THE MITRE CORPORATION
METREK Division

WORKING PAPER

WP. 12119 _____
No. Vol. Series Rev. Supp. Corr.

Subject: Site-Specific Data Files and Analysis of Technology R&D and
Other Needs for Near-Term Hydrothermal Development

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Contract No.: New Contract

Sponsor: ERDA

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Project No.: 1526A

Dept.: W-52

Date: 28 February 1977

Approved for MITRE/METREK Distribution: _____

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ABSTRACT:

This working paper contains the data files and analysis of postulated development at 20 candidate hydrothermal sites. The technology R&D and other needs for this postulated development are provided. The detailed site-level analysis may be used as a basis for mission-oriented planning for hydrothermal development. The entire paper is in chart format.

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FOREWORD

This paper presents data for 20 potential liquid-dominated hydrothermal resources postulated for development in the 1977-1990 time frame and analyzes the needs for their development. The paper comprises a summary of the needs identified followed by 20 individual data files, one for each site.

The paper is directed towards deriving implications from site-specific analyses of postulated development. The areas covered by the analysis include land leasing and major site-specific development milestones, technology R&D, and economics.

The individual reservoir-specific data and development analysis files contain data on the physical, geological and geothermal characteristics of each site, the estimated development schedule (with major milestones), and projected economics.

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INTRODUCTION

This paper presents site-specific files for 20 high-temperature (>150° C), liquid-dominated hydrothermal resources postulated for geothermal-electric development in the 1977-1990 time frame. Included with the descriptive data for each site is an analysis of its geothermal development needs.

Available data, and analysis based on this data, has been entered in the files. It is intended that the files will be expanded to include additional hydrothermal and geopressured resources, which have been currently identified. In addition, the file will be updated as new data and geothermal prospects are identified.

In effect, each of the site-specific files provides the basis for a development-oriented prospectus for the site. These prospectuses may be used in the development of realistic regional scenarios (see Figure 1 for Geothermal Regions). The files may also form the basis of a geothermal operations monitor.

FIGURE 1

GEOTHERMAL ENERGY OPERATIONS RESEARCH REGIONAL BOUNDARIES^{*}

^{*}Regional boundaries based on rough estimates of near future development activities as deduced by ERDA from the USGS Circular 726, Assessment of Geothermal Resources of the United States - 1975. The regions were established such that roughly equivalent levels of activity are expected to occur in each region.

FORMAT FOR THE GEOTHERMAL SITE DATA
AND DEVELOPMENT-ANALYSIS FILE

Each of the following site-specific files has been arranged in two sections: Analysis of Postulated Site Development, and Description and Data for the site.

Analysis of Postulated Development

Contents: Site Development Schedule (For First 50 MWe Plant)
Principal Assumptions and Milestones for Site
Development
Technology R&D Needs Analysis
Technology R&D Needs and Timing for Postulated
Development
Site Economics (Assuming No Cost Reductions Due
to R&D)

The analysis of postulated site development begins with a site development schedule followed by a list of the principal assumptions (derived from site-specific data and description), which were used to formulate the development schedules. Principal milestones derived from the site development schedule are also listed.

The first page on Technology R&D Needs Analysis describes the structure that was used to list the needs identified for this site. The headings for the technology needs are those contained in the "Analysis of Hydrothermal Development: R&D Technology Needs Checklist" (MITRE WP-12055, 28 January 1977).

The analysis of site economics contains the estimated cost of electricity using an annualized cost model in the absence of improvements in technology or government incentives and/or subsidy programs. The cost and financial data on which the estimate is based are also included.

Description and Data

Contents: Summary
Map of Site
Site Location and Physical Description
Reservoir Characteristics and Geological/
Geophysical Description
Land Ownership and Leasing
Geothermal Development Status
Administrative Requirements
Description of the Environment
Population, Transportation, and Utilities
Geothermal Resources File (Geotherm)

The section on site-specific description and data contains the information used as the basis for the preceding analysis. Contained in this section are the overall framework and data elements needed for regional and site-specific development analysis. Information from available sources has already been entered. It may be noted, however, that some information such as leasing of state and private land has not been presented in a comprehensive manner. Such information may only be obtainable in detail through personal contacts.

A summary of the data collected for each of the 20 sites is found in Table I.

TABLE 1

SUMMARY OF DESCRIPTION AND DATA FOR EACH SITE

RESOURCE	TEMPERATURE, °C Surface - Subsurface	TOTAL DEVELOPABLE SOLIDS (FPO)	ESTIMATED ELECTRIC ENERGY POTENTIAL (MWH/10 YEARS)	TYPE OF OVERLAYING ROCK	ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS)	TOTAL FPO'S ACRES	TOTAL FEDERAL ACRES	FEDERAL ACRES LEASED	TOTAL STATE AND PRIVATE ACRES	STATE AND PRIVATE ACRES LEASED	GEOHERMAL DEVELOPMENT STATUS	LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENT	LAND USE AND POPULATION	COMMENTS AND CRITICAL ISSUES
Roberts, CA	190	15,000	971 ⁽¹⁾	Soft	1,000	58,568	0	0	58,568		As of January 1977, tentative plans for a 65 Mw binary cycle generating unit. EPRI has agreed to contribute \$5.5 million to the project. (10)	Reasonable state and local regulations. (1A)	Irrigated agricultural land. Generally sparse population. Roberts population is 800. (6)	Extremely flat topography, sensitive to disturbance of runoff patterns. (1D) In seismically active area. (1D)
Reynolds, R.D., HI	88	230	7,800 ⁽⁵⁾	100 ⁽¹⁾	Medium- Hard	830	29,791 ⁽⁹⁾	24,592			Reasonable wells drilled. Projected total mass flow capacity of well is 1 million lbs/hr of steam and hot water. (15)	Positive public attitude. As of August 1975, no regulations or constraints. (111)	Rural bordered by mountains. Rice, agriculture and tourism in county. (5)	Cooling water is probably not available. Withdrawal from the aquifer has caused up to 181 cm (6 ft.) of subsidence. (5) Zoning at the resource restricts only salvage yards, dumps, and gravel pits. (6)
Yaffee, California, HI	87	250	6,000	1,870 ⁽¹⁾	Hard	1,000	168,761				As of June 1976, 9 productive wells, negotiations to sell steam to utility. Continued drilling and testing of field with possible agreement to construct 50 Mw flash-steam power plant. (2)		Open grazed woodland in mountains. Population centers within 16 km (10 mi.). (6)	Transportation, utility and water located nearby. (1)
Reynolds, CA	200	Low to Moderate (11)	333	Soft	1,500	28,885	0	0	28,885		As of August 1975, 1 successful well was drilled and 10 more wells were planned. Testing was to take place after drilling on injection well and constructing field pipeline. (1)	Reasonable state and local regulations. (1A)	Flat, irrigated land used for agriculture. Town of Reynolds has a population of 14,667. (6)	
Ready, O.S., NV	98	214	2,450 ⁽⁵⁾	393 ⁽¹⁾	Hard	500	98,546	1/2 (1A)	21,008	1/2 (1A)	Reasonable wells have been drilled. (5, 17)	County concerned with maintaining open areas in natural state, but receptive to controlled development. (6) RHD constraints and brief delays can be expected. Special use permit required. (1A)	Rural population, agriculture; some recreation and mining.	Surface water not available. (6) As of August 1975, all exploration occurred on private property. (1A) RHD has prepared an environmental analysis of the area. (5) There is some evidence of recent seismic activity. (6)
Reynolds, NV	226	250	1,700 ⁽⁶⁾	624	Hard	1,000	11,725 (2)	1/2 (1A)		1/2 (1A)	More than 12 wells drilled. (Some drilled recently.) (2, 17)	Development generally welcome. One permit for land required. RHD constraints and brief delays expected. (1A)	Sparsely populated desert. Mining, grazing and irrigated agriculture. (5)	A water shortage exists. (1A) RHD has prepared a regional environmental analysis. (5)
Sutton, Nevada, CA	101	150	250,000 Avg 100,000 Max	2,129 ⁽¹⁾	Soft	1,000	95,825 (7)	18,644 (1)	76,180 ⁽¹⁾	(Buckley)	Reasonable productive wells drilled. An experimental facility has been constructed to test geothermal fluids. Later tests may operate a 10 Mw generator. (16) As of June 1976, 650 Mw plans for 1980-95, predicated as direct flash technology for hyperdome below. (9)	Reasonable state and local regulations. (1A)	Irrigated land used for agriculture. Relatively sparse population with small population centers nearby. (6)	Extremely flat topography sensitive to disturbance of runoff patterns. In seismically active area. (6)

TABLE 1
SUMMARY OF DESCRIPTION AND DATA FOR EACH SITE (Continued)

RESOURCE	TEMPERATURE °C		TOTAL DISSOLVED SOLIDS (PPM)	ESTIMATED ELECTRIC ENERGY POTENTIAL (MM. 30 YEARS)	TYPE OF OVERLAYING ROCK	ESTIMATED DEPTH TO 100' OR RESERVOIR (METERS)	TOTAL FERA ACRES	TOTAL FEDERAL ACRES	FEDERAL ACRES LEASED	TOTAL STATE AND PRIVATE ACRES	STATE AND PRIVATE ACRES LEASED	GEOTHERMAL DEVELOPMENT STATUS	LOCAL AND STATE ATTITUDE TOWARD GEOTHERMAL DEVELOPMENT	LAND USE AND POPULATION	COMMENTS AND CRITICAL ISSUES
Coso H.S., CA	95	220	2,000	4,511 ⁽¹⁾	Bedrock/ Hard	1,000	51,260	44,340 (16,690 BLM; 26,640 Bavy)		8,490		As of February 1977, 18 shallow temperature gradient wells drilled. ⁽¹⁷⁾ The Navy, Bureau, and USGS involved in development. ⁽¹⁸⁾	Administrative constraints are stringent and may cause long delays. ⁽¹⁸⁾ Significant public opposition not expected. ⁽⁴⁾	Desert area. Recreation, military and agricultural use. Agriculture declining because of lack of irrigation water. ⁽⁴⁾ Rural population.	Environmental Study completed by Bavy. ⁽⁴⁾ Coso is surrounded by faults and may be seismically active. ⁽⁴⁾ Tentative lease rate 11-78. ⁽¹⁴⁾ Possible indications that dry steam may be available. ⁽¹⁸⁾
Long Valley, CA	94	220	1-2,000 ⁽⁴⁾	4,921 ⁽¹⁾	Bedrock/ Hard	1,000	455,256	392,096 (101,690 BLM; 288,406 Forest Service)	5,481	61,160		Numerous wells drilled. Comprehensive investigation of resource by USGS. ⁽⁴⁾ City of Burbank to start exploratory drilling in April 1976. If successful, installation of a 50 Mw plant is planned. ⁽¹⁾	Administrative constraints are stringent. Lengthy delays have occurred. ^(18,2) Public reaction generally negative, although county official reaction is positive. ⁽¹⁸⁾	Rural area, low population. Primarily recreation and tourism with some mining and agriculture. Focus on increasing recreation and tourism. ⁽⁴⁾	Sample air quality ppm exceeded state standards. ⁽⁴⁾ Highly scenic area. Southern California Edison concerned that projected peak loads will exceed existing transmission capabilities and wants to transfer part of load to geothermal space heating.
Imperial Valley, CA	175	175	1,500 ⁽¹⁸⁾	2,102 ⁽¹⁾	Bedrock/ Hard	1,000	72,446 (9)	13,857 (11,972 BLM; 1,880 USFS)	10,584 (1)	12,399 (1)		Numerous wells drilled. ^(4,2)	Stringent administrative constraints cause delays. ⁽¹⁸⁾ Public opinion is mixed. ⁽⁴⁾ Possible conflict between BLM and County for control of activities on Federal lands. ⁽¹⁸⁾	Mountain valley with grazing, farming, and lumbering. Sparsely populated with several small towns nearby.	As of August 1975, all exploration has occurred on private lands. ⁽¹⁸⁾ Environmental Impact Report completed. ⁽⁴⁾ Water supply is limited. ⁽⁴⁾
Cave Point - Sulphur Springs, UT		200		275 ⁽¹⁾	Bedrock/ Hard	15,000	24,874 (9)		19,409			Surface exploration underway, ⁽²⁾ with exploratory drilling likely to begin in early 1977. ⁽¹⁸⁾	Beaver County: positive administrative attitude. As of August 1975, no regulations or constraints. ⁽¹⁸⁾	Forest and open woodland with some grazing. In area of low and high mountains. ⁽⁶⁾ Adjacent to National Forest. Sparse population. ⁽⁶⁾	
Blue Key H.S., OR	71	210		15 ⁽¹⁾								No known development.		Depopulated area, plains with high mountains, may be some grazing. ⁽⁶⁾	Remote with no transportation or utilities nearby. ⁽⁶⁾ Same KGRA as Hot Lake, OR.
Bogon Springs, CA	95	210		112 ⁽¹⁾	Bedrock	1,000							Opposition may occur due to scenic quality of land.	Sparsely populated, Federal land adjacent to National Forest. Forest and woodland. ⁽⁶⁾	High scenic value. Concern that reservoir continues into the National Park.

