-down resulting from fluid withdrawal may induce microseismic events. (This, however, could be beneficial by precluding a large acute event.)	3	Low - Minor impact expected, however, sufficient baseline observations should be made in early phases of development to establish data base necessary for distinguishing between natural seismic events and possible induced activity.	It is expected that monitoring program will indicate no need for controls or that procedural control will impose minor cost penalties.	None expected, but early baseline data on seismic activity should be developed and monitoring program established for early (1-2 yr) fluid withdrawal and injection.	Low - However, essential to establish pre-startup background data and monitoring program during early resource utilization -- both electrical and non-electrical applications.

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MEDIUM = 0.4-0.6 probability of occurrence
HIGH = 0.7-0.9 probability of occurrence

** These are order of magnitude cost estimates

Appendix A. (Continued)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
Column Content Concern statement as provided in Appendix A	Present Knowledge of: - severity of hazard - adequacy of control	Years of required research (as in Appendix A)	Estimate of probability of adverse finding (high, medium, or low) and character of likely adverse finding	The total cost (direct and indirect) of controls that may be required in the event of adverse finding	Period of program delay that may result from adverse finding	Assessment of risk of proceeding with technical development schedule in light of state-of-environmental knowledge, research schedule, and uncertainty of research outcome
6. Water Use Many proposed methods of utilizing geothermal energy will require outside sources of water for cooling systems. As many geothermal resource areas are in semi-arid regions, conflicts concerning the most beneficial uses of water may arise.	In most cases, powerplant condensate will not be available for cooling purposes since it may be needed for reinjection into the ground for control of possible subsidence. Alternate sources of water should be recognized and developed. It may be possible to use agricultural waste water in the Imperial Valley. Alternatives for cooling water resources in most KGRAs have yet to be identified.	1	Medium - Depending upon the development of sources for cooling water and extent of reinjection. Local regulations in Imperial Valley mandate injection of volumes of water equivalent to quantities extracted. Other KGRAs (both electric and non-electric) face similar problems, except vapor dominated resource areas of the Geysers. Hot water resources in the Geysers will present reinjection and water resource problems.	Indeterminate	Delay could be substantial if alternative water resources use becomes an issue.	Significant environmental effects from utilizing water resources, i.e., agricultural waste water, Salton Sea, etc. could stop further development.

* LOW = 0.1-0.3 probability of occurrence
MEDIUM = 0.4-0.6 probability of occurrence
HIGH = 0.7-0.9 probability of occurrence

** These are order of magnitude cost estimates

Appendix A. (Continued)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
Column Content Concern statement as provided in Appendix A	Present Knowledge of: - severity of hazard - adequacy of control	Years of required research (as in Appendix A)	Estimate of probability of adverse finding (high, medium, or low) and character of likely adverse finding	The total cost (direct and indirect) of controls that may be required in the event of adverse finding	Period of program delay that may result from adverse finding	Assessment of risk of proceeding with technical development schedule in light of state-of-environmental knowledge, research schedule, and uncertainty of research outcome
7. Land Use Some geothermal developments may cause land use conflicts. They may threaten pristine wilderness areas; impact upon habitat of endangered, threatened, or recreationally important species; or conflict with other beneficial uses such as agriculture or recreation.	Full scale development in Imperial Valley is predicted not to result in major conflict with agriculture or game refuge areas. Baseline data insufficient in most KGRA's and impact on endangered species is hard to predict at this time. Disturbance of raptor nesting areas may be threatened in The Geysers and Raft River, Idaho, KGRA's. Insufficient data exists between relationship of hot springs and nearby drilling of geothermal wells when common reservoir is involved.	2	Low - Relationship between well drilling and impact on hot springs may prove to be benign. Will affect development of wells within 1-2 miles of protected hot springs. Effects on raptor nesting areas and wild population and nearby human population need to be confirmed.	Indeterminate	Permanent - If drilling near protected hot springs (especially California) cannot be shown to have minimal effects on hot spring productivity, nearby areas could be withdrawn from geothermal development.	Land will be removed from alternative uses. Well sites and associated resource technologies will include agriculture, wild game hunting, recreation, placement of lodges and other human recreation resources in the area.

* LOW = 0.1-0.3 probability of occurrence
MEDIUM = 0.4-0.6 probability of occurrence
HIGH = 0.7-0.9 probability of occurrence

** These are order of magnitude cost estimates

Appendix A. (Continued)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
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8. Social Services, Community Structure All hydrothermal developments will have an impact through the demand for workers and the influx of money. This impact may be considered positive or negative depending upon the existing community structure and life-style, and may range from negligible to major depending upon the size of the development and the size and diversity of the local economy.	Present knowledge indicates economic impacts will be positive, especially in Imperial Valley. Impacts on life-styles in the Geysers KGRA cannot be assessed fully due to lack of data. Social and life-style modifications relative to religious and other cultural beliefs need further analysis and assessments.	3	Low - In Imperial Valley. Possible significant problems in Hawaii, the Geysers, Coso Hot Spring, Long Valley due to established religious-social mores associated with hot springs and energy extraction. Environmental organizations may object to development in some KGRAs in Oregon and Long Valley, California.	Indeterminate	Could be significant within specific areas of several KGRAs (e.g., Lake Country and Long Valley, Coso).	Failure to resolve issues where there is local opposition to siting could result in generalized public reaction to hydrothermal development.

* LOW = 0.1-0.3 probability of occurrence
MEDIUM = 0.4-0.6 probability of occurrence
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Appendix A. (Concluded)

Environmental Concern	Status (State of Knowledge)	Research Time	Likelihood of a Finding Adverse to Technology Development*	Additional Mitigation Cost ($)**	Program Delay	Environmental Risk of Proceeding with Technology Development
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9. System Safety and Occupational Health The safety of hydrothermal energy extraction and utilization systems could become a major issue if early significant failures occur. Problems may arise related to proper handling of high pressure, corrosive hydrothermal fluids and explosive fluids, such as isobutane and propane which may be used in secondary or tertiary heat exchange loops.	Data from field experience in hydrothermal binary systems using isobutane and/or propane does not exist. Although much data is available for handling volatile gases in other industries, hazards could be considerable with heat exchangers utilizing corrosive high temperature geothermal fluids. Possible effects to workers exposed to low levels of H_2S have not been fully evaluated.	3	Low - Since most systems will flash hot water to steam. H_2S will be controlled by abatement strategies.	Incremental cost, above H_2S and noise abatement, for safety controls will be 0-1% of levelized busbar cost.(1)	Low - Unless major emphasis is placed upon development of binary systems, especially in Niland, Calif. where geothermal fluids are the most corrosive and constitute a worst case situation.	Low

* LOW = 0.1-0.3 probability of occurrence
MEDIUM = 0.4-0.6 probability of occurrence
HIGH = 0.7-0.9 probability of occurrence

** These are order of magnitude cost estimates

Reference

1. Imputed using subjective evaluation.

APPENDIX B

COMMENTS ON THE DSEIS AND STAFF COMMENTS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 9 1981

OFFICE OF THE ADMINISTRATOR

Mr. Kenneth F. Plumb, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street., N.E.
Washington, D.C. 20426

Dear Secretary Plumb:

The U.S. Environmental Protection Agency (EPA), in accordance with Section 309 of the Clean Air Act (42 U.S.C. 7609), has reviewed the Western Regional Draft Supplemental Environmental Impact Statement (EIS) for the Federal Energy Regulatory Commission's (FERC) Proposed Rulemaking for Small Power Production and Cogeneration Facilities - Exemptions for Geothermal Facilities (FERC Docket No. RM81-2).

Our procedure for reviewing Draft EIS's is to categorize our comments on both the environmental consequences of the proposed action and the adequacy of the impact analysis. EPA has categorized this EIS as "LO-2". EPA has no objections to the proposed action, but we want the final EIS to provide some additional information. Although we found this EIS to be a well written and thorough document, we have prepared the enclosed detailed comments to assist you in preparing the final EIS.

If you have any questions concerning EPA's comments, please contact John Meagher of my staff (755-0790).

Sincerely yours,

William N. Hedeman, Jr.
Director
Office of Environmental Review

Enclosure

DETAILED COMMENTS
OF THE
U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)
ON THE
DRAFT SUPPLEMENTAL EIS
FOR
FERC'S PROPOSED RULEMAKING
ON
EXEMPTIONS FOR GEOTHERMAL FACILITIES

1. Although the EIS suffices as a programmatic analysis of the geothermal exemption program, many of EPA's environmental concerns are site specific. The Final SEIS should commit FERC to conducting NEPA reviews of the individual geothermal exemptions. EPA's comments are predicated on the assumption that necessary environmental reviews at the local, state and federal level will occur on qualifying facilities, as was stated in the background section of the proposed rulemaking.

2. EPA recommends the addition of boric acid to the list of principal adverse environmental impacts in the Summary Chapter. This will give additional prominence to the problems of boric acid that are discussed in Chapter VII of the DSEIS. Boric acid is the only pollutant with a noticeable visible effect - the destruction of vegetation - and it warrants mention in the Summary. (The reference to "boron" on page VII-10 should, of course, be changed to "boric acid.") The discussion of boric acid in Chapter VII does not adequately reflect its potentially significant environmental effects. We believe that the statement "boric acid" ... (is) relatively innocuous" (page VII - 15) understates the problem. A more detailed discussion of the effects of boric acid should be included in the FSEIS. EPA's Pollution Control Guidance for Geothermal Energy Development, EPA 600/7-78-101, should help you (see page 38) in making these modifications.

3. The discussion of the air quality impacts from hydrogen sulfide on page VII-1 needs to be clarified. A reader could infer incorrectly that EPA is developing a National Ambient Air Quality Standard (NAAQS) for hydrogen sulfide; whereas, EPA is considering a New Source Performance Standard (NSPS) for hydrogen sulfide plants.

   Page I-3 of the Summary cites the "hydrogen sulfide scrubber" system as an example of emission control for geothermal facilities. We believe that the EIC copper sulfate process (discussed on page VII-4) is the most significant government funded measure for near term development. This and other near term development technologies should be mentioned on page I-3.

Except where noted, the suggested changes have been incorporated into the EIS.

4. The permit requirements of EPA's Underground Injection Control (UIC) regulations should be referenced on page VII-7. In addition, there should be some mention of the USGS Geothermal Resources Operational Orders which provide for strict regulation of drilling procedures on public lands to protect groundwater and environmental quality. The reference on page VII-7 to an EPA draft order to develop state groundwater designations (Federal Register November 24, 1980) should be clarified. The draft order did discuss the proposed National Groundwater Strategy encouraging aquifer study and classification, but it is not as yet part of the UIC regulatory framework.

5. The EIS on page V-8 listed Washington among the states in which no project-specific near-term PURPA-induced development is expected. With one active and several dormant volcanoes, the State of Washington would seem to have a high potential for geothermal energy development. Congress recently enacted the Pacific Northwest Electric Power Planning and Conservation Act (P.L. 96-501), which in combination with your rulemaking will promote development of renewable energy resources, including geothermal resources. EPA recommends that a discussion of the combined effects of these developments be included in the SFEIS.

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MANPOWER
RESERVE AFFAIRS
AND LOGISTICS

Mr. Kenneth F. Plumb
Secretary
Federal Energy Regulatory Commission
Washington, D.C. 20462

Dear Mr. Plumb:

This is in response to your December 12, 1980, letter which requested Department of Defense (DoD) comments on the western regional draft supplemental environmental impact statement (DSEIS) for the Federal Energy Regulatory Commission (FERC) proposed rulemaking on small power production and cogeneration facilities (SPPFs), docket number RM 81-2.

The DoD has no objection to the principal provisions of the proposed rulemaking. These provisions include:

- An increase in the maximum size of SPPFs from 30 megawatts (MW) to 90 MW for exemption from regulation,
- Exemption of utility-owned geothermal SPPFs, of not more than 80 MW capacity, from certain federal and state laws regarding utility rates and financial regulations, and
- Provision of avoided-cost pricing benefits of section 2 of the Public Utilities Regulatory Policy Act (PURPA) of 1978 for utility-owned facilities.

The DoD supports fully the development of United States geothermal resources, as evidenced in our active participation in the Interagency Geothermal Coordinating Council (IGCC) over the past five years. We have indicated, however, on numerous occasions at IGCC meetings, in the presence of FERC representatives, that the possible impact on defense operations of geothermal development on land adjacent to DoD property must be assessed thoroughly.

We are concerned, therefore, that the DSEIS does not address the potential impact that the increase in the maximum exemption size for SPPFs may have on DoD. For example, the DSEIS indicates that PURPA-induced geothermal development in the near term is anticipated for California, Nevada, and Idaho. There are 114 major DoD installations, activities, and properties in those states, and, of these, at least 13 are located over potential

This concern has been addressed in the discussion of land use in Section VII of the EIS and certain DOD installations have been identified on Figure V-1.

geothermal resources. Increased development will more than likely increase encroachment pressures on the military activities proximate to the geothermal resources.

In conclusion, while DoD has no philosophical objection to the principal provisions of the proposed rulemaking, I request that the impact on DoD of the increased development of geothermal resources in the western United States be assessed in the DSEIS. If you have any questions concerning this request, please call Thomas Ladd, Head, Energy Programs Branch, Naval Facilities Engineering Command, at 325-0102.