TABLE 1

SUMMARY OF DESCRIPTION AND DATA FOR EACH SITE (Concluded)

RESOURCE	TEMPERATURE °C Surface Subsurface		TOTAL DISSOLVED SOLIDS (PPM)	ESTIMATED ELECTRIC ENERGY POTENTIAL (MILLION 30 YEARS)	TYPE OF OVERLYING ROCK	ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS)	TOTAL AGRA ACRES	TOTAL FEDERAL ACRES	FEDERAL LEASED ACRES	TOTAL STATE AND PRIVATE ACRES LEASED	GEO THERMAL DEVELOPMENT STATUS	LOCAL AND STATE ATTITUDE TOWARD GEO THERMAL DEVELOPMENT	LAND USE AND POPULATION	COMMENTS AND CRITICAL ISSUES
Sulphur H.S., NV	94	120		96 ⁽⁷⁾	Hard	500							Mountainous area, no close population centers other than Indian reserves. Adjacent to National Forest. ⁽⁶⁾	Transportation and utilities not available near site. ⁽⁶⁾
East Bend, CA		180		58 ⁽¹¹⁾	Soft	1,000	95,965 (9)	12,125 (11)	11,170 (15)	4,850 ⁽¹¹⁾	Nine wells have been drilled. ⁽¹⁷⁾ U.S. Bureau of Reclamation is operating a multiple flash-steam water desalination plant. One application to con- struct a 10 Mw plant has been filed recently and a separate request to con- struct a 35 Mw plant (under an ERDA grant) is being prepared. ⁽¹⁵⁾	Numerous state and local regulations. ^(1A)	Flat irrigated land and desert scrubland. Rural area near population centers. ⁽⁶⁾	Natural water shortage exists in area.
Hot Lake, OR	96	180		106 ⁽⁷⁾	Hard	1,000							Unpopulated grassland and woodland in low mountains.	No population centers, transpor- tation, or utilities in the area. ⁽⁶⁾ Some AGRA as Mickey H.S.
Green Bottoming (City Lake) Springs, NV	86	120		201 ⁽⁷⁾	Medium	500	16,297 (9)		8,494 (5)		As of August 1975, no drilling had occurred. ⁽⁴⁾	The permit required on zoned lands. Mild constraints and brief delays expected. ^(1A) Administration attitude is favorable, and no public opposition is apparent. ⁽⁴⁾	Sparsely populated foothills/ mountainous. Grazing, farming, mineral production, recreation. Land zoned for open use. ⁽⁴⁾	EAR is complete. ⁽⁴⁾ Reservoir is located on a major regional fault intersection. ⁽⁵⁾ A water shortage exists. Tentative lease sale on BLH lands, 10-18-77. ⁽¹⁴⁾
Castle Creek, ID		200 ⁽¹⁹⁾					19,127 (9)				One non-producing well drilled to 1,351 M (11,000 ft.). ⁽¹⁹⁾		Grazed desert shrubland and irrigated land of considerable relief. Sparse population. ⁽⁶⁾	In seismically active area. ⁽⁶⁾
Soda Lake, NV	90	165	1,000 ⁽¹⁹⁾	96	Hard	500	225,241 (9)				Several holes have been drilled. ⁽¹⁹⁾		Plains with low mountains and possible standing water in low lands. Grazed desert shrubland and irrigated land, with rural population.	
Steamboat Springs, NV	96	240	2,500 ⁽⁴⁾	208 ⁽⁷⁾	Medium/ Hard	800	8,914	112	1,558	112	Numerous wells drilled. ⁽⁴⁾ Some used for space heating. ⁽²⁾	Public opinion is mixed. Negative reaction based on diversion of recreational use or possible additional growth in the community. ⁽⁴⁾ Because of regulations, mild con- straints and brief delays expected. Disposition of local administration is positive. ^(1A)	Mountainous with many non-wade intrusions. Suburban area with future plans for possible resi- dential development. Steamboat Springs is used as a resort. Reservoir is in a mining dis- trict. ⁽⁴⁾	Steamboat Springs is a designated historical area. ⁽⁵⁾ By August 1975, ^(1A) all exploration was on private land.

SITE: HEBER, CA
ANALYSIS OF POSTULATED DEVELOPMENT

I-I

SITE: Heber, CA

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
SLC, Owner	Issue Prospecting/ Exploration Permits	Developer	ASSUMED COMPLETED										
SLC, County Government	Process EIR												
SLC, Owner	Lease Land	Developer											
County Government	Issue Land Use Permits												
DOG Developer	Issue Drilling Permits												
Developer	Preliminary Geophysical Exploration												
Developer	Utility Identified												
Developer	Exploratory Drilling and Reservoir Evaluation												
Developer	Site Selection												
Developer and Utility	Feasibility Study												
Producer (Developer) and Utility	Financial Negotiations												
ERDA	Letter of Intent	Producer and Utility	Δ										
Producer and Utility	Process Notice of Interest												
Producer and Utility	Commit to Construction		Δ										
Utility	Prepare Environmental Data Statement	CPUC, County Government											
CERCDC, CPUC	Certify Plant and Site, Issue Permits	Producer and Utility											
Producer and Utility	Design (Preliminary, Final)												
Utility, ERDA	SDG&E/ERDA Design Review												
Producer Utility	Development Drilling												
	Plant Construction												

Source of Data: SDG&E Pre-Proposal to ERDA, "Construction of 50 MW Demonstration Geothermal Power Plant," 7-9-76.

SITE: Heber, CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (State and Private) land is leased for a 50 MWe power plant.
- Exploratory drilling is complete and the resource has been well identified.
- SDG&E is interested to build a commercial-scale demonstration power plant with ERDA support.
- Basis for the development schedule is the SDG&E Pre-Proposal to ERDA, "Construction of a 50MW Demonstration Geothermal Power Plant," July 9, 1976. Proposed schedule is assumed to have slipped one year.

Principal Milestones:

• ERDA commits to demonstration project, producer and utility commit to construction	November 1977
• Start development drilling	July 1977
• Initiate plant design	October 1977
SDG&E/ERDA design review	April 1979
• Start plant construction	April 1979
• On line	November 1981

SITE: Heber, CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Heber, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
EXTRACTION							
<u>Primary Technology</u>							
• High Temperature, Deep-well Down-hole Pumps	X		3	77			
• Brine Injection Pumps--low to medium salinity brines		X	4	77			
• Brine Deaerators	X	X	4	77			
• Injection Technology--sedimentary rocks	X		4	77			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	X		4	77			
• Instrumentation and Control--with regard to injection process	X		4	77			
• Resource Characterization--with regard to behavior of field when produced	X	X	3	77			
• Reservoir Engineering--with regard to best way to produce field	X	X	2	77			
• Basic Understanding of Injection Process--for this type of field	X	X	4	77			
<u>Environmental</u>							
• Injection Impact Prediction Technology--with regard to	X		3	77			
- aquifer contamination							
- triggering seismic events							
• Subsidence Prediction Technology	X		3	77			

SITE: Heber, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperatures between 190°C-200°C	X		2	78			
• Working Fluid Selection Technique--(or Fluid Development Program)	X		2	78			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (190°C-200°C)	X	X	2	78			
• Secondary Fluid Condensers--to operate where cooling water is scarce	X	X	2	78			
• Waste-heat Handling--arid semi-desert, water scarce area	X	X	2	78			
<u>Supporting Technology--Binary Concepts</u>							
• Brine Chemistry--scale control in process equipment		X	3	78			
• Waste Brine Purification--for this type field		X	3	78			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		1	79			

SITE: Heber, CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water TEMPERATURE, °C: 190 DEPTH, M: 1000

ROCK TYPE: Soft SYSTEM SIZE, MW: 50 TYPE: Binary

YEAR	1981	1982	1983	1984	1985	1986+
CAPACITY FACTOR ASSUMED	.40	.47	.54	.59	.65	.70
COST OF ELECTRICITY (MILLS/KWH)	60.7	51.7	45.0	41.2	37.4	34.7

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ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	3.17	LIFE:	10
INJECTION WELLS:	0.70	LIFE:	20
PRODUCER PLANT:	7.99	LIFE:	20
GENERATING PLANT:	37.2	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 0.988
UTILITY: 1.248

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.154
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.372
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

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SITE: HEBER, CA
DESCRIPTION AND DATA

SITE: Heber, CA

SUMMARY

TEMPERATURE °C

Surface:

Subsurface: 190

TOTAL DISSOLVED SOLIDS (PPM): 14,000
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 973⁽¹⁾
TYPE OF OVERLAYING ROCK: Soft
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres:	58,568	
Total Federal Acres:	0	Total State and Private Acres: 58,568
Federal Acres Leased:	0	State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

As of January 1977, tentative plans for a 65 MWe binary cycle generating unit. EPRI has agreed to contribute \$4.5 million to the project.⁽¹⁶⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Numerous state and local regulations.^(1A)

LAND USE AND POPULATION:

Irrigated agricultural land. Generally sparse population. Heber population is 800.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

Extremely flat topography sensitive to disturbance of runoff patterns.⁽¹³⁾ In seismically active area.⁽¹³⁾

11-1

KEY		1976 APPLICATIONS	
	Known geothermal resource area - Showing water temperature °F		COMPETITIVE INT. ± 80%
	Hot Spring		LEASE APPLICATION
	Hot Spring Location questionable		LEASE APPLICATION
	Well		LEASE APPLICATION
	Lands valuable prospectively for geothermal resources		LEASE APPLICATION
	Well Showing water temperature °F		LEASE APPLICATION

MEXICO

1" = 8 mi

SITE: HEBER, CA

SITE: Heber CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 32° 43' 00" N

REGION 1

LONGITUDE: 115° 31' 42" W

COUNTY: Imperial

ADJACENT COUNTIES: San Diego, Riverside, Yuma, Az., Mexico

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Extremely flat region lying mostly below sea level.(13)	Irrigated land used for agriculture.(6)			

SITE: Heber, CA

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface:
Subsurface: 190° C

Geochemical
SiO₂:
Na-k-Ca:

1-13 TOTAL DISSOLVED SOLIDS (TDS): 14,000 ppm, includes significant quantities of barium, calcium, strontium, sulfate and bicarbonate ions.⁽¹³⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 973⁽¹⁾

TYPE OF OVER LAYING ROCK: Sandy Deltaic Sediments (soft).⁽⁸⁾

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft).⁽⁸⁾

SEISMIC ACTIVITY: Heber is in one of the most seismically active regions of North America. Numerous low-magnitude earthquakes have been recorded near Heber. It is projected that an earthquake of approximate magnitude 7.5 on the Richter Scale might occur once per century.⁽¹³⁾

SITE: Heber, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Heber		58,568 ⁽¹⁾	N/A	58,568 ⁽¹⁾ (State & Private)	
LAND LEASED IN KGRA			N/A		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		12,355			

GEOTHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>In the Heber KGRA, Chevron Oil Company is performing hardware studies and resource assessment aimed at having a plant on line in the Heber area by early 1979. They are working with Magma Power Company and New Albion Resource Company and have nine wells drilled. As of August 1975, they were involved in resource assessment, brine tests, and heat exchanger tests.(1)</p> <p>Maximum flow rate of free-flowing wells drilled in the area is 198,000 kg/hr (440,000 lbs/hr).(13)</p> <p>Leaseholders at Heber have indicated an ability to supply hot brine and reinject cooled brine and cooling tower blowdown (waste-water) simultaneously at rates required for a power plant.(13)</p> <p>As of January 1977, the San Diego Gas and Electric Co. has invited the California Energy Resources Conservation and Development Commission (ERCDC) to participate in a proposed power plant project (65 MW binary cycle generating unit).(16)</p>	<p>It is possible that Chevron, San Diego Gas and Electric, EPRI, ERDA, The Los Angeles Department of Water and Power, Southern California Edison Co., Imperial Irrigation District, Nevada Power Co., and Portland General Electric Co. may all be involved in the development of a demonstration plant at Heber.(15,16) The Electric Power Research Institute has already agreed to contribute 4.5 million to the project.(16)</p>

SITE: Heber, CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>Production Permit must be issued by Imperial County (requires compliance with all other permits and regulations such as building, plumbing, electrical and construction permits). The most important and time-consuming requirement of the Production Permit is the Environmental Impact Report (EIR) which may require at least 10 months of lead time for data collection and report preparation.</p> <p>The State's District Air Pollution Control Board requires construction and operation permits.</p> <p>Imperial County requires underground installation of collection and reinjection pipes at geothermal sites.</p> <p>Air pollution standards are set by the Occupational Safety and Health Administration (OSHA) and by the California Air Resources Board.</p> <p>California Division of Oil and Gas (DOG) is responsible for determining that potable groundwater supplies are protected during oil-, gas-, and geothermal-field operations, and for assuming that subsidence will not occur. (13)</p>		

SITE: Heber, CA

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds Summer from S.E. at 13.7 Kph (8.5 mph), Winter from North at 11.3 Kph (7 mph). (13)

Precipitation (Annual): 6.73 cm (2.65 inches)

Average Temperature

Minimum: 12.2°C (54°F)

Maximum: 33.3°C (92°F)

Relative Humidity
(Seasonal Peaks)