Sincerely,

G Marienthal

George Marienthal
Deputy Assistant Secretary of Defense
(Energy, Environment & Safety)

Related to 80-80-0043

SIGNOFF ~~AZ STATE CLEARINGHOUSE~~ Major

OMB Approval No. 29-R0218

FEDERAL ASSISTANCE

2. Applicant's application — a. Number; b. Date 19 Year Month Day

3. State application identifier — a. Number AZ 80-80-0078; b. Date Assigned 1980 12 19

Leave Blank JAN 07 1981

JoAnn Y. Stephens

1. Type Of Action (Mark appropriate box)
- ☐ Preapplication
- ☐ Application
- ☐ Notification Of Intent (Opt.)
- ☐ Report Of Federal Action

4. Legal Applicant/Recipient
- a. Applicant Name: Federal Energy Regulatory Commission
- b. Organization Unit:
- c. Street/P.O. Box: 825 North Capitol Street, N.E.
- d. City: Washington   e. County:
- f. State: D.C.   g. Zip Code: 20426
- h. Contact Person (Name & telephone no.): Dr. Jack M. Heinemann, Advisor on Environmental Quality (202) 357-8228

5. Federal Employer Identification No.

6. Program (From Federal Catalog)
- a. Number 99-999
- b. Title Unknown

Federal Energy Regulatory Commission

7. Title and description of applicant's project: RULEMAKING FOR SMALL POWER PRODUCTION AND COGENERATION FACILITIES - EXEMPTIONS FOR GEOTHERMAL FACILITIES - WESTERN REGIONAL DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT - DOCKET NO. RM 81-2 - FERC/EIS-0019DS

Analyzes the environmental effects of geothermal development in the western United States projected as the result of additional rulemaking in Docket No. RM81-2 changes to the Public Utility Regulatory Policies Act of 1978 (PURPA) by the Federal Energy Regulatory Commission (FERC).

8. Type of applicant/recipient
A–State, B–Interstate, C–Substate District, D–County, E–City, F–School District, G–Special Purpose District, H–Community Action Agency, I–Higher Educational Institution, J–Indian Tribe, K–Other

(Specify): Federal Agency — Enter appropriate letter [K]

9. Type of assistance
A–Basic Grant, B–Supplemental Grant, C–Loan, D–Insurance, E–Other — Enter appropriate letter(s) [E]

10. Area of project impact (Names of cities, counties, states, etc.): Statewide, Arizona

11. Estimated number of persons benefiting

12. Type of application
A–New, B–Renewal, C–Revision, D–Continuation, E–Augmentation — Enter appropriate letter [E]

13. Proposed Funding

a. Federal	$ .00
b. Applicant	.00
c. State	.00
d. Local	.00
e. Other	1 .00
f. Total	$ 1 .00

14. Congressional Districts Of:
- a. Applicant
- b. Project: 01 02 03 04

15. Type of change For 12c or 12e
A–Increase Dollars, B–Decrease Dollars, C–Increase Duration, D–Decrease Duration, E–Cancellation, F–Other Specify: — Enter appropriate letter(s)

16. Project Start Date Year month day 19

17. Project Duration Months

18. Estimated date to be submitted to federal agency Year month date 19

19. Existing federal identification number

20. Federal agency to receive request (Name, city, state, zip code)

21. Remarks added ☐ Yes ☒ No

22. The Applicant Certifies That
a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved

b. If required by OMB Circular A-95 this application was submitted, pursuant to instructions therein, to appropriate clearinghouses and all responses are attached:

	No response	Response attached
(1) Arizona State Clearinghouse	☐	☒
(2) Region V Clearinghouse (CAAG)	☐	☒
(3) Region II Clearinghouse (PAG)	☐	☒

23. Certifying representative — a. Typed name and title; b. Signature; c. Date signed Year month day 19

24. Agency name

25. Application received Year month day 19

26. Organizational Unit

27. Administrative office

28. Federal application identification

29. Address

30. Federal grant identification

31. Action taken
- ☐ a. Awarded
- ☐ b. Rejected
- ☐ c. Returned for amendment
- ☐ d. Deferred
- ☐ e. Withdrawn

32. Funding

a. Federal	$ .00
b. Applicant	.00
c. State	.00
d. Local	.00
e. Other	.00
f. Total	$ .00

33. Action date Year month day 19

34. Starting date Year month day 19

35. Contact for additional information (Name and telephone number)

36. Ending date Year month day 19

37. Remarks added ☐ Yes ☐ No

38. Federal agency A-95 action
a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, it has been or is being made.
b. Federal Agency A-95 Official (Name and telephone number)

Section I - Applicant / Recipient Data; Section II - Certification; Section III - Federal Agency Action

TO:

Mr. Les Ormsby, Admin.
Arizona Power Authority
1810 West Adams Street
Phoenix, Arizona 85005

State Application Identifier (SAI)

DEC 19, 1980 State AZ No 80-80-0078

Transportation 6 Regions
Game & Fish
Az. Natural Heritage Program
Power
Health
Water
Parks
Land
Indian Affairs
Center for Public Affairs
Bu. of Geology & Mineral Tech.
OEPAD: N. Wrona
P. Bergthold

FROM: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

This project is referred to you for review and comment. Please evaluate as to the following questions. After completion, return THIS FORM AND ONE XEROX COPY to the Clearinghouse no later than 17 WORKING DAYS from the date noted above. Please contact the Clearinghouse at 255-5004 if you need further information or additional time for review.

☒ No comment on this project ☐ Proposal is supported as written ☐ Comments as indicated below

1. Is project consistent with your agency goals and objectives? ☐ Yes ☐ No ☐ Not Relative to this agency

2. Does project contribute to statewide and/or areawide goals and objectives of which you are familiar? ☐ Yes ☐ No

3. Is there overlap or duplication with other state agency or local responsibilities and/or goals and objectives? ☐ Yes ☐ No

4. Will project have an adverse effect on existing programs with your agency or within project impact area? ☐ Yes ☐ No

5. Does project violate any rules or regulations of your agency? ☐ Yes ☐ No

6. Does project adequately address the intended effects on target population? ☐ Yes ☐ No

7. Is project in accord with existing applicable laws, rules or regulations with which you are familiar? ☐ Yes ☐ No

Additional Comments (Use back of sheet, if necessary)

Reviewers Signature [signature] Date 12/24/80

Title ______ Telephone ______

State Application Identifier (SAI)

DEC 19, 1980 State AZ No. 80-80-0078

TO:

Mr. Robert Jantzen, Director
Game and Fish Dept.
2222 W. Greenway
Phoenix, Arizona 85023

Transportation 6 Regions
Game & Fish
Az. Natural Heritage Program
Power
Health
Water
Parks
Land
Indian Affairs
Center for Public Affairs
Bu. of Geology & Mineral Tech.
OEPAD: N. Wrona
P. Bergthold

FROM: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

This project is referred to you for review and comment. Please evaluate as to the following questions. After completion, return THIS FORM AND ONE XEROX COPY to the Clearinghouse no later than 17 WORKING DAYS from the date noted above. Please contact the Clearinghouse at 255-5004 if you need further information or additional time for review.

☐ No comment on this project ☐ Proposal is supported as written ☒ Comments as indicated below

1. Is project consistent with your agency goals and objectives? ☐ Yes ☐ No ☐ Not Relative to this agency

2. Does project contribute to statewide and/or areawide goals and objectives of which you are familiar? ☐ Yes ☒ No

3. Is there overlap or duplication with other state agency or local responsibilities and/or goals and objectives? ☐ Yes ☒ No

4. Will project have an adverse effect on existing programs with your agency or within project impact area? ☐ Yes ✓ ☐ No

Future geothermal development in Ariz. could pose adverse impacts on fish & wildlife resources.