Summer: 20% - 30%

Winter: 40%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	Water table of only 1.5 meters (5 feet). Series of irrigation canals from Colorado River. (13)		Cresote bush, bur sage, salt- bush, grease- wood. (6)		

SITE: Heber, CA

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Heber	<16 Km (10 miles)	800	<16 Km (10 miles) from secondary (100 to 161 Kv) line. ⁽⁶⁾ High voltage feeder lines within 1 mile of site. ⁽³⁾	State Highway 86 goes through town of Heber. ⁽⁶⁾	Rail service in Heber. 56 Cm (22") or smaller gas pipe- line within a few miles. ⁽⁶⁾ Good air service accessibility (13)
El Centro (County Seat)	10 Km (6 miles)				

RECORD 00010

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000298
 CROSS INDEX NO.. CF-00491
 RECORD TYPE..... A

NAME..... J. RENNER, J. P. CALZIA
 DATE..... 74/12
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. HEBER
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 32-43-00N

COUNTRY NAME..... UNITED STATES
 COUNTY..... IMPERIAL
 LONGITUDE..... 115-31-42W

TOWNSHIP RANGE SECTION 1/4 1/4
 16S 14E 29 SE

BASE & MERIDIAN..... SAN BERNARDINO
 AVAILABLE MAPS OF AREA: HEBER 1:24,000

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 0.0 KM**2
 ELEVATION..... -1.5240E+00M -5. FT
 RESOURCE CATEGORY..... B
 PRESENT USE & DEVELOPMENTS: B WELLS DRILLED. HOLTZ #1 168C AT 1560 M (PERS. COM. BILL HARDT,
 SURFACE THERMAL ACTIVITY..... NO VISIBLE MANIFESTATION, FOUND BY HEAT FLOW ANOMALY,

GEOTHERMAL CHARACTERISTICS

WELL INFORMATION

BOTTOM-HOLE TEMPERATURE..... 168.0 C TO 1560.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 150. C TO 225. C ASSUMED
 BEST ESTIMATE..... 190.0 C
 SUBSURFACE AREA..... 10.0 KM**2 TO 85.0 KM**2
 BEST ESTIMATE..... 50.0 KM**2
 BASED ON: C F/100 FT. CONTOUR
 DEPTH TO TOP OF RESERVOIR..... 700.00 M 0.700 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 1000.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2300.00 M 2.300 KM
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR..... 15.000 KM**3 TO 195.000 KM**3
 BEST ESTIMATE..... 100.000 KM**3
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 5.0228E+18 J 1.1999E+18 CAL TO 1.0465E+20 J 2.4999E+19 CAL
 BEST ESTIMATE..... 4.6042E+19 J 1.0999E+19 CAL ABOVE 15. C

GEOLOGY

GENERAL ROCK TYPES: SANDY DELTATIC SEDIMENTS

65-1

GEOPHYSICS

GRAVITY SURVEY INFORMATION: TEST MADE
ELECTRICAL RESISTIVITY: DC RESISTIVITY TEST MADE
OTHER GEOPHYSICAL INFORMATION: TEMPERATURE GRADIENT

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
DATE..... 1975
TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) DUTCHER, L.C. AND OTHERS, 1972, PRELIMINARY APPRAISAL OF GROUND WATER IN STORAGE WITH REFERENCE TO GEOTHERMAL RESOURCES IN THE IMPERIAL VALLEY AREA, CALIFORNIA: U.S.G.S. CIRC. 649, 57 P.
- 2) U.S. BUREAU OF RECLAMATION, 1972, GEOTHERMAL RESOURCE INVESTIGATION, IMPERIAL VALLEY, CALIFORNIA DEVELOPMENTAL CONCEPTS: U.S. DEPT. INT. BUR. RECLAMATION, 58P.

SITE: ROOSEVELT H.S., UT
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: ROOSEVELT H.S., UTAH (Federal Land)
SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM	Issue STC Permit	Developer	} ASSUMED COMPLETED										
USGS	Issue Drilling Permits	Developer											
BLM	Process EIA/EIS	CEQ											
County Gov't	Issue Land Use Permit	Developer											
BLM	Issue Loans	Developer											
Developer	Preliminary Geophysical Exploration												
Developer	Exploratory Drilling and Reservoir Assessment												
Developer	Develop Utility Interest												
Developer	Feasibility Study												
Utility													
Producer/Developer) and Utility	Financial Negotiations		—										
Producer	Site Selection		—										
Producer	Preliminary Design		—										
Utility	Final Design			—									
Producer/Utility	Prepare Master Development Plan	BLM, USGS	—	—									
Utility	Prepare Environmental Data Statement	BLM, FPC/CPUC, CERCDC, County Gov't	—	—									
Producer/Utility	Commitment to Development		Δ										
BLM/FPC/CPUC	Certify Plant and Site, Issue Permits	Producer & Utility		—	—								
CERCDC	Process EIR			—	—								
County Gov't	Process EIA/EIS (Drilling)	CEQ		—	—								
USGS	Process EIA/EIS (Plant)	CEQ		—	—								
FPC	Process EIA/EIS (Transmission Line)	CEQ		—	—								
FPC/CPUC				—	—								
Producer	Development Drilling					—	—						
Utility	Plant Construction					—	—	—					
Utility	Install Transmission Line (96.5km)					—	—	—					

SITE: ROOSEVELT H.S., UTAH

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal) land is leased for a 50 MWe power plant.
- Utility and developer/producer are in financial negotiations, ready to select site.

Principal Milestones:

• Select site, commit to development	July 1977
• Start development drilling	October 1979
• Start construction	January 1980
• On line	April 1982

SITE: Roosevelt H.S., UT

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Roosevelt H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to define reservoir boundaries	X	X	2	76*			
• Drilling Techniques		X	3	76*			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	76*			
• Data Analyses and Interpretation	X	X	3	76*			
• Resource Characterization--with regard to determining type and extent of field	X	X	4	76*			
• Basic Understanding of the Geothermal Process--in the earth at this site	X		4	76*			
* Technology Need dates have passed. Status of technology development and exploratory drilling at this site need further investigations.							

SITE: Roosevelt H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Injection Technology--(volcanic rock)	X		4	79			
• Drilling Technology--(<230°C-volcanics)		X	1	81			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of field where produced	X	X	2	79			
• Reservoir Engineering--to define best approach to producing reservoir	X	X	2	79			
• Brine Chemistry	X		1	80			
• Basic Understanding of the Injection Process--for this type of field	X		1	81			
<u>Environmental</u>							
• Injection Impact Prediction Technology--with regard to	X		2	79			
- triggering seismicity							
- aquifer contamination							
• Subsidence Prediction Technology	X		2	79			

SITE: Roosevelt H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator Design--to minimize scaling	X	X	2	78			
• Waste Heat Handling--water is in short supply or unavailable		X	2	78			
<u>Supporting Technology</u>							
• Brine Chemistry--scale control in process equipment	X		2	78			
• Spent Brine Purifications	X		3	78			
<u>Environmental</u>							
• Non condensable gas control/disposal			(1D)	(1D)			
(1D) Insufficient data							

SITE: ROOSEVELT H.S., UTAH

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water TEMPERATURE, °C: 230 DEPTH, M: 1000

ROCK TYPE: Medium/
Hard SYSTEM SIZE, MW: 50 TYPE: Flash

YEAR	1982	1983	1984	1985+		
CAPACITY FACTOR ASSUMED	0.40	0.47	0.54	0.60		
COST OF ELECTRICITY (MILLS/KWH)	43.3	36.9	32.1	28.9		

2-8

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS^{*} AND LIVES (YEARS):

PRODUCING WELLS:	4.30	LIFE:	10
INJECTION WELLS:	0.83	LIFE:	20
PRODUCER PLANT:	5.29	LIFE:	20
GENERATING PLANT:	25.4	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .203
UTILITY: .693

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.139
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.254
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

2-9

SITE: ROOSEVELT H.S., UTAH

DESCRIPTION AND DATA

SITE: Roosevelt H.S., UT

SUMMARY

TEMPERATURE °C

Surface: 88

Subsurface: 230

204 (Steam)

TOTAL DISSOLVED SOLIDS (PPM): 7,800⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 100⁽⁷⁾

TYPE OF OVERLAYING ROCK: Medium/Hard

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 830

DESCRIPTION OF KGRA

Total KGRA Acres: 29,791⁽⁹⁾

Total Federal Acres:

Federal Acres Leased: 24,592

Total State and Private Acres:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Numerous wells drilled. Projected total mass flow capacity of well is 1 million lbs/hr of steam and hot water.⁽¹⁴⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Positive public attitude. As of August 1975, no regulations or constraints.^(1A)

LAND USE AND POPULATION:

Rural, bordered by mountains. Mining, agriculture and tourism in county.⁽⁴⁾

COMMENTS AND CRITICAL ISSUES:

Cooling water is probably not available. Withdrawal from the aquifer has caused up to 183 cm (6 ft.) of subsidence.⁽⁴⁾ Zoning at the resource restricts only salvage yards, dumps, and gravel pits.⁽⁴⁾

SITE: ROOSEVELT H.S., UT

SITE: Roosevelt H.S., Utah

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 38° 30' 00" N

REGION 4

LONGITUDE: 112° 50' 00" W

COUNTY: Beaver

ADJACENT COUNTIES: Iron, Piute Sevier, Millard; Lincoln, NV.

LAND OWNERSHIP: of Beaver County Land BLM & National Forest = 78.0%
State = 9.4%
Private = 12.6%

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Desert type - grazing, bordered by mountains. ⁽⁴⁾	Mining, agriculture & Tourism in County. Land proposed for geo- thermal usage is zoned so that use restriction apply to only salvage yards, dumps & gravel pits. ⁽⁴⁾		Mountainous & Southeast area are moderately to highly scenic. ⁽⁴⁾	12 historic & pre-historic inhabited sites are known in the area. Increased activity could pose a threat to archeological values. ⁽⁴⁾

SITE: Roosevelt H.S., Utah

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 88°C (190°F)
Subsurface: 230°C (446°F)

Geochemical

SiO₂: 213°C
Na-k-Ca: 283°C

TOTAL DISSOLVED SOLIDS (TDS): 7800 ppm (including a silica content of 313 ppm).⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 100⁽⁷⁾

TYPE OF OVER LAYING ROCK: Tertiary and Quarternary unconsolidated sediments. Precambrian (?) metamorphics and Tertiary volcanics outcropping to east.⁽⁴⁾ Roosevelt H.S. may be a part of a series of geothermal resources occurring along a line from the southwestern corner of Utah to Salt Lake City and just to the west of the mountain range running in that general direction.⁽¹⁰⁾

ESTIMATED DEPTH TO TOP OF RESERVOIR: Top of altered volcanic pay zone = 830 M (2724 ft)⁽⁴⁾

SEISMIC ACTIVITY:

SITE: Roosevelt, VT

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Roosevelt H.S.		29,791 ⁽⁹⁾			
LAND LEASED IN KGRA			24,592		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
128.04	Phillips Petroleum Co.				
128.04	Phillips Petroleum Co.				
58.38	A.L. & W.L. McDonald				
53.38	Phillips Petroleum Co.		2,454		
TENTATIVE LEASE SALE DATES			1,940		
1977			40		
1978			1,640		
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 0					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE): 0					
SUBSURFACE AREA OF RESERVOIR		988			

GEOTHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>Thermal Power Company, subsidiary of Natomas Co. completed a joint-venture well which was drilled to 382 M (1254 feet). Preliminary testing demonstrated a well-head pressure of 25 Kg/cm² (355 lbs./sq. inch) gravity and temperature of 222°C (132°F). Projected total mass flow capability of well is 1 million lbs./hour of steam and hot water.(14)</p> <p>Phillips Petroleum reports that from 823-840 M (2,700-2,800 feet) test well had initial flow rate of 90,700 Kg/hr (200,000 lb/hr) of steam at 204°C (400°F)--equivalent to water flow rate of 1,514 lpm (400 gpm).</p>	<p>Thermal Power Company plans to build a larger test facility to determine more precisely the electric generating capability potential being considered.</p> <p>Thermal Power holds options to drill on an additional 3 sections of geothermal leaseholds in the Roosevelt fields.</p> <p>The Utah Power Corp. is planning to build a power plant on Phillips Petroleum Co. Federal leases.(14)</p>

SITE: Roosevelt H.S., Utah

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
As of August 1975, there were no local legislation, regulations or planning agencies to deal with geothermal energy, and no constraints existed at the county level. (3III)	Local residents generally welcome geothermal development. (4)	

SITE: Roosevelt, H.S., Utah

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 29.9 cm (11.77 inches)

Average Temperature

Minimum: -3°C (26.2°F)

Maximum: 21°C (69.2°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30%

Winter: 60% - 70%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
No measurements made Air relatively free of pollutants except dust. ⁽⁴⁾	TDS of 7800 ppm (silica content of 313 ppm) ⁽⁴⁾	Ambient noise of site is minimal from State Hwy. #257	Shadscale, greasewood, great basin sage, cheat grass, halo- geton, rabbit brush, blue- bunch, wheat grass, ponderosa pine, mountain mahogany	mule deer, bob cat, coyote, golden & bald eagle, great basin rattle- snake, great basin spadefoot toad.	prairie and perigrine falcon.

SITE: Roosevelt H.S., Utah
POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Milford ⁽⁴⁾	19.3 Km (12 miles)	1,471 ⁽⁶⁾	96.5 Km (60 miles) from primary trans- mission lines (230 KV) ⁽⁶⁾	Within view of State Highway #257 ⁽⁴⁾	primary railroad main 16-32 Km (10- 20 miles) from resource. No major pipelines near resource area. ⁽⁶⁾
Beaver ⁽⁴⁾	32 Km (20 miles)	1,548 ⁽⁶⁾			

RECORD 00195

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000734
 CROSS INDEX NO.. CF02671
 RECORD TYPE..... A

NAME..... J. RENNER
 DATE..... 75/04
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. ROOSEVELT HOT SPRING
 WARNING FIGURE..... 7
 COUNTRY CODE..... US
 STATE/PROVINCE..... UTAH
 LATITUDE..... 38-30-00N

WARNING NUMBER..... 51
 COUNTRY NAME..... UNITED STATES
 COUNTY..... BEAVER
 LONGITUDE..... 112-50-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 27S 09W 3 NW

BASE & MERIDIAN..... SALT LAKE
 AVAILABLE MAPS OF AREA: RICHFIELD 1:250,000

GENERAL DESCRIPTION

ELEVATION..... 1584.90 M 5200. FT
 RESOURCE CATEGORY..... B
 PRESENT USE & DEVELOPMENTS: ONE SHALLOW WELL ABANDONED BECAUSE OF PROBLEMS; PHILLIPS CURRENTL
 SURFACE THERMAL ACTIVITY..... DEPOSITS
 ASSOCIATED DEPOSITS..... SINTER
 NO. OF HOT SPRINGS..... NONE

GEOTHERMAL CHARACTERISTICS

SPRING TEMPERATURES..... 55. C TO 88. C
 WELL INFORMATION
 MAXIMUM WELL TEMPERATURE..... 132. C
 BOTTOM-HOLE TEMPERATURE..... TO 85.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 0. C TO 0. C ASSUMED
 BEST ESTIMATE..... 230.0 C
 SUBSURFACE AREA.....
 BEST ESTIMATE..... 4.0 KM**2
 DEPTH TO TOP OF RESERVOIR.....
 BEST ESTIMATE..... 1000.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR..
 BEST ESTIMATE..... 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR.....
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR.....
 BEST ESTIMATE..... 8.000 KM**3
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT.....
 BEST ESTIMATE..... 4.1860E+18 J 9.9999E+17 CAL ABOVE 15. C

2-19
6-19

GEOLOGY

GENERAL ROCK TYPES: PRECAMBRIAN GRANITE AND PLEISTOCENE OR PLEISTOCENE VOLCANICS

PRIMARY REFERENCE:

AUTHOR..... D.F. WHITE & D.L. WILLIAMS, EDITORS

DATE..... 1975

TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975

REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) MUHDORFF, J.C., 1970, MAJOR THERMAL SPRINGS OF UTAH: UTAH GEOL. AND MINERALOG. SURVEY WATER-RESOURCES BULL. 13
- 2) PETERSEN, C.A., 1973, ROOSEVELT AND THERMO HOT SPRINGS, BEAVER COUNTY, UTAH, IN GEOLOGY OF THE MILFORD AREA, 1973: UTAH GEOL. ASSOC. PUB. 3, P. 73-74
- 3) PETERSEN, C.A., 1974, GEOLOGY (AND GEOTHERMAL POTENTIAL) OF THE ROOSEVELT HOT SPRINGS AREA, BEAVER COUNTY, UTAH: UTAH UNIV., M.S. THESIS, 52P.
- 4) WARING, C.A., 1965, THERMAL SPRINGS OF THE UNITED STATES AND OTHER COUNTRIES OF THE WORLD--A SUMMARY: U.S.G.S. PROF. PAPER 492

RECORD 00196

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000735
 CROSS INDEX NO.. CF02671
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... J. RENNER
 DATE..... 75/04
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. ROOSEVELT HOT SPRING
 COUNTRY CODE..... US
 STATE/PROVINCE..... UTAH
 LATITUDE..... 38-30.00 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... BEAVER
 LONGITUDE..... 112-50.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 WATER SAMPLING TEMP.... 55.0 C

WATER ANALYSIS

ANALYSIS DATE..... 57/09

SOLUTE ANALYSIS (WATER)

LI	NA	K	RB	CS	NA+K
	2500.00	480.00			
MG	CA	SR	BA	CA+MG	
	22.00				
F	CL	BR	I		
	4240.00				
NH4	NO3	PO4	S102	S04	CO3
			315.00	73.00	HCO3
					156.00

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726
 MUNDORFF, 1970

SITE: VALLES CALDERA, NM

ANALYSIS OF POSTULATED DEVELOPMENT

SITE: VALLES CALDERA, N.M. (State/Private Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Owner, State	Issue Permits -- Prospecting, Exploration, Land Use, Drilling	Developer	} ASSUMED COMPLETED										
Developer	Lease Land	Developer											
Developer	Process Environmental Reports												
Developer	Preliminary Geophysical Exploration												
Developer	Exploratory Drilling and Reservoir Evaluation												
Developer & Utility	Develop Utility Interest												
Developer & Utility	Feasibility Study												
Producer & Utility	Financial Negotiations		—										
Producer	Site Selection		—										
Producer & Utility	Preliminary Design		—										
Producer & Utility	Final Design												
Producer & Utility	Commitment to Development		Δ										
Utility	Prepare Environmental Data Statement	FPC/State/ County Gov't	—										
FPC/State PUC	Certify Plant & Site, Issue Permits	Producer & Utility											
State/County	Process EIR (Drilling)												
State PUC	Process EIR (Plant)												
State PUC	Process EIR (Transmission Line)												
Producer	Development Drilling												
Utility	Plant Construction												
Utility	Initial Power Line (16km)												

SITE: Valles Caldera, N.M.

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (private or state) land is leased for a 50 MWe power plant.
- Utility and producer/developer are in financial negotiations.
- Feasibility study completed.

Principal Milestones:

• Select site, commit to development	July 1977
• Start development drilling	October 1979
• Start construction	January 1980
• On line	April 1982

SITE: Valles Caldera, NM

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Valles Caldera, NM

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Technology--(<240° volcanics)		X	4	79			
• Injection Technology--(volcanic rock)	X		1	81			
• High Temperature Down-Hole Measurement Equipment		X	4	79			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of field where produced	X	X	2	79			
• Reservoir Engineering--to define best way to produce reservoir	X	X	2	79			
• Brine Chemistry	X		1	80			
• Basic Understanding of the Injection Process--for this type of field	X		1	81			
<u>Environmental</u>							
• ReInjection Impact Prediction Technology with regard to	X		2	79			
- Triggering seismic events							
- Aquifer contamination							
• Subsidence Prediction Technology	X		2	79			
(NOTE--ground collapsed under one drill site at this location)							

SITE: Valles Caldera, NM

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator--to minimize scaling	X	X	2	78			
<u>Supporting Technology</u>							
• Brine Chemistry--scale control in process equipment	X		2	78			
• Spent Brine Purifications	X		4	78			
<u>Environmental</u>							
• Non-Condensable Gas Control/Disposal			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Valles Caldera, N.M.

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 240

DEPTH, M: 1000

ROCK TYPE: Hard

SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1982	1983	1984	1985+		
CAPACITY FACTOR ASSUMED	.40	.47	.54	.60		
COST OF ELECTRICITY (MILLS/KWH)	41.7	35.5	30.9	27.8		

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ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	4.84	LIFE:	10
INJECTION WELLS:	1.02	LIFE:	20
PRODUCER PLANT:	4.54	LIFE:	20
GENERATING PLANT:	24.5	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .205
UTILITY: .669

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.139
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.245
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

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SITE: VALLES CALDERA, NM

DESCRIPTION AND DATA

SITE: Valles Caldera, NM

SUMMARY

TEMPERATURE °C

Surface: 87

Subsurface: 240

TOTAL DISSOLVED SOLIDS (PPM): 6,000
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 1,870⁽⁷⁾
TYPE OF OVERLAYING ROCK: Hard
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres: 168,761

Total Federal Acres:

Federal Acres Leased:

Total State and Private Acres:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

As of June 1976, 9 producible wells, negotiations to sell steam to utility. Continued drilling and testing of field with possible agreement to construct 50 MWe flashed-steam power plant.⁽²⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

LAND USE AND POPULATION:

Open grazed woodland in mountains. Population centers within 16 km (10 miles).⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

Transportation, utilities and water located nearby.⁽⁶⁾

SITE: Valles Caldera, NM

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 35° 45' 00" N

REGION 4

LONGITUDE: 106° 32' 00" W

COUNTY: Sandoval

ADJACENT COUNTIES: San Juan, Rio Arriba, Los Alamos, Santa Fe, Bernaillio, Valencia, McKinley

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Open high mountains.	Open grazed woodland.			Civil War Sites in area.(6)

SITE: Valles Caldera, NM

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 87°C (189°F)
Subsurface: 240°C (464°F)

Geochemical

SiO₂:
Na-k-Ca:

TOTAL DISSOLVED SOLIDS (TDS): 6000 ppm⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 1870⁽⁷⁾

TYPE OF OVER LAYING ROCK: igneous rock types - caldera volcanics

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3280 ft)

SEISMIC ACTIVITY: Caldera area which may still be in stage of collapse many normal faults in area.

SITE: Valles Caldera, NM

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Baca Location No. 1		168,761			
LAND LEASED IN KGRA			None		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
TENTATIVE LEASE SALE DATES					
1977 3-30 (USFS), ⁽¹⁴⁾ 6-9 ⁽¹⁵⁾					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		16,062			

SITE: Valles Caldera, NM

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>Nine producible wells of about 15 holes drilled in 25.9 Km² (10 miles²) area (Union Oil); negotiations with utility over contract to sell steam. Continued drilling of production wells and testing of field, possible agreement to construct 50 MW flashed-steam power plant.</p> <p>(2)</p>	

SITE: Valles Caldera, NM

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)

SITE: Valles Caldera, NM

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 45.72 cm (18 inches)

Average Temperature

Minimum: 0.6°C (33°F)

Maximum: 21°C (70°F)

Relative Humidity

(Seasonal Peaks)

Summer: 50% - 60%

Winter: 50% - 60%

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AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	Surface and ground- water available. (6) (Fuel-electric power generation using fresh surface water in Sante Fe.) (6)		pinon, juniper, aspen, chaparral and brush		

SITE: Valles Caldera, NM

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Bernalillo	16 Km (10 miles)	2,574	< 16 Km (10 miles) from secondary (100 to 161 KV) lines.	State Highway 44 & Interstate I-25 < 16 Km (10 miles) from site	< 16 Km (10 miles) from minor (22" or smaller) gas pipeline < 16 Km (10 miles) from major (12" and larger) crude oil pipeline < 16 Km (10 miles) from primary rail- road line
Santa Fe	61 Km (38 miles)	40,000			

RECORD 00185

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000666

CROSS INDEX NO.. C102331

RECORD TYPE..... A

NAME..... J. RENNER, E. PATTERSON

DATE..... 75/03

ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. VALLES CALDERA

WARNING FIGURE..... 2

COUNTRY CODE..... US

STATE/PROVINCE..... NEW MEXICO

LATITUDE..... 35-43-00N

WARNING NUMBER..... 12

COUNTRY NAME..... UNITED STATES

COUNTY..... SANDOVAL

LONGITUDE..... 106-32-00W

TOWNSHIP RANGEL SECTION 1/4 1/4
20N 02E 35

BASE & MERIDIAN..... NEW MEXICO

AVAILABLE MAPS OF AREA: VALLE SAN ANTONIO 1:24,000

GENERAL DESCRIPTION

ELEVATION..... 2647.80 M 8687. FT

RESOURCE CATEGORY..... B

PRESENT USE & DEVELOPMENTS: MORE THAN 6 GEOTHERMAL WELLS DRILLED, DEPTHS REPORTED TO RANGE FR

SURFACE THERMAL ACTIVITY..... HOT SPRINGS

ASSOCIATED DEPOSITS..... TRAVERTINE

NO. OF HOT SPRINGS..... 5 AREAS IN CALDERA

GEOTHERMAL CHARACTERISTICS

SPRING TEMPERATURES..... 25. C TO 87. C

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 100. C TO 300. C ASSUMED

BEST ESTIMATE..... 240.0 C

SUBSURFACE AREA..... 45.0 KM**2 TO 300.0 KM**2

BEST ESTIMATE..... 65.0 KM**2

DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 2000.00 M 2.000 KM

BEST ESTIMATE..... 1000.00 M 1.000 KM

DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM

BEST ESTIMATE..... 3000.00 M 3.000 KM

THICKNESS OF RESERVOIR..... 1000.00 M 1.000 KM TO 2500.00 M 2.500 KM

BEST ESTIMATE..... 2000.00 M 2.000 KM

VOLUME OF RESERVOIR..... 45.000 KM**3 TO 750.000 KM**3

BEST ESTIMATE..... 130.000 KM**3

COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 9.6274E+18 J 2.2999E+18 CAL TO 5.4414E+20 J 1.2999E+20 CAL

BEST ESTIMATE..... 7.5344E+19 J 1.7999E+19 CAL ABOVE 15. C

GEOLOGY

GENERAL ROCK TYPES: PLEISTOCENE CALDERA VOLCANICS

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
 REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) SMITH, R.L., AND OTHERS, 1970, GEOLOGIC MAP OF THE JEMEZ MOUNTAINS, NEW MEXICO: U.S.G.S. MISC. GEOL. INV. MAP I-577
- 2) SUMMERS, W.K., 1965A, A PRELIMINARY REPORT ON NEW MEXICO'S GEOTHERMAL ENERGY RESOURCES: NEW MEXICO BUR. MINES AND MINERAL RESOURCES CIRC. 80, 41P.
- 3) SUMMERS, W.K., 1965B, CHEMICAL CHARACTERISTICS OF NEW MEXICO'S THERMAL WATERS--A CRITIQUE: NEW MEXICO BUR. MINES AND MINERAL RESOURCES CIRC. 83, 27P.
- 4) WAKING, C.A., 1965, THERMAL SPRINGS OF THE UNITED STATES AND OTHER COUNTRIES OF THE WORLD--A SUMMARY: U.S.G.S. PROF. PAPER 492, 363 P.