5. Does project violate any rules or regulations of your agency? ☐ Yes ☒ No

6. Does project adequately address the intended effects on target population? ☒ Yes ☐ No

7. Is project in accord with existing applicable laws, rules or regulations with which you are familiar? ☒ Yes ☐ No

Additional Comments (Use back of sheet, if necessary):

Reviewers Signature Robert K. Weaver Date Dec. 23, 1980

Title Habitat Evaluation Coordinator Telephone 942-3000

Comment Form To Be Completed by Reviewing Agency

TO:

Dr. James Becker
Center for Public Affairs
Arizona State University
Tempe, Arizona 85281

State Application Identifier (SAI)

DEC 19, 1980 State AZ No 80-80-0078

Transportation 6 Regions
Game & Fish
Az. Natural Heritage Program
Power
Health
Water
Parks
Land
Indian Affairs
Center for Public Affairs
Bu. of Geology & Mineral Tech.
OEPAD: N. Wrona
P. Bergthold

FROM: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

This project is referred to you for review and comment. Please evaluate as to the following questions. After completion, return THIS FORM AND ONE XEROX COPY to the Clearinghouse no later than 17 WORKING DAYS from the date noted above. Please contact the Clearinghouse at 255-5004 if you need further information or additional time for review.

[X] No comment on this project [ ] Proposal is supported as written [ ] Comments as indicated below

1. Is project consistent with your agency goals and objectives? [ ] Yes [ ] No [ ] Not Relative to this agency

2. Does project contribute to statewide and/or areawide goals and objectives of which you are familiar? [ ] Yes [ ] No

3 Is there overlap or duplication with other state agency or local responsibilities and/or goals and objectives? [ ] Yes [ ] No

4. Will project have an adverse effect on existing programs with your agency or within project impact area? [ ] Yes [ ] No

5 Does project violate any rules or regulations of your agency? [ ] Yes [ ] No

6 Does project adequately address the intended effects on target population? [ ] Yes [ ] No

7 Is project in accord with existing applicable laws, rules or regulations with which you are familiar? [ ] Yes [ ] No

Additional Comments (Use back of sheet, if necessary)

Reviewers Signature R. J. Becker Date 12-22-80

Title Prof. Center [illegible] Public Affairs Telephone 965-1013

TO:

Art Auerbach, Supervisor
Socio Economic Analysis Section
Dept. of Transportation
206 So. 17th Ave., Rm. 310 B
Phoenix, Arizona 85007

State Application Identifier (SAI)

DEC 19, 1980 State AZ No. 80-80-0078

Transportation 6 Regions
Game & Fish
Az. Natural Heritage Program
Power
Health
Water
Parks
Land
Indian Affairs
Center for Public Affairs
Bu. of Geology & Mineral Tech.
OEPAD: N. Wrona
P. Bergthold

FROM: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

RECEIVED
DEC 23 1980
SOCIOECONOMIC ANALYSIS

This project is referred to you for review and comment. Please evaluate as to the following questions. After completion, return THIS FORM AND ONE XEROX COPY to the Clearinghouse no later than 17 WORKING DAYS from the date noted above. Please contact the Clearinghouse at 255-5004 if you need further information or additional time for review.

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5. Does project violate any rules or regulations of your agency? ☐ Yes ☐ No

6. Does project adequately address the intended effects on target population? ☐ Yes ☐ No

7. Is project in accord with existing applicable laws, rules or regulations with which you are familiar? ☐ Yes ☐ No

Additional Comments (Use back of sheet, if necessary):

Reviewers Signature Paul T. Klooz Date 12-29-80

Title State Planner Telephone 261-7251

TO:

Tom Swanson, Exec. Dir.
Pima Association of Gov'ts.
405 Transamerica Building
Tucson, AZ 85701

FROM. Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

State Application Identifier (SAI)

DEC 19, 1980 State AZ No. 80-80-0078

Transportation 6 Regions
Game & Fish
Az. Natural Heritage Program
Power
Health
Water
Parks
Land
Indian Affairs
Center for Public Affairs
Bu. of Geology & Mineral Tech.
OEPAD: N. Wrona
P. Bergthold

RECV'D. Pima Assoc. of Govts.

This project is referred to you for review and comment. Please evaluate as to the following questions. After completion, return THIS FORM AND ONE XEROX COPY to the *Clearinghouse no later than* 17 WORKING DAYS from the date noted above. Please contact the Clearinghouse at 255-5004 if you need further information or additional time for review.

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6. Does project adequately address the intended effects on target population? ☐ Yes ☐ No

7 Is project in accord with existing applicable laws, rules or regulations with which you are familiar? ☐ Yes ☐ No

Additional Comments (Use back of sheet, if necessary).

Reviewers Signature Kathleen W. Childers Date 12/23/80

Title ______________________ Telephone

TO:

John Blackburn, Exec. Dir.
Central Arizona Association
of Governments
P.O. Box JJ (1810 Main St.)
Florence, AZ 85232

State Application Identifier (SAI)

DEC 19, 1980 State AZ No 80-80-0078

Transportation 6 Regions
Game & Fish
Az. Natural Heritage Program
Power
Health
Water
Parks
Land
Indian Affairs
Center for Public Affairs
Bu. of Geology & Mineral Tech.
OEPAD: N. Wrona
P. Bergthold

FROM: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

This project is referred to you for review and comment. Please evaluate as to the following questions. After completion, return THIS FORM AND ONE XEROX COPY to the Clearinghouse no later than 17 WORKING DAYS from the date noted above. Please contact the Clearinghouse at 255-5004 if you need further information or additional time for review.

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6. Does project adequately address the intended effects on target population? ☐ Yes ☐ No

7. Is project in accord with existing applicable laws, rules or regulations with which you are familiar? ☐ Yes ☐ No

Additional Comments (Use back of sheet, if necessary).

Reviewer's Signature ______________________ Date ______________

MONTANA HISTORICAL SOCIETY
HISTORIC PRESERVATION OFFICE
225 NORTH ROBERTS STREET • (406) 449-4584 • HELENA, MONTANA 59601

DEC 29 ... REGULATORY COMMISSION

OFFICIAL FILE COPY

CENTRAL FILES

December 19, 1980

RM81-2

Mr. Kenneth F. Plumb, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street NE
Washington, D.C. 20426

Dear Mr. Plumb:

Re: Western Regional Draft
Supplemental E. I. S. Rulemaking
for small Power production and
Cogeneration Facilities
-Exemptions for Geothermal Facilities

Thank you for the opportunity to review the above-mentioned document. The rules for protecting cultural properties should include reference to responsibilities as outlined in Section 106 of the National Historic Preservation Act, Executive Order 11593, and 36CFR800 among others. The terms and procedures used in the document could be more clearly presented if used as found in the above-named federal legislation, regulations, etc.