SITE: BRAWLEY, CA
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Brawley, CA (State/Private Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
SLC/Owner	Issue Prospecting/Exploration Permits	Developer	} ASSUMED COMPLETED										
County Gov't	Issue Land Use Permits	Developer											
DOG	Issue Drilling Permits	Developer											
SLC/Owner	Acquire Leases	Developer											
SLC/County Developer	Process EIR												
	Preliminary Geophysical Exploration												
Developer	Exploratory Drilling & Reservoir Evaluation												
Developer	Develop Utility Interest												
Developer & Utility	Feasibility Study												
Producer (Developer) & Utility	Financial Negotiations												
Producer Utility	Site Selection												
	Prepare Environmental Data Statement	CPUC/County Gov't											
Producer & Utility	Preliminary Design												
	Final Design												
Producer/Utility	Commitment to Development				Δ								
CERCDC/CPUC	Certify Plant, & Site, Issue Permits	Producer & Utility											
County Gov't	Process EIR (Drilling)												
CPUC	Process EIR (Plant >50MW)												
CPUC	Process EIR (Transmission Line)												
Producer Utility	Development Drilling												
	Plant Construction												
Utility	Install Transmission Line (16km)												

SITE: Brawley, CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (private or state) land is leased for a 50 MWe power plant.
- Development is well into exploratory drilling.
- Utility has not been identified.

Principal Milestones:

• Identify utility	October 1977
• Complete feasibility study	July 1978
• Select site, commit to development	April 1979
• Start development drilling	July 1981
• Start construction	October 1981
• On line	January 1984

SITE: Brawley, CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Brawley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> • Improved Geophysical Exploration Methods-- to define boundaries of reservoir • Drilling Techniques 		X X	3 3	77 77			
<u>Supporting Technology</u> <ul style="list-style-type: none"> • Basic Understanding of the Geothermal Process--in the earth for this type of field 	X		4	77			

SITE: Brawley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--sedimentary rock, temperature <200°C		X	4	80			
• High Temperature, Deep-Well Down-Hole Pumps	X		2	81			
• Brine Injection Pumps--low to medium salinity brines	?	?	2	81			
• Brine Deaerators	?	?	2	81			
• Injection Technology--sedimentary rocks	X		2	81			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	X		2	81			
• Instrumentation and Control--with regard to injection process	X		2	81			
• Resource Characterization--with regard to behavior of field when produced	X	X	1	80			
• Reservoir Engineering--with regard to best way to produce field	X	X	1	80			
• Basic Understanding of Injection Process--for this type of field	X	X	2	81			
<u>Environmental</u>							
• Injection Impact Prediction Technology--with regard to	X		1	80			
- aquifer contamination							
- triggering seismic events							
• Subsidence Prediction Technology	X		1	80			

SITE: Brawley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperatures between 190°C-200°C	X		2	79			
• Working Fluid Selection Technique--(or fluid Development Program)	X		2	79			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (190°C-200°C)	X	X	2	79			
• Secondary Fluid Condensers--to operate where cooling water is scarce	X	X	2	79			
• Waste-Heat Handling--arid semi-desert, water scarce area	X	X	2	79			
<u>Supporting Technology--Binary Concepts</u>							
• Brine Chemistry--scale control in process equipment		X	3	79			
• Waste Brine Purification--for this type field		X	3	79			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		4	78			

SITE: Brawley, CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 200

DEPTH, M: 1500

ROCK TYPE: Soft

SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1983	1984	1985	1986	1987	1988+
CAPACITY FACTOR ASSUMED	.40	.47	.54	.59	.65	.7
COST OF ELECTRICITY (MILLS/KWH)	60.5	51.5	44.9	41.1	37.3	34.6

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ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	4.03	LIFE:	10
INJECTION WELLS:	0.58	LIFE:	20
PRODUCER PLANT:	7.25	LIFE:	20
GENERATING PLANT:	36.8	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .952
UTILITY: 1.236

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.154
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.368
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

6-7

SITE: BRAWLEY, CA
DESCRIPTION AND DATA

SITE: Brawley, CA

SUMMARY

TEMPERATURE °C

Surface:

Subsurface: 200

TOTAL DISSOLVED SOLIDS (PPM):

Low-to-moderate⁽¹⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS):

333

TYPE OF OVERLAYING ROCK:

Soft

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS):

1,500

DESCRIPTION OF KGRA

Total KGRA Acres: 28,885

Total Federal Acres: 0

Federal Acres Leased: 0

Total State and Private Acres: 28,885

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

As of August 1975, 3 successful wells were drilled and 10 more wells were planned. Testing was to take place after drilling an injection well and constructing field pipeline.⁽¹⁾

LOCAL AND STATE ATTITUDE TOWARD GEOTHERMAL DEVELOPMENTS:

Numerous state and local regulations.^(1A)

LAND USE AND POPULATION:

Flat, irrigated land used for agriculture. Town of Brawley has a population of 14,467.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

11-4

SITE: BRAWLEY, CA

SITE: Brawley, CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 33° 01' 00" N

REGION 1

LONGITUDE: 115° 31' 00" W

COUNTY: Imperial

ADJACENT COUNTIES: San Diego, Riverside; Yuma, Az., Mexico

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Desert in gently sloping area.	Irrigated land used for agriculture ⁽⁶⁾			

SITE: Brawley

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface:
Subsurface: 200°C

Geochemical

SiO₂:

Na-k-Ca: —

TOTAL DISSOLVED SOLIDS (TDS): Low-to-Moderate⁽¹⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 333⁽⁷⁾

TYPE OF OVER LAYING ROCK: Sediment, siltstone and sandstone

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1500 M (4921 ft)

SEISMIC ACTIVITY: The area is in an active tectonic region and has experienced significant earthquakes many times since the late 1940's.⁽⁶⁾

4-1-7
CI-1

SITE: Brawley, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Brawley		28,885		28,885 ⁽¹⁾ (State & Private)	
LAND LEASED IN KGRA			N/A		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		4,448			

SITE: Brawley, CA

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>As of August 1975, Union Oil Company of California drilled three successful wells and filed notices to drill another ten. It was projected that testing would start after an injection well was drilled and a field pipeline constructed. After testing, Union was to decide how many of the proposed ten wells would actually be drilled. Depths were 1219 to 1524 meters (4,000 to 5,000 feet).</p>	

SITE: Brawley, CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>Production Permit must be issued by Imperial County (requires compliance with all other permits and regulations such as building, plumbing, electrical and construction permits). The most important and time-consuming requirement of the Production Permit is the Environmental Impact Report (EIR) which may require at least 10 months of lead time for data collection and report preparation.</p> <p>The State's District Air Pollution Control Board requires construction and operation permits.</p> <p>Imperial County requires underground installation of collection and reinjection pipes at geothermal sites. Air pollution standards are set by the Occupational Safety and Health Administration (OSHA) and by the California Air Resources Board.</p> <p>California Division of Oil and Gas (DOG) is responsible for determining that potable groundwater supplies are protected during oil-, gas-, and geothermal-field operations, and for assuming that subsidence will not occur. (13)</p>		

SITE: Brawley, CA

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 5.8 cm (2.3 inches)

Average Temperature

Minimum: 12.2°C (54°F)

Maximum: 33.9°C (93°F)

Relative Humidity

(Seasonal Peaks)

Summer: 20% - 30%

Winter: 40%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
			Creosote bush, bur sage, saltbush, greasewood ⁽⁶⁾		

SITE: Brawley, CA
POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Brawley	< 16 Km (10 miles)	14,467	< 16 Km (10 miles) from secondary (100 to 161 KV) line.	State Highway 86 runs through Brawley	Rail service in Brawley. 56 cm (22") or smaller gas pipe- line within a few miles. 25 cm (10") or larger oil products pipeline ~ 17 miles to north.(6)

RECORD 00009

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000390
 CROSS INDEX NO.. CF00951
 RECORD TYPE..... A

NAME..... J. RENNER, J. P. CALZIA
 DATE..... 75/01
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. GLAMIS OR EAST BRAWLEY
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 32-58-00N

COUNTRY NAME..... UNITED STATES
 COUNTY..... IMPERIAL
 LONGITUDE..... 115-11-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 14S 17E 2 NE

BASE & MERIDIAN..... SAN BERNARDINO
 AVAILABLE MAPS OF AREA: GLAMIS NW 1:2400

GENERAL DESCRIPTION

ELEVATION..... 36.58 M 120. FT
 RESOURCE CATEGORY..... C
 SURFACE THERMAL ACTIVITY..... NO VISIBLE MANIFESTATION, FOUND BY HEAT FLOW ANOMALY,

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 100. C TO 150. C ASSUMED
 BEST ESTIMATE..... 135.0
 SUBSURFACE AREA..... 0.6 KM**2 TO 5.0 KM**2
 BEST ESTIMATE..... 2.0 KM**2
 BASED ON: TEMP. GRADIENT ANOMALY
 DEPTH TO TOP OF RESERVOIR..... 1000.00 M 1.000 KM TO 2000.00 M 2.000 KM
 BEST ESTIMATE..... 1500.00 M 1.500 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1000.00 M 1.000 KM TO 2000.00 M 2.000 KM
 BEST ESTIMATE..... 1500.00 M 1.500 KM
 VOLUME OF RESERVOIR..... 0.600 KM**3 TO 10.000 KM**3
 BEST ESTIMATE..... 3.000 KM**3
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 1.2558E+17 J 2.9999E+16 CAL TO 3.3468E+18 J 7.9999E+17 CAL
 BEST ESTIMATE..... 8.3716E+17 J 1.9999E+17 CAL ABOVE 15. C

GEOLOGY

GENERAL ROCK TYPES: SANDY DELTAIC DEPOSITS

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975

4-19

REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) U.S. BUREAU OF RECLAMATION, 1972, GEOTHERMAL RESOURCE INVESTIGATION, IMPERIAL VALLEY, CALIFORNIA DEVELOPMENTAL CONCEPTS: U.S. DEPT. INT. BUR. RECLAMATION, 58 P.