Sincerely,

Marcella Sherfy

Marcella Sherfy
Deputy SHPO

TAF/MS/dot

Department of Energy

VICTOR ATIYEH
GOVERNOR

LABOR & INDUSTRIES BUILDING, ROOM 102, SALEM, OREGON 97310 PHONE 378-4040

P 3-1

December 30, 1980

Jack M. Heineman
Federal Energy Regulatory Commission
Advisor on Environmental Quality
825 N Capital Street NE
Washington D.C. 20426

Dear Mr. Heineman:

I am responding to misleading information contained in Docket No. RM-81-2 entitled Rulemaking for Small Power Production and Co-generation Facilities - Exemptions for Geothermal Facilities. Specifically, I refer you to page V-9, paragraph 2.

False conclusions have been drawn from phone conversations we have had with your staff. Oregon has significant geothermal resources, some of which we are counting on being developed in the 1990-1995 time frame. Our research and work with Oregon utilities has led us to concluded that at least 20 average MW of geothermal electrical potential will be developed by 1990 and 60 average MW by 1995. Depending on resource discoveries, I believe that this may be very conservative, particularly in the 1995 timeframe.

Summarizing the geothermal development climate in Oregon as being typified by environmental challenges in the Alvord and Newberry Caldera is misleading. In fact, we are expecting deep drilling in both the Alvord and the Oregon Cascades this coming year.

Your conclusion that no PURPA-induced hot water development is anticipated before 1995, may be correct, but not for the reasons implied. Geothermal development will occur, but it is expected that the resource development will typically be completed by a resource company which then sells the energy to a utility that owns and operates the generation facility.

We have been working with a possible 40 MW hybrid, geothermal-woodwaste, cogeneration facility in Hines, Oregon. This would be developed by a private industry and would likely be influenced by proposed PURPA regulations.

I feel that the misrepresentation of geothermal development potential in Oregon is very serious. I request that a correction be sent to all that received copies of the Docket.

Please contact me at 503-378-6063 if I can be of any assistance or if you would like more information on development potential in Oregon.

Sincerely,

David Philbrick

David Philbrick, Administrator
Renewable Resources

DP/BJS:cs
0999B

Department of Energy
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

FILED OFFICE OF THE SECRETARY
DEC 29 9 48 AM '80
FEDERAL ENERGY REGULATORY COMMISSION

OFFICIAL FILE COPY

DEC 24 1980

CENTRAL FILES

In reply refer to: PRT

RM81-2

Secretary
Federal Energy Regulatory Commission
825 North Capital Street, NE.
Washington, D.C.

Dear Sir:

I have reviewed the Western Regional Draft Supplemental Environmental Impact Statement and feel the sentence on page V-9, "Two sources predicted that geothermal development would not occur in Oregon before 1995 because of institutional barriers...", has overly condensed my conversation on November 7, 1980, too much. This statement must be clarified to express that based on current conditions it is not anticipated that substantial amounts of geothermal power will be on-line by 1995. This opinion holds not only for Oregon, but for all states within BPA's service area, which includes Oregon, Washington, Idaho, and western Montana. This is not meant to imply development of pilot, demonstration, or a limited number of commercial plants will not occur before 1995.

Institutional factors are only one of several concerns limiting geothermal development in this region. Barriers of even more significance to geothermal development are the limited number of known reservoirs with temperatures potentially suitable for commercial development with existing technologies, and the lack of a commercially proven technology capable of generating electricity from moderate to hot water reservoirs.

It is in light of these conditions that only limited geothermal development is anticipated in the Pacific Northwest by 1995. However, if any of these conditions change, such as a technology being proven commercially feasible for reservoir temperatures near 150°C, or if new reservoirs with temperatures greater than 200°C are discovered, development of geothermal resources in the Pacific Northwest could be accelerated.

Sincerely,

Stephen D. Vickers /WBH

Stephen D. Vickers
Environmental Specialist

The requested changes have been made.

Department of Energy
Washington, D.C. 20461

January 12, 1981

Mr. Kenneth F. Plumb, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street, N.E.
Washington, D.C. 20426

Dear Mr. Plumb:

The Department of Energy Division of Geothermal Energy (DGE) has reviewed the Draft Supplemental Environmental Impact Statement (DSEIS) entitled "Rulemaking for Small Power Production and Cogeneration Facilities - Exemptions for Geothermal Facilities," Docket No. RM 81-2, FERC/EIS-0019 DS, December 1980. This review resulted in no substantive comments on the DSEIS, however, the following errors were noted and re-wordings are offered for your consideration:

Location	Should Read
p. I-2, line 15	--- the most environmentally objectionable being hydrogen sulfide ---.
p. I-2, line 23	--- and therefore may not be discharged to surface waters without degrading their quality. Local geologic conditions and hydrology may preclude injection of spent geothermal fluids into the ground where they could contaminate potable groundwater.
p. I-2, line 35	--- of a geothermal facility should be much easier and more successful than rehabilitation associated with fossil fuel power plants ---.
p. I-3, line 2	Increased development of geothermal facilities will reduce impacts ---.
p. I-3, line 14	For example, the Department of Energy (DOE) has funded development of a new hydrogen sulfide scrubber system to reduce emission ---.
p. V-1, line 12	--- 80 MW ---.
p. V-7, line 39	--- capital formation ---.
p. V-8, last line	--- geopressured resource ---.
p. VI-9, line 20	should this be "Newberry Crater"?
p. VI-1, line 5	--- earth's mantle ---.

Except where noted, the suggested changes have been incorporated into the text.

Location	Should Read
p. VI-1, line 8	--- with the hot magma, or with rock that has been heated by the magma, steam or heated water ---.
p. VI-3, line 7	--- hydrogen sulfide (H_2S) ---.
p. VI-3, line 27	delete "arsenic" (It appears in line 25).
p. VI-7, line 9	--- steam that may be corrosive.
p. VI-7, line 15	--- after an initial well has been tested.
p. VI-7, line 17	--- gunite at each production drill site. A portable drill rig is used to drill the wells sequentially.
p. VI-7, line 19	Several production wells are required ---.
p. VI-7, line 23	--- above ground, while additional wells ---.
p. VII-1, line 11	80 MW geothermal facility would usually be minor on a ---.
p. VII-5, line 15	--- of New Mexico, which is 0.010 ppm (0.014 microgram/m^3) (The standard was changed in 1979).
p. VII-5, line 19	--- 0.01 ppm ---.
p. VII-7, line 42	--- where open systems are employed.
p. VII-8, after line 15	Add: If 100 percent injection is required (as it is in Imperial County, California), then even flashed steam plants will require a source of water to make up the required volume of injected fluid.
p. VII-8, line 31	--- about 1310 l/min (346 gal/min) ---.
p. VII-8, line 34	--- or 13.2×10^6 m^3/yr ---.
p. VII-8, line 1	--- according ---.
p. VII-8, line 13	Separation of precipitated solids from spent geothermal fluids may be necessary ---.
p. VII-8, line 22	--- solid wastes which contain ---.
p. VII-13, line 37	--- structures can be ---.

Constituents include arsenic as an ion and arsenic as a metal; therefore, the suggested revision was not made.

Location	Should Read
p. VII-15, line 20	--- potentially hazardous level.
p. VII-20, line 13	--- playing --- geothermal development is low ---.
p. VII-21, line 2	--- such as water for cooling and for fluid injection.
p. VII-21 lines 14 & 27	--- Mayacmas Range ---.