RECORD 00001

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000296
 CROSS INDEX NO.. CF00481
 RECORD TYPE..... A

NAME..... J. P. CALZIA, J. RENNER
 DATE..... 75/01
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BRAWLEY
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 33-01-00N

COUNTRY NAME..... UNITED STATES
 COUNTY..... IMPERIAL
 LONGITUDE..... 115-31-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 13S 14E 15 SW

BASE & MERIDIAN..... SAN BERNARDINO
 AVAILABLE MAPS OF AREA: WESTMORLAND 1:24,000

GENERAL DESCRIPTION

ELEVATION..... -4.5720E+01M -150. FT
 RESOURCE CATEGORY..... B
 PRESENT USE & DEVELOPMENTS: 1 OIL WELL TO 2400M; FOUR GEOTHERMAL LOCATIONS BY UNION OIL.
 NO. OF HOT SPRINGS..... NONE

GEOTHERMAL CHARACTERISTICS

WELL INFORMATION

BOTTOM-HOLE TEMPERATURE..... 139.0 C TO 2588.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 150. C TO 300. C ASSUMED
 BEST ESTIMATE..... 200.0 C
 SUBSURFACE AREA..... 13.0 KM**2 TO 31.0 KM**2
 BEST ESTIMATE..... 18.0 KM**2
 BASED ON: 8 F/100 FT. BUR. RECLAMATION TEMP GRADIENT CONTOUR
 DEPTH TO TOP OF RESERVOIR..... 1000.00 M 1.000 KM TO 2000.00 M 2.000 KM
 BEST ESTIMATE..... 1500.00 M 1.500 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1000.00 M 1.000 KM TO 2000.00 M 2.000 KM
 BEST ESTIMATE..... 1500.00 M 1.500 KM
 VOLUME OF RESERVOIR..... 13.000 KM**3 TO 62.000 KM**3
 BEST ESTIMATE..... 27.000 KM**3
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 4.1860E+18 J 9.9999E+17 CAL TO 4.6042E+19 J 1.0999E+19 CAL
 BEST ESTIMATE..... 1.2558E+19 J 2.9999E+18 CAL ABOVE 15. C

GEOLOGY

GENERAL ROCK TYPES: DELTAIC SEDIMENTS, SILTSTONE & SANDSTONE

GEOPHYSICS

OTHER GEOPHYSICAL INFORMATION: TEMPERATURE GRADIENT

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
DATE..... 1975
TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) DUTCHER, L.C. AND OTHERS, 1972, PRELIMINARY APPRAISAL OF GROUND WATER IN STORAGE WITH REFERENCE TO GEOTHERMAL RESOURCES IN THE IMPERIAL VALLEY AREA, CALIFORNIA: U.S.G.S. CIRC. 649, 57 P.
- 2) MOYLE, W.R., JR., 1974, TEMPERATURE & CHEMICAL DATA FOR SELECTED THERMAL WELLS & SPRINGS IN SOUTHEASTERN CALIF: U.S.G.S. WATER RES. INVS. 33-73
- 3) U.S. BUREAU OF RECLAMATION, 1972, GEOTHERMAL RESOURCE INVESTIGATION, IMPERIAL VALLEY, CALIFORNIA DEVELOPMENTAL CONCEPTS: U.S. DEPT. INT. BUR. RECLAMATION, 58P.
- 4) MUNGERS DAILY OILGRAM 12-74

5-1

SITE: BRADY H.S., NV
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Brady H.S., Nevada (Federal Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM County USGS BLM BLM/USFS	Issue STG Drilling Permit Issue Special Use Permit Issue Drilling Permit Lease Land Process EIA/EIS	Developer Developer Developer Developer CEQ	ASSUMED COMPLETED										
Developer	Exploratory Drilling & Reservoir Evaluation		-----	-----									
Developer	Develop Utility Interest		-----										
Developer & Utility	Feasibility Study		-----										
Producer (Developer) & Utility	Financial Negotiations			-----									
Producer	Site Selection			-----									
Producer & Utility	Preliminary Design				-----								
Producer & Utility	Final Design				-----	-----							
Producer & Utility	Commitment to Development				△								
Producer & Utility	Prepare Master Development Plan	BLM/USGS			-----								
Utility	Prepare Environmental Data Statement	BLM/FPC/ State DEQ			-----								
BLM/FPC/State PUC	Certify Plant & Site, Issue Permits	Producer & Utility			-----	-----							
USGS	Process EIA/EIS (Drilling)	CEQ			-----	-----							
FPC	Process EIA/EIS (Plant)	CEQ			-----	-----							
FPC/State PUC	Process EIA/EIS (Transmission Line)	CEQ			-----	-----							
Producer	Development Drilling						-----	-----	-----				
Utility	Plant Construction						-----	-----	-----				
Utility	Install Transmission Line (16km)						-----	-----	-----				

SITE: Brady H.S., NV

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal) land is leased for a 50 MWe power plant -- it may be only marginally sufficient.
- Development is well into exploratory drilling -- two good wells have been drilled to the east.
- No evidence of utility interest. Success in drilling may be assumed to encourage utility interest.

Principal Milestones:

• Identify utility	July 1977
• Complete feasibility study	April 1978
• Select site, commit to development	January 1979
• Start development drilling	April 1981
• Start construction	July 1981
• On line	October 1983

SITE: Brady H.S., NV

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Brady H.S., NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to define boundaries of reservoir	X	X	2	77			
• Drilling Techniques--(basaltic rock)		X	3	77			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	77			
• Data Analyses and Interpretation	X	X	3	77			
• Resource Characterization--with regard to determining type and extent of field	X	X	4	77			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	77			

SITE: Brady H.S. , NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Technology--(<214°C Basalts)		X	4	80			
• Injection Technology--(basaltic rock)	X		1	82			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of field where produced	X	X	2	80			
• Reservoir Engineering--to define best way to produce the reservoir	X	X	2	80			
• Brine Chemistry	X		1	81			
• Basic Understanding of the Injection Process--for this type of field	X		1	82			
<u>Environmental</u>							
• Injection Impact Prediction Technology-- with regard to	X		2	80			
- triggering seismic events							
- aquifer contamination							

SITE: Brady H.S., NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator Design--to minimize scaling	X	X	2	79			
• Waste Heat Handling--(water is in short supply)		X	2	79			
<u>Supporting Technology</u>							
• Brine Chemistry--scale control in process equipment		X	2	79			
• Spent Brine Purification	X		3	79			
<u>Environmental</u>							
• Non-condensable Gas Control/Disposal			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Brady H.S., NV

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 214

DEPTH, M: 500

ROCK TYPE: Hard

SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1983	1984	1985	1986+		
CAPACITY FACTOR ASSUMED	.40	.47	.54	.6		
COST OF ELECTRICITY (MILLS/KWH)	46.5	39.6	34.4	31.0		

5-8

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	4.02	LIFE:	10
INJECTION WELLS:	.75	LIFE:	20
PRODUCER PLANT:	7.07	LIFE:	20
GENERATING PLANT:	27.1	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER:	.225
UTILITY:	.738

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.153
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.271
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

5-9

SITE: BRADY H.S., NV

DESCRIPTION AND DATA

SITE: Brady H.S., NV

SUMMARY

TEMPERATURE °C

Surface: 98

Subsurface: 214

TOTAL DISSOLVED SOLIDS (PPM):

2,450⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS):

393⁽⁷⁾

TYPE OF OVERLAYING ROCK:

Hard

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS):

500

DESCRIPTION OF KGRA

Total KGRA Acres: 98,446

Total Federal Acres: ~ 1/2^(1A)

Federal Acres Leased: 21,008

Total State and Private Acres: ~ 1/2^(1A)

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Numerous wells have been drilled.^(4,17)

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

County concerned with maintaining open areas in natural state, but receptive to controlled development.⁽⁴⁾ Mild constraints and brief delays can be expected. Special use permit required.^(1A)

LAND USE AND POPULATION:

Rural population, agriculture, some recreation and mining.

COMMENTS AND CRITICAL ISSUES:

Surface water not available.⁽⁴⁾ As of August 1975, all exploration occurred on private property.^(1A) BLM has prepared an environmental analysis of the area.⁽⁴⁾ There is some evidence of recent seismic activity.⁽⁶⁾

SITE: Brady H.S., NV

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 39° 47' 13" N

REGION 4

LONGITUDE: 119° 00' 00" W

COUNTY: Churchill and Lyon⁽⁶⁾

ADJACENT COUNTIES: Douglas, Carson City, Storey, Washoe, Pershing, Lander, Nye, Mineral

LAND OWNERSHIP: Federal (BLM and Bu. of Reclamation)⁽⁴⁾ and Private⁽¹⁴⁾

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
alkali flats, dry washes, buttes. ⁽⁴⁾	Rural Agriculture, recreation, some mining. ⁽⁴⁾	County concerned with maintaining open areas in natural state; but receptive to con- trolled geothermal development. ⁽⁴⁾	Little scenic or aesthetic quality. ⁽⁴⁾	History includes numerous mining camps. ⁽⁴⁾

SITE: Brady H.S., NV

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 98°C
Subsurface: 214°C

Geochemical
SiO₂: 179°C
Na-k-Ca:

TOTAL DISSOLVED SOLIDS (TDS): 2450 ppm⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 393⁽⁷⁾

TYPE OF OVER LAYING ROCK: Basalt and alluvium

ESTIMATED DEPTH TO TOP OF RESERVOIR: 500 M (1640 ft)

SEISMIC ACTIVITY: Thermal activity lies along Brady Thermal Fault which trends northerly for approximately six miles. Movement probably strike-slip but can't be ascertained because scarp is covered by alluvium. There is some evidence of recent activity.⁽⁴⁾

SITE: Brady, NV

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Brady-Hazen		98,446	~49,200 ^(3-III)	~49,200 ^(3-III) (State & Private)	
LAND LEASED IN KGRA			21,008		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
20.00	Natomas Co.				
15.00	Natomas Co.				
10.16	Geo Resources Intl.				
7.93	So. Union Prod. Co.				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 18			39,650		
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE): 1			2,561		
SUBSURFACE AREA OF RESERVOIR		2,965			

SITE: Brady, H.S., NV

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>Several companies have been drilling in the area since 1959. Magma Power Company drilled several shallow wells between 1959 and 1961. Earth Energy, Inc. drilled a well to 1,519 M (5,062 feet) in 1964. By August 1975, Phillips and Union drilled deeper than 2,100 M (7,000 feet) and Magma has drilled 2 wells to 1,050 M (3,500 feet) and 1,350 M (4,500 feet) near the old holes.⁽⁴⁾</p> <p>As of February 1977, Southern Union Products Co. suspended operations; and Standard Oil of California has drilled a producing well.⁽¹⁷⁾</p>	

SITE: Brady H.S., NV

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>A special use permit is required for all geothermal activity. Mild constraints and brief delays can be expected. (1A) The county general plan includes a partial EIS. (4)</p>	<p>The county administration is in favor of geothermal development at a rate that can be planned and controlled. (4) (The administration perceives geothermal as a means to growth and improvements.) (1A)</p>	<p>BLM has prepared an environmental analysis of the thermal area. (4)</p>

SITE: Brady H.S., NV

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 0-20.3 cm (0-8 inches)⁽⁶⁾

Average Temperature

Minimum: -.6°C (31°F)

Maximum: 21.1°C (70°F)

Relative Humidity

(Seasonal Peaks)

Summer: 20% - 30%

Winter: 50% - 60%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
Not measured, but quality is good. ⁽⁴⁾	No permanent streams; shallow groundwater available. ⁽⁴⁾	Ambient noise levels not measured but may be high because of proximity of inter- state 80. ⁽⁴⁾	desert scrub including greasewood, sage, salt grass, squirrel tail. ⁽⁴⁾	coyote, bob- cat, rabbit, porcupine, mule deer, many birds. ⁽⁴⁾	No data existing. ⁽⁴⁾

SITE: Brady H.S., NV

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Reno	80.5 Km (50 miles)	70,000	< 16 Km (10 miles) (4)	1.6 Km (1 mile) from Interstate Hwy 80 ⁽⁴⁾	Minor 15-20 cm (6-8 inches) oil products pipeline 16 Km < (10 miles) Primary rail line within 16 Km (10 miles) Minor 56 cm (22") gas pipeline 16 Km < (10 miles) ⁽⁶⁾
Fernley	32 Km (20 miles)	900			

RECORD 00061

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 000602
 CROSS INDEX NO.. CPO2011
 RECORD TYPE..... A

NAME..... E. A. JOHNSON, J. RENNER
 DATE..... 75/01
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BRADY HOT SPRINGS
 WARING FIGURE..... B
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 39-47-13N

WARING NUMBER..... 72
 COUNTRY NAME..... UNITED STATES
 COUNTY..... CHURCHILL
 LONGITUDE..... 119-00-00W

TOWNSHIP RANGI SECTION 1/4 1/4
 22H 26E 12 SW

BASE & MERIDIAN..... MT. DIABLO
 AVAILABLE MAPS OF AREA: FIRE BALL RIDGE 1:62,500; RENO 1:250,000

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 0.6 KM**2
 ELEVATION..... 1255.78 M 4120. FT
 RESOURCE CATEGORY..... B
 SURFACE THERMAL ACTIVITY..... HOT SPRINGS, FUMAROLE OR WARM VAPOR
 ASSOCIATED DEPOSITS..... SINTER
 NO. OF HOT SPRINGS..... SEVERAL

GEOTHERMAL CHARACTERISTICS

TOTAL CALCULATED DISCHARGE OF DEEP WATERS: 45.00 L/S 2700.00 L/MIN
 TOTAL NATURAL HEAT FLUX..... 33.91 J/S 8.0999E+00 CAL/S
 SPRING TEMPERATURES..... 70. C TO 98. C

WELL INFORMATION

MAXIMUM WELL TEMPERATURE..... 214. C

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 200. C TO 230. C ASSUMED
 BEST ESTIMATE..... 214.0 C
 SURFACE AREA..... 5.0 KM**2 TO 30.0 KM**2
 BEST ESTIMATE..... 12.0 KM**2
 BASED ON: GEOLOGY, TEMP GRADIENT, EXPLORATION, SURFACE EXPRESSION
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 500.00 M 0.500 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM
 BEST ESTIMATE..... 2500.00 M 2.500 KM
 VOLUME OF RESERVOIR..... 7.500 KM**3 TO 75.000 KM**3
 BEST ESTIMATE..... 30.000 KM**3
 COMMENTS: DEPTH TO BOTTOM OF RESERVOIR IS ASSUMED.