The opportunity to comment on this DSEIS is appreciated.

Sincerely,

John W. Salisbury, Acting Director
Division of Geothermal Energy

cc:
D. Lombard

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JAN 5 11 20 AM '81
FEDERAL ENERGY REGULATORY COMMISSION

CRA
RM 3 nec

DEC 29 1980

Secretary
Federal Energy Regulatory
Commission
825 North Capitol Street, NE
Washington, DC 20426

Dear Sir:

This is in response to your request for comments on the Western Regional Draft Supplemental Environmental Impact Statement for a proposed rulemaking on Small Power Production and Cogeneration Facilities - Exemptions for Geothermal Facilities.

We have reviewed the statement and determined that the proposed action has no significant radiological health and safety impact nor will it adversely impact any activities subject to regulation by the Nuclear Regulatory Commission.

Since we made no substantive comments, you need not send us the Final Environmental Statement, when issued.

Thank you for providing us with the opportunity to review this Draft Environmental Statement.

Sincerely,

Daniel R. Muller

Daniel R. Muller, Assistant Director
for Environmental Technology
Division of Engineering

cc: K. Cornell

Scott M. Matheson
Governor

Kent Briggs
State Planning Coordinator

K n 181.2

STATE OF UTAH

Office of the

STATE PLANNING COORDINATOR
124 State Capitol
Salt Lake City, Utah 84114
(801) 533-5245

December 22, 1980

DEC 24 9 50 AM '80

Secretary
Federal Energy Regulatory Commission
825 North Capitol St., N.E.
Washington, D.C. 20426

Madam/Sirs:

SUBJECT: FERC Western Regional Draft Supplement - Rulemaking for Small Power Production & Cogeneration Facilities - Exemptions for Geothermal Facilities, State ID #801215050

We have received the above-referenced document for review at the Utah State Clearinghouse. The comment deadline date is January 5, 1981.

We are not sure why we did not receive a copy of this document until December 15th, but now feel we cannot make an accurate review of it by January 5th and would like to request an extension of the comment period to January 19th.

Please let me know as soon as possible if this extension can be granted.

Please refer to the State ID# 801215050 when corresponding with us on this matter.

Thank you for your cooperation.

Sincerely,

Carolyn M. Jones

Carolyn M. Jones
Assistant A-95 Coordinator

These comments were received after the final date for commenting and therefore too late to be responded to and are included for information only.

MONTANA HISTORICAL SOCIETY
HISTORIC PRESERVATION OFFICE
225 NORTH ROBERTS STREET • (406) 449-4584 • HELENA, MONTANA 59601

January 29, 1981

Federal Energy Regulatory Commission
Adviro on Environmental Quality
825 North Capitol Street N.E.
Washington, D.C. 20426

Dear Sirs:

Re: Rulemaking for Categorical Exemption from Licensing Under Part I of the Federal Power Act for Small Hydroelectric Power Projects with an installed Capacity of 5 megawatts or less.

Thank you for the opportunity to comment on the above-named environmental assessment. I concur that in most cases the proposed rule would have little effect on cultural resources. However, I do believe that related right-of-way clearing will most probably affect archaeological properties. I suggest that the rules and procedures for identifying archaeological sites eligible for listing in the National Register be added and presented in a clear fashion. In addition this discussion should expound on the applicant's and agency's responsibilities under appliable Federal Legislation.

Sincerely,

Marcella Sherfy

Marcella Sherfy
Deputy SHPO

TAF/MS/det

Dist. Cetter

OREGON PROJECT NOTIFICATION AND REVIEW SYSTEM

STATE CLEARINGHOUSE

INTERGOVERNMENTAL ... DIVISION
JAN 19 1981

Intergovornmental Relations Division
155 Cottage ST NE
Salem, Oregon 97310, Phone: 378-3732

P N R S STATE REVIEW

Project #: 8012 4 410 Due Date: 1-9-81

To Agency Addressed: If you intend to comment but cannot respond by the return date, please notify us immediately. If no response is received by the due date, it will be assumed that you have no comment and the file will be closed

---

PROGRAM REVIEW AND COMMENT

To State Clearinghouse: We have reviewed the subject Notice and have reached the following conclusions on its relationship to our plans and programs:

( ) It has no adverse effect.

( ) We have no comment.

(X) Effects, although measurable, would be acceptable.

( ) It has adverse effects. (Explain in Remarks Section)

( ) We are interested but require more information to evaluate the proposal. (Explain in Remarks Section)

( ) Please coordinate the implementation of the proposal with us.

(X) Additional comments for project improvement. (Attach if necessary)

REMARKS (Please type or print legibly)

Agency Fish & Wildlife By [signature]
Environmental Mgmt. Section 1-9-81

PNRS 8012-4-410

The Oregon Department of Fish and Wildlife has reviewed the Western Regional Draft Supplemental Environmental Impact Statement for Small Power Production and Cogeneration Facilities-Exemptions for Geothermal Facilities. However, it was difficult to develop significant comments since the Department did not have the opportunity to review the DEIS referred to in the cover letter and abstract of the supplemental draft.

The proposed exemptions for geothermal facilities could, according to the supplemental draft, stimulate the development of geothermal development in California, Nevada and Idaho. However, since Oregon does have significant geothermal resources identified, these rules could relate to development in Oregon.

In the text of Notice of Proposed Rulemaking (Docket No. RM 81-2, page 29) there is the statement that "PURPA - induced development of geothermal small power production facilities would not create significant environmental effects". In Oregon several of the known geothermal resource areas are located in environmentally fragile areas. These areas include Eastern Oregon Desert, with shallow erosive soils and limited water resources. Several KGRA are associated with unique, threatened or endangered fish habitats as well as sensitive big game habitats (e.g., winter ranges). Geothermal development in these areas could create significant environmental effects.

The Department agrees that federal, state and local control of geothermal siting and enforcement of existing environmental laws will mitigate many adverse effect of development. However, there is also the potential for other mitigation, including off-site fish and/or wildlife habitat improvement that should be considered as an integral part of any development proposal.

JN:te

OREGON PROJECT NOTIFICATION AND REVIEW SYSTEM

STATE CLEARINGHOUSE

Intergovernmental Relations Division
155 Cottage St NE , Salem, Oregon , 97310
Phone Number: 378-3732

PNRS STATE REVIEW

Project #: 0012 4 410 Return Date: 1-9-81

ENVIRONMENTAL IMPACT REVIEW PROCEDURES

If you cannot respond by the above return date, please call to arrange an extension at least one week prior to the review date.

ENVIRONMENTAL IMPACT REVIEW
DRAFT STATEMENT

( ) This project has no significant environmental impact.

( ) The environmental impact is adequately described.

(X) We suggest that the following points be considered in the preparation of a Final Environmental Impact Statement.

( ) No comment.

Remarks

We strongly urge that this document be revised to include a more realistic representation of Oregon's geothermal development planning. Specifically, PV-9 states incorrectly Oregon's potential for geothermal development ________refer to attached letter.