RESERVED

5-19

TOTAL STORED HEAT.....	3.4743E+18 J	8.2999E+17 CAL	TO 4.0604E+19 J	9.6999E+18 CAL
BEST ESTIMATE.....	1.5069E+19 J	3.5999E+18 CAL	ABOVE 15.	C

GEOLOGY

GENERAL ROCK TYPES: PLIOCENE-PLEISTOCENE BASALT; QUATERNARY ALLUVIUM

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
DATE..... 1975
TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) GAKSIDE, L.J., 1974, GEOTHERMAL EXPLORATION & DEVELOPMENT IN NEVADA THROUGH 1973: NEVADA BUR. MINES AND GEOLOGY REPORT 21
- 2) KOENIG, J.B., 1970, GEOTHERMAL EXPLORATION IN THE WESTERN UNITED STATES: GEOTHERMICS SPEC. ISSUE 2, V.2, PT.1, P.1-13
- 3) ULMSTED, F.H., AND OTHERS, 1975, PRELIMINARY HYDROGEOLOGIC APPRAISAL OF SELECTED HYDROTHERMAL SYSTEMS IN NORTHERN & CENTRAL NEVADA: U.S.G.S. OPEN-FILE REPORT 75-56
- 4) WARING, G.A., 1965, THERMAL SPRINGS OF THE UNITED STATES AND OTHER COUNTRIES OF THE WORLD-A SUMMARY: U.S.G.S. PROF. PAPER 492

RECORD 00062

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 6

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000894

CROSS INDEX NO..

RECORD TYPE..... B

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/03

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BRADY HOT SPRINGS

NAME OF SAMPLE SOURCE.. MUD VOLCANO #2

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 39-47. N

COUNTRY NAME..... UNITED STATES

COUNTY..... CHURCHILL

LONGITUDE..... 119-01. W

OTHER LOCALITY INFORMATION: 15 MILES NE OF BRADY'S STATION NEAR BRADY'S HOT SPRINGS

SAMPLE INFORMATION

COLLECTION DATE..... 1960/09/08

COLLECTOR(S)..... D. E. WHITE

WATER SAMPLING TEMP.... BOILING

OTHER CHEMICAL CHARACTERISTICS: SI02

WATER ANALYSIS

W

ANALYSIS DATE..... 1961/04/11

ANALYST(S)..... H. C. WHITEHEAD

PH 1)..... 4.7

SPECIFIC CONDUCTANCE.... 7290. UMHO/CM

ALKALINITY..... 1150. PPM AS CaCO3

TOTAL DISSOLVED SOLIDS... 5930. PPM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
3.3	1386	114						
MC	CA	SR	BA	CA+MG				
28	412							
7N	HG	B	HBO2	AL	PB	AS	SB	U
		7.1						
F	CL	BR	I					
2.4	1070							
NO4	NO3	PO4	SI02	SO4	CO3	HC03		
	.5	2.0	149	2760	0	2		

OTHER SOLUTES & GASES TOTAL CATIONS IN EPM 86.29. TOTAL ANIONS IN EPM 87.79.
 REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK.

RECORD 00063

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION 1.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 000093
 CROSS INDEX NO..
 RECORD TYPE..... 1
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BRADY HOT SPRINGS

NAME OF SAMPLE SOURCE.. MUD VOLCANO, NEW VENT, AT U.S. HIGHWAY 50 1+ MILE N. OF BRADY'S HOT SPRINGS

COUNTRY CODE..... US

COUNTRY NAME..... UNITED STATES

STATE/PROVINCE..... NEVADA

COUNTY..... CHURCHILL

TOWNSHIP RANGE SECTION 1/4 1/4
 22N 26E 1 SE

MAP REFERENCE: FIREBALL RIDGE, NEVADA QUAD

SAMPLE INFORMATION

SOURCE TYPE..... NEW VENT IN MUD VOLCANO

COLLECTION DATE..... 1960/09/07

COLLECTOR(S)..... J. H. FETH

POINT OF COLLECTION..... SMALL GREEN MUD - SPATTER CONE CUT FLOW, W. EDGE OF HIGHWAY, SOUTH OF CULVERT

WATER FLOW RATE..... LT .06 L/S LT 1. GAL/MIN

WATER TREATMENT DATA: SAMPLES UNFIXED, FILTERED THRU MILLIPORE OR FIXED, ACETIFORM

OTHER CHEMICAL CHARACTERISTICS: BASIN DRAINED OF STANDING WATER AND NEW FLOW COLLECTED. VERY MUDDY

WATER ANALYSIS

W

ANALYSIS DATE..... 1961/07/25

ANALYST(S)..... H. C. WHITEHEAD, CHECKED BY W. L. POLZER

PH 1)..... 7.3

SPECIFIC CONDUCTANCE..... 1210. UMHO/CM

ALKALINITY..... 120. PPM AS CaCO3

TOTAL DISSOLVED SOLIDS... 1050. PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	HA	K	RB	CS	NA+K
.19	200	31			

MG	CA	SR	BA	CA+MG
2.6	44	1.1		

MM+3	MM(TOT)	FL+3	FE(TOT)	CU
	.5			

ZH	HS	B	HE02	AL	Pb	AS	SB	U
		2.4		.69		.35		

F	CL	FR	I
5.6	43	0	.6

HH4	HO3	PO4	SI02	SO4	CO3	HCO3
0	0	2.1	108	341	0	204

OTHER SOLUTES & GASES TOTAL CATION IN EPM 11.96, TOTAL ANION IN EPM 11.94.
REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

RECORD 00064

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 2

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000889
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/03
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BRADY HOT SPRINGS (SPRINGERS HOT SPRINGS)
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... CHURCHILL
 LATITUDE..... 39-47. N LONGITUDE..... 119-01. W
 OTHER LOCALITY INFORMATION: HOT SPRING STATION ON SOUTHERN PACIFIC RAILROAD (BRADY'S OR SPRINGER'S HOT SPRING)

SAMPLE INFORMATION

COLLECTION DATE..... 1882?

WATER ANALYSIS

TOTAL DISSOLVED SOLIDS... 2495. PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
TRACE	774.3	66.9						
HC	CA	SR	BA	CA+MG				
1.0	30							
ZN	HG	B	HBO2	AL	PB	AS	SR	U
				1				
F	CL	BR	I					
	967.9							
NI4	NO3	PO4	SIO2	SO4	CO3	HCO3		
			278.8			335.5		

REFERENCES: RUSSELL, ISRAEL COOK, U.S. GEOL. SURVEY MON. 11, P. 49, GEOLOGIC HISTORY OF LAKE LAHONTAN, A QUATERNARY LAKE OF NORTHWESTERN NEVADA.

5-24

RECORD 00065

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000892
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... WELL

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BRADY HOT SPRINGS
 NAME OF SAMPLE SOURCE.. STEAM WELL
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 39-47. N
 OTHER LOCALITY INFORMATION: 10 MILES NE OF FERNLEY, NEV.

COUNTRY NAME..... UNITED STATES
 COUNTY..... CHURCHILL
 LONGITUDE..... 119-01. W

SAMPLE INFORMATION

COLLECTION DATE..... 1960/06/10
 COLLECTOR(S)..... UMAR LOELTZ
 WATER SAMPLING TEMP.... BOILING

WATER ANALYSIS

W

ANALYSIS DATE..... 1960/06/10
 ANALYST(S)..... H. C. WHITEHEAD CHECKED BY A. S. VAN DENBURGH
 PH 1)..... 7.3
 SPECIFIC CONDUCTANCE..... 4090. UMHO/CM
 ALKALINITY..... 138. PPM AS CaCO3

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM.

LI	NA	K	RB	CS	NA+K			
1.8	780	65						
MG	CA	SR	BA	CA+MG				
1.2	53	1.9						
MN+3	MN(TOT)	FE+3	FE(TOT)	CU				
	.00		.08	.00				
ZN	HG	B	HBO2	AL	PB	AS	SB	U
.00		6.8		.52	.00	.15		
F	CL	BR	I					
7.6	978	2.1	0					
NO4	NO3	PO4	SIO2	SO4	CO3	HCO3		
.00	.4	.22	242	377	0	162		

OTHER SOLUTES & GASES CATION TOTAL IN EPM = 38.59, ANION TOTAL IN EPM = 38.50.

COMMENTS: MINERAL NODULES ON X - RAY SHOW QTZ., TRIDIMITE, AND CRISTOBOLITE.
 REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

5-25

RECORD 00066

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000891

CROSS INDEX NO..

RECORD TYPE..... B

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/C4

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BRADY HOT SPRINGS

NAME OF SAMPLE SOURCE.. MUD VOLCANO NO. 1

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 39.47.3 N

COUNTRY NAME..... UNITED STATES

COUNTY..... CHURCHILL

LONGITUDE..... 119-01.0 W

TOWNSHIP RANGE SECTION 1/4 1/4
22N 26E 12

SAMPLE INFORMATION

COLLECTION DATE..... 1960/09/68

COLLECTOR(S)..... D. E. WHITE

POINT OF COLLECTION..... 200' NORTH OF NEVADA THERMAL WELL NO. 2

WATER SAMPLING TEMP..... COLD

OTHER CHEMICAL CHARACTERISTICS: INACTIVE MUD VOLCANO, 5 FT DIAMETER CONE 12-18 FT. ABOVE GROUND. SiO2 DATA IS

COLORIMETRIC, MAYNOT REPRESENT TOTAL

WATER ANALYSIS

W

ANALYSIS DATE..... 1961/02/06

ANALYST(S)..... H. C. WHITEHEAD, CHECKED BY C. E. ROBERSON

PH 1)..... 7.3

SPECIFIC CONDUCTANCE..... 6240. UMHO/CM

ALKALINITY..... 298. PPM AS CaCO3

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K				
2.5	1170	91							
NO	CA	SR	BA	CA+MG					
1.5	117								
MN+3	MN(TOT)	FE+3	FE(TOT)	CU					
	0		0						
ZN	HG	B	HBO2	AL	PB	AS	SB	U	
		8.2		0					
F	CL	BR	I						
6.6	1510								
NH4	NO3	PO4	SiO2	SO4	CO3	HC03			
	0	.72	169	694	0	269			

OTHER SOLUTES & GASES CATION TOTALS IN LPM 59.55, ANION TOTALS IN EPM 61.79
REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK.

RECORD 00067

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000890
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BRADY HOT SPRINGS
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 36-47.3 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... CHURCHILL
 LONGITUDE..... 119-01.0 W

TOWNSHIP RANGE SECTION 1/4 1/4
 22N 26E 12 NE

OTHER LOCALITY INFORMATION: 1/3 MILE EAST OF U.S. 40 AT BRADY'S STATION

SAMPLE INFORMATION

COLLECTION DATE..... 1957/05/22
 COLLECTOR(S)..... D. E. WHITE
 WATER SAMPLING TEMP.... 94. C
 WATER FLOW RATE..... 4.4030E-26 L/S 10-20 GAL/MIN
 DEPOSITS OR ALTERATION: H2S .3 PPM FROM SILICEOUS SINTER ON ALLUVIUM

WATER ANALYSIS

W

ANALYSIS DATE..... 1958/01/31
 ANALYST(S)..... H. C. WHITEHEAD, CHECKED BY C. ROBERSON
 PH 1)..... 7.1
 SPECIFIC CONDUCTANCE..... 3640. UMHO/CM
 ALKALINITY..... 54. PPM AS CaCO3
 TOTAL DISSOLVED SOLIDS... 2360 PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
1.3	730	62						
MG	CA	SR	BA	CA+MG				
0	22	0						
MN+3	MN(TOT)	FE+3	FE(TOT)	CU				
	0		0					
ZN	HG	B	HB02	AL	PB	AS	SB	U
.01		4.7		0	0	.11		
F	CL	BR	I					
7.3	910	2.2	.1					
NH4	NO3	PO4	S102	SO4	CO3	HC03		
.5	0	.26	226	315	0	67		

OTHER SOLUTES & CASES ANION TOTALS IN EPM - 33.74.
REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK.

RECORD 00068

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000003
CROSS INDEX NO.. CPO2011
RECORD TYPE..... B
SAMPLE TYPE..... SURFACE

NAME..... E. A. JOHNSON, J. RENNER
DATE..... 75/01
ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BRADY HOT SPRINGS
COUNTRY CODE..... US
STATE/PROVINCE..... NEVADA
LATITUDE..... 39-47.21 N

COUNTRY NAME..... UNITED STATES
COUNTY..... CHURCHILL
LONGITUDE..... 119-00.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

WATER ANALYSIS

W
PH 1)..... 9.00

SOLUTE ANALYSIS (WATER)

NH4	NO3	PO4	SI02	SO4	CO3	HCO3
			242.00			

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726
OLMSTED AND OTHERS, 1975

SITE: BEOWAWE, NV
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Beowawe, Nevada (Federal Land, possibly some Private)

SITE DEVELOPMENT SCHEDULE (FOR FIRST MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM USGS BLM/Owner BLM County	Issue STG Drilling Permit Issue Drilling Permit Lease Land Process EIA/EIS Issue Use Permit	Developer Developer Developer CEQ Developer	ASSUMED COMPLETED										
Developer	Exploratory Drilling & Reservoir Evaluation		—	—	—								
Developer	Develop Utility Interest		—										
Developer & Utility	Feasibility Study			—									
Producer (Developer) & Utility	Financial Negotiations				—								
Producer	Site Selection				—								
Producer & Utility	Preliminary Design				—								
Producer & Utility	Final Design				—	—							
Producer & Utility	Commitment to Development				Δ								
Producer & Utility	Prepare Master Development Plan	BLM, USGS			—	—							
Utility	Prepare Environmental Data Statement	BLM, FPC, STATE DEQ			—	—							
BLM/FPC/ State PUC	Certify Plant & Site, Issue Permits	Producer & Utility				—	—						
USGS	Process EIA/EIS (Drilling)	CEQ				—	—						
FPC	Process EIA/EIS (Plant)	CEQ				—	—						
FPC/State PUC	Process EIA/EIS (Transmission Line)	CEQ				—	—						
Producer	Development Drilling							—	—				
Utility	Plant Construction							—	—	—			
Utility	Install Transmission Line (40km)							—	—	—			

SITE: Beowawe, NV

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal) land has been leased for a 50 MWe power plant. Probably sufficient private land has also been leased.
- Development is in early exploratory drilling phase.
- Utility has not been identified.