Additionally, we have 2-3 sites that would initially be amendable to PURPA induced actively. These would be in the Cruyr-Warner and Alvord valley.

Bill Sidle
(503) 378-5981

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON 20426

IN REPLY REFER TO:

Small Power Production and
Cogeneration Facilities
Docket No. RM81-2

February 13, 1981

TO THE PARTY ADDRESSED:

The enclosed Western Regional Final Supplemental Environmental Impact Statement (FSEIS) for the Commission's final rules on Small Power Production and Cogeneration Facilities -- Exemption for Geothermal Facilities -- is being sent to you pursuant to the requirements of the National Environmental Policy Act of 1969 (NEPA) and Commission Order No. 415-C.

The Federal Energy Regulatory Commission (FERC) intends to issue final rules (Docket No. RM81-2) to implement provisions of Section 643 of the Energy Security Act of 1980 (ESA) concerning geothermal energy. The FERC issued a proposed rulemaking on November 6, 1980 in Docket No. RM81-2 regarding Eligibility, Rates and Exemptions for Qualitying and Utility-Owned Geothermal Small Power Production Facilities, which amended parts of the Federal Power Act and the Public Utility Regulatory Policies Act (PURPA). A Draft SEIS was circulated for comment on that rulemaking on December 12, 1980. Previous rules issued by FERC (Docket Nos. RM79-54 and RM79-55) which implemented sections 201 and 210 of PURPA dealt with the requirements for qualification of and incentives available to cogeneration and small power production facilities, including geothermal small power production facilities. These rules were evaluated in a Draft EIS on "Rulemakings for: SMALL POWER PRODUCTION AND COGENERATION FACILITIES -- QUALIFYING STATUS/RATES AND EXEMPTIONS," Docket Nos. RM79-54 and RM79-55, June 1980. Section 643 of ESA provides for further incentives to encourage geothermal development.

This FSEIS is being circulated prior to the completion of the Final EIS on the overall small power production and cogeneration facilities qualifying program in order for the Commission to expeditiously complete its regulatory responsibilities under Section 643 of ESA. Since geothermal facilities are technologically distinct from and environmentally unrelated to other facilities which were considered in the previously described Draft EIS, the Commission staff, in consultation with the Council on Environmental Quality, has determined that it is consistent with the intent of NEPA to issue this FSEIS and proceed with the rulemaking in Docket No. RM81-2 before completion of the Final EIS in Docket No. RM79-54 and RM79-55. This geothermal FSEIS will become part of that Final EIS when it is completed and circulated to the public.

In accordance with section 102(2)(C) of NEPA, the Commission staff has considered comments received on the Draft SEIS in preparing the final rules and the Final SEIS. A copy of each letter received during the comment period is included in this document.

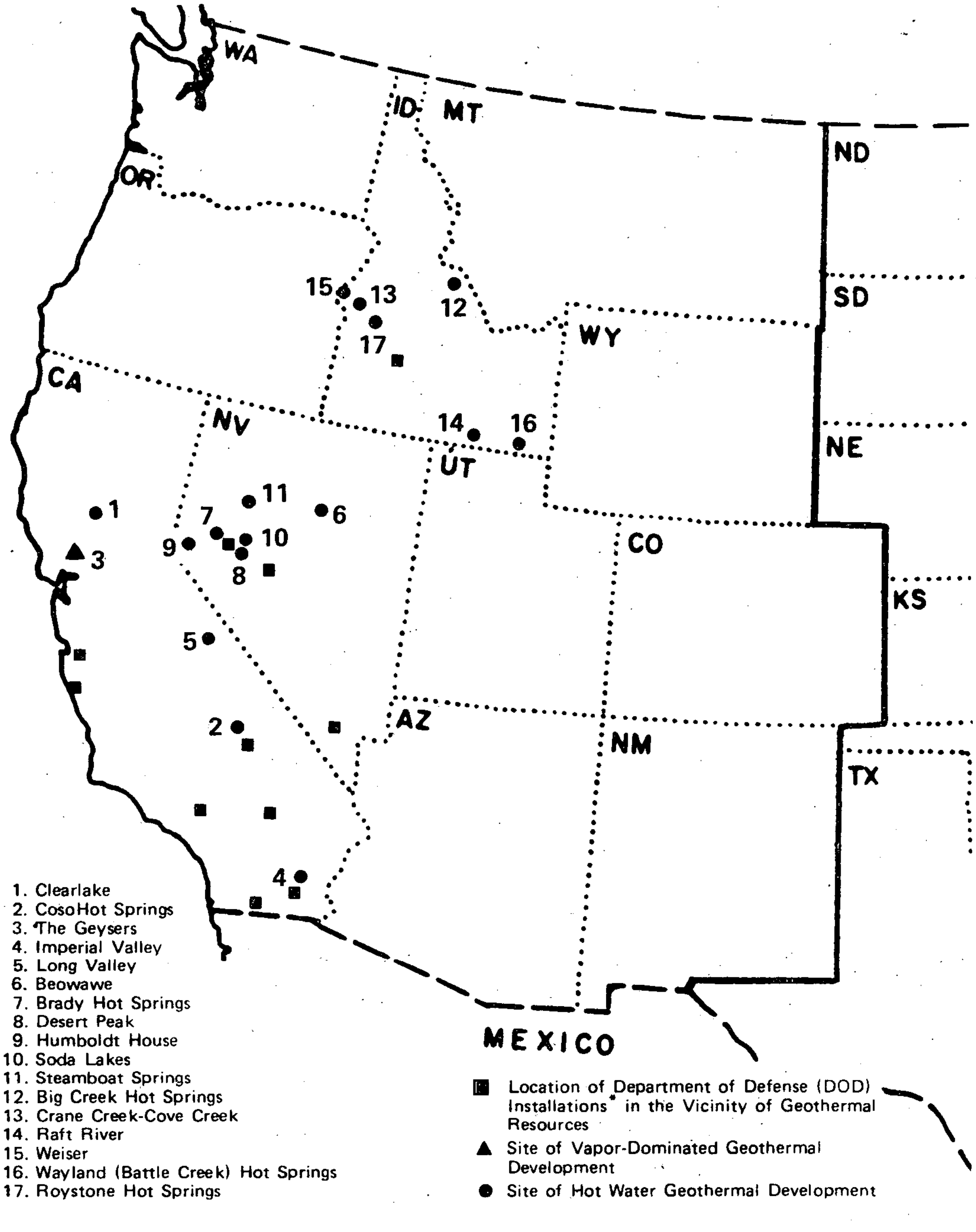
Copies of this FSEIS have been sent to the addressees listed in Section II. The FSEIS is available for public inspection in the Commission's Division of Public Information, Room 1000, and in its regional offices in New York City, Chicago, Atlanta, Fort Worth and San Francisco. Limited copies are available upon request from the Commission's Division of Public Information in Washington, D.C. Anyone wishing to comment on the FSEIS should submit them to the Secretary, Federal Energy Regulatory Commission, 825 North Capitol St., N.E., Washington, D.C. 20426, no later than March 23, 1981.

Kenneth F. Plumb

Secretary

Enclosure

ADDENDA



* When geothermal development occurs in the vicinity of DOD installations, FERC and DOD will coordinate all activities to assure that military operations are not adversely affected.

FIGURE V-1. LOCATIONS OF PURPA-INDUCED GEOTHERMAL DEVELOPMENT

9EPR

Resources Building
1416 Ninth Street
(916) 445-5656

Department of Conservation
Department of Fish and Game
Department of Forestry
Department of Boating and Waterways
Department of Parks and Recreation
Department of Water Resources

EDMUND G. BROWN JR.
GOVERNOR OF
CALIFORNIA

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

Air Resources Board
California Coastal Commission
California Conservation Corps
Colorado River Board
Energy Resources Conservation and Development Commission
Regional Water Quality Control Boards
San Francisco Bay Conservation and Development Commission
Solid Waste Management Board
State Coastal Conservancy
State Lands Commission
State Reclamation Board
State Water Resources Control Board

1981 JAN 9

Mr. Kenneth F. Plumb, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street, N.E.
Washington, D.C. 20426

Dear Mr. Plumb:

The State of California has reviewed the Western Regional Draft Supplemental EIS on Rulemaking for Small Power Production and Cogeneration Facilities--Exemptions for Geothermal Facilities, submitted through the Office of Planning and Research in the Governor's Office.

The State's review, in accordance with the provisions of Office of Management and Budget Circular A-95 and the National Environmental Policy Act of 1969, was coordinated with the Departments of Boating and Waterways, Conservation, Fish and Game, Parks and Recreation, Water Resources, Food and Agriculture, and Transportation; the Air Resources, Solid Waste Management, and State Water Resources Control Boards; and the Coastal, Energy, Public Utilities, and State Lands Commissions.

The report is quite general in nature, and may be of limited value in analyzing of environmental impacts of specific projects. The section on wildlife and vegetation (page VII-9) is only a brief summary of effects reported in The Geysers Geothermal Field. It does not include impacts which may occur in other geothermal areas. The section concludes that "Geothermal facilities should be sited to avoid loss or disturbance of important wildlife habitats...". In the Geysers area, facilities have commonly been sited where they meet geological, air quality, and visual needs rather than fish and wildlife needs.

We believe that the report should be revised, therefore, to provide greater emphasis on specific impacts and required mitigation measures to reduce environmental degradation. The State recommends that the final EIS include the following mitigation measures, developed by the Department of Fish and Game for geothermal development in the Geysers area, so that they will be considered in the preparation of environmental documents for specific projects:

1. Environmental reports for a project should include an assessment of the fish, wildlife, and their habitat in the project area; a description of the facilities and their locations; alternatives for the selected developments; and the impacts of and mitigation necessary for each alternative. Regarding wildlife resources, vegetation types and values should be discussed and mapped on the leasehold as well as for adjoining areas that may be affected. Particular attention should be given to identifying and protecting important habitat types including nesting and breeding areas, migration routes, deer fawning meadows, den and nest trees, snags, oak stands, riparian growth, waterholes, springs, seeps, and unique associations of mixed plant species.

2. Those areas altered by construction activity, but not needed for operation of the facilities, such as cut or fill slopes, should be restored to their former wildlife habitat value. This would require soil preparation, application of fertilizer, immediate seeding with appropriate quantity and mixture of grass and herb species, and planting of trees and shrubs of the kind which are found in the area. Such plantings should be watered and tended during their establishment period to ensure survival. Any of the trees or shrubs which do not survive to maturity should be replaced.

3. The carrying capacity of wildlife habitat not in the immediate vicinity of the development should be increased to replace habitat lost with project construction. This area should be selected so that it will not be subject to impacts of future development. Management to increase wildlife carrying capacity would continue for the life of the project, and would include:

   a. Development of watering sites or small ponds in areas of low water availability. If seeps or springs are not available, then a water well should be drilled, a pump installed and maintained, and a pond to retain water should be constructed. At least one such site should be available on a 100-acre parcel.

   b. The habitat and forage value of brush areas should be increased by controlled burning or mechanical crushing and removal. The selected method would depend on the soil type and physical characteristics of the area. Generally, a strip about 100 feet wide and several hundred yards long on approximately each 25 acres of dense brush would provide increased forage and trail access.

   c. Placement of nest boxes for squirrels and songbirds in appropriate habitats where it has been determined that populations may benefit from such development.

d. Slash, trimmings, and brush from clearing for facilties and roads should be stacked in loose piles. Largest limbs and trunks should be loosely stacked on the bottom of the piles, and other material then be stacked on top. These brush piles may be circular or linear, and should be about 2 meters high and 4 meters wide at the base.

e. Mature trees greater than 35 cm DBH removed as a consequence of clearing for facilities sites and access road should be used to create snags as habitat.

4. To reduce the effects of erosion and accidental discharges, project facilities should be designed so that the potential for these problems is minimized. Areas where the problems may occur should be identified, and such devices as automatic valves or containment basins should be installed and contingency plans developed to cope with spills.

5. Clearing and grading operations should not be conducted during the winter rain season, November 1 to May 1. All erosion control measures (drainage structures, grass seeding, mulch application) should be completed before November 1.

6. Roads intended for all-weather travel should be compacted, paved, and drainage systems installed to prevent erosion. Road drainage systems should be designed to eliminate discharges of runoff into erodible areas.

7. Sedimentation basins should be placed in sites directly below extensive cut or fill slopes. Collected sediment should be removed periodically. The basins should have impermeable clay linings so as to retain water for wildlife during summer.

8. Buffer zones of undisturbed vegetation should be maintained 500 feet on either side of streams. No construction should occur in this buffer zone. Roads crossing riparian areas should be limited to the minimum safe width.

We greatly appreciate having been given an opportunity to review this report.

Sincerely,

James W Burns

JAMES W. BURNS
Assistant Secretary for Resources

cc: Office of Planning and Research
(SCH 80062703)

The subject of this EIS is a rulemaking for a national program of regulatory exemptions designed to encourage development of geothermal energy resources. The document is therefore programmatic in nature and not intended to analyze, in depth, specific projects, but rather assesses anticipated activity at a national level which might be expected to occur over a 15 year period. The action by the Commission to certify facilities as "Qualifying Facilities" does not grant a construction or siting permit or a license to an applicant seeking qualification.

In line with the Commission's proposed NEPA regulations in Docket No. RM79-69, which encourage the reduction in length of EISs, only principal (significant) generic environmental issues which could be common to most sites are identified. Additional environmental review and coordination activities would be undertaken by appropriate lead agencies for each specific development site (see VII-16). Appropriate consideration of the mitigation measures necessary at specific sites would be taken at the time of a specific proposal to develop a geothermal field.

Regarding discussion in this document of fish and wildlife protection concerns, we refer you to Table VII-1, VII-9-10, and Appendix A for generic descriptions and assessment of anticipated national levels of impact. Table VII-4 shows the expected levels of impact on vegetation and wildlife from PURPA-induced development in identified areas having geothermal protection.