Principal Milestones:

• Identify Utility	April 1978
• Complete feasibility study	January 1979
• Select site, commit to development	October 1979
• Start development drilling	January 1982
• Start construction	April 1982
• On line	July 1984

SITE: Beowawe, NV

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Beowawe, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
EXPLORATION DRILLING							
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to define reservoir boundaries	X	X	2	78			
• Drilling Techniques--(basalts at 240°C)		X	3	78			
• High Temperature Down-Hole Measurement Equipment--(240°C)		X	3	78			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	78			
• Data Analysis and Interpretation	X	X	3	78			
• Resource Characterization--with regard to determining type and extent of field	X	X	4	78			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	78			

SITE: Beowawe, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Technology--(<240°C basalts)		X	4	81			
• Injection Technology--(basaltic rocks)	X		1	83			
• High Temperature Down-Hole Measurement Equipment--(<240°C)		X	4	81			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of field when produced	X	X	2	81			
• Reservoir Engineering--to define best way to produce the reservoir	X	X	2	81			
• Brine Chemistry	X		1	82			
• Basic Understanding of Injection Process--for this type of field	X	X	1	82			
<u>Environmental</u>							
• Injection Impact Prediction Technology--with regard to - triggering seismic events - aquifer contamination	X		2	81			
• Subsidence Prediction Technology	X		2	81			

SITE: Beowawe, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator Design--to minimize scaling	X	X	2	80			
• Waste Heat Handling--(water is in short supply)		X	2	80			
<u>Supporting Technology</u>							
• Brine Chemistry--scale control in process equipment		X	2	80			
• Spent Brine Purification Processes--for this type field	X		2	80			
<u>Environmental</u>							
• Non-condensable Gas Control/Disposal			(1D)	(1D)			
(1D) Insufficient Data							

SITE: Beowawe, NV

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 240

DEPTH, M: 1000

ROCK TYPE: Hard

SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1984	1985	1986	1987+		
CAPACITY FACTOR ASSUMED	.40	.47	.54	.6		
COST OF ELECTRICITY (MILLS/KWH)	40.5	34.5	30.0	27.0		

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ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	4.84	LIFE:	10
INJECTION WELLS:	1.02	LIFE:	20
PRODUCER PLANT:	4.49	LIFE:	20
GENERATING PLANT:	24.5	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER:	.204
UTILITY:	.669

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.138
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.245
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

SITE: BEOVAWE, NV
DESCRIPTION AND DATA

SITE: Beowawe, NV

SUMMARY

TEMPERATURE °C

Surface: 226

Subsurface: 240

TOTAL DISSOLVED SOLIDS (PPM): 1,200⁽⁴⁾
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 624
TYPE OF OVERLAYING ROCK: Hard
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres: 33,225⁽²⁾
Total Federal Acres: ~ 1/2^(1A)
Federal Acres Leased:

Total State and Private Acres: ~ 1/2^(1A)
State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

More than 12 wells drilled. (Some drilled recently.)^(2,17)

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Development generally welcome. Use permit for land is required. Mild constraints and brief delays expected.^(1A)

LAND USE AND POPULATION:

Sparsely populated desert. Mining, grazing and irrigated agriculture.⁽⁴⁾

COMMENTS AND CRITICAL ISSUES:

A water shortage exists.^(1A) BLM has prepared a regional environmental analysis.⁽⁴⁾

SITE: BEOWAWE, NV

SITE: Beowawe, NV

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 40° 34' 12" N

REGION 4

LONGITUDE: 116° 34' 48" W

COUNTY: Eureka and Lander Counties⁽⁸⁾

ADJACENT COUNTIES: Elko, White Pine, Nye, Churchill, Pershing, Humboldt

LAND OWNERSHIP: Federal and Private ownership⁽⁶⁾

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Desert	Sparsely populated - principally mining, grazing, irrigation, agriculture. ⁽⁴⁾		Bold, stark beauty and isolation; substantially altered by construction of roads, power lines, mines. ⁽⁴⁾	Immigrant Trail north of site, Pony Express route south of site. Shoshone and Piute Indians inhabited area. ⁽⁴⁾

SITE: Beowawe, NV

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 226°C
Subsurface: 240°C

Geochemical

SiO₂: 226°C
Na-k-Ca: 242°C

TOTAL DISSOLVED SOLIDS (TDS): 1200 ppm⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 624⁽⁷⁾

TYPE OF OVER LAYING ROCK: Tertiary Basalt, Quarternary Alluvium

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY:

SITE: Beowawe, NV

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Beowawe		33,225	~16,600 ^(3III)	~16,600 ^(3III) (State & Private)	
LAND LEASED IN KGRA			13,768		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
203.75	Chevron Oil Co.				
30.59	Chevron Oil Co.				
18.00	Getty Oil Co.				
12.91	So. Union Prod. Co.				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 5			5,047		
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE): 0					
SUBSURFACE AREA OF RESERVOIR		5,189			

SITE: BEOWAWE, NV

GEOTHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>As of August 1975, the deepest well drilled was 2915 M (9,563 feet).⁽⁴⁾ By June 1976, more than 12 holes were drilled, with Magma Power (Chevron) planning additional holes.⁽²⁾ By February 1977, 1 well drilled by Standard Oil of California.⁽¹⁷⁾</p>	

SITE: Beowawe, NV

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>Eureka County requires a use permit for land, and geothermal activity must comply with county zoning. Mild constraints and brief delays may be expected. (1A)</p>	<p>Residents concerned about demands on services if population increases significantly, however geothermal development is generally welcome. (4)</p>	<p>BLM has prepared a regional environmental analysis pertaining to geothermal leasing. (4)</p>

SITE: Beowawe, NV

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 23 cm (9.13 inches)

Average Temperature

Minimum: -5.5°C (22°F)

Maximum: 21°C (70°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30 - 40%

Winter: 60 - 70%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
ppm undetermined. ⁽⁴⁾ Principal pollutant is wind-borne dust, while some sulphur dioxide and hydrogen sulfide from hot springs.	Surface water-Humboldt River-Shallow ground water of good quality is ⁽⁴⁾ available. However, a water ^(1A) shortage exists.	Ambient noise level is low.	greasewood, shadscale, rabbit brush, big sage, winter fat, wild-rye, squirreltail, cheat grass. Aquatic plant life found in thermal springs. ⁽⁴⁾	wild horse, fox, weasel, bat, coyote, bobcat, rabbit, mule deer, prong-horn antelope. Springwater heavily used by wildlife and livestock. ⁽⁴⁾	Spotted Bat and a relict fish found in Carico Lake Valley. ⁽⁴⁾

SITE: Beowawe, NV

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Battle Mountain	32 Km (20 miles)	1850 ⁽⁶⁾	~241 Km (150 mi.) from primary (750 KV DC) ⁽⁶⁾ 40 Km (25 miles) to distribution line. ⁽⁴⁾	Interstate Hwy 80 a few miles north of site. ⁽⁶⁾	Railroad few miles north of site (primary railroad) Minor gas pipeline few miles north of site. ⁽⁶⁾

RECORD 00045

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000588

CROSS INDEX NO.. CF01941

RECORD TYPE..... A

NAME..... E. A. JOHNSON, J. RENNER

DATE..... 75/01

ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BEOWAWE

WARNING FIGURE..... 8

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 40-34-12N

WARNING NUMBER..... 77A

COUNTRY NAME..... UNITED STATES

COUNTY..... EUREKA

LONGITUDE..... 116-34-48W

TOWNSHIP	RANGE	SECTION	1/4	1/4
31N	48E	17	NW	

BASE & MERIDIAN..... MT. DIABLO

AVAILABLE MAPS OF AREA: DUNPHY 1:62,500; WINNEMUCCA 1:250,000

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 1.6 KM**2

ELEVATION..... 1524.00 M 5000. FT

RESOURCE CATEGORY..... B

PRESENT USE & DEVELOPMENTS: 9 WELLS 131M TO 3000M; TEMPS TO 212C

SURFACE THERMAL ACTIVITY..... HOT SPRINGS, GEYSERS, FUMAROLE OR WARM VAPOR

ASSOCIATED DEPOSITS..... SINTER

NO. OF HOT SPRINGS..... 15

GEOTHERMAL CHARACTERISTICS

SPRING TEMPERATURES..... 50. C TO 98. C

WELL INFORMATION

MAXIMUM WELL TEMPERATURE..... 212. C TO 220. M

BOTTOM-HOLE TEMPERATURE..... 212.0 C TO 220.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 165. C TO 220. C ASSUMED

BEST ESTIMATE..... 240.0 C

SUBSURFACE AREA..... 0.6 KM**2 TO 31.0 KM**2

BEST ESTIMATE..... 21.0 KM**2

BASED ON: GEOLOGY, GEOPHYSICS, EXPLORATION

DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM

BEST ESTIMATE..... 1000.00 M 1.000 KM

DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM

BEST ESTIMATE..... 3000.00 M 3.000 KM

THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM

BEST ESTIMATE..... 2000.00 M 2.000 KM

VOLUME OF RESERVOIR..... 0.900 KM**3 TO 77.500 KM**3

BEST ESTIMATE..... 42.000 KM**3

COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

61-9

TOTAL STORED HEAT.....	4.1880E+17 J	9.9999E+16 CAL	TO 5.1484E+19 J	1.2299E+19 CAL
BEST ESTIMATE.....	2.3860E+19 J	5.6999E+18 CAL	ABOVE 15.	C

GEOLOGY

GENERAL ROCK TYPES: TERTIARY BASALT, QUATERNARY ALLUVIUM

GEOPHYSICS

GRAVITY SURVEY INFORMATION: TEST MADE

MAGNETIC SURVEY INFORMATION: TEST MADE

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS

DATE..... 1975

TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975

REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

1) GILLULY, JAMES, AND GATES, DUDLEY, 1965, TECTONIC AND IGNEOUS GEOLOGY OF THE NORTHERN SHOSHONE RANGE, NEVADA:

U.S.G.S. PROF. PAPER 465

2) HUSE, R.K., AND TAYLOR, B.E., 1974, GEOTHERMAL SYSTEMS OF NORTHERN NEVADA: U.S.G.S., OPEN-FILE REPORT 74-271

3) MABEY, D.R., 1964, GRAVITY MAP OF EUREKA COUNTY AND ADJOINING AREAS, NEVADA: U.S.G.S. GEOPHYS. INV. MAP GP-415

4) MARINER, R.H., & OTHERS, 1974, THE CHEMICAL COMPOSITION AND ESTIMATED MINIMUM THERMAL RESERVOIR TEMPERATURE OF THE PRINCIPAL HOT SPRINGS OF NORTHERN AND CENTRAL NEVADA: USGS OPEN-FILE REPORT

ROBINSON, E.S., 1970, RELATIONS BETWEEN GEOLOGIC STRUCTURE AND AEROMAGNETIC ANOMALIES IN CENTRAL NEVADA: GEOL. SOC. AMERICA BULL. V. 81, NO. 7, P. 2045-2060

STEWART, J.H. & MCKEE, E.H., 1970, GEOLOGIC MAP OF LANDER COUNTY, NEVADA: USGS OPEN-FILE REPORT

ZOBACK, M.L., 1974, A GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BEDWAVE GEOTHERMAL AREA, NORTH-CENTRAL NEVADA: STANFORD UNIV., M.S. REPORT

RECORD 00046

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION E

SECTION E.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000819
 CROSS INDEX NO..
 RECORD TYPE..... E
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BEOWAWE
 NAME OF SAMPLE SOURCE.. SPRING #3
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 40-33. N
 OTHER LOCALITY INFORMATION: SAME AS #423

COUNTRY NAME..... UNITED STATES
 COUNTY..... EUREKA
 LONGITUDE..... 116-35. W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1958/09/01
 COLLECTOR(S)..... D. E. WHITE
 WATER FLOW RATE..... 0.026418 L/S 6. GAL/MIN
 WATER TREATMENT DATA: OPALINE SIO2 ADDED WHEN COLLECTED

WATER ANALYSIS

ANALYSIS DATE..... 1958/07/11
 ANALYST(S)..... H. C. WHITEHEAD
 PH 1)..... 9.3
 SPECIFIC CONDUCTANCE..... 1200. UMHO/CM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

MG	CA	SR	BA	CA+MG		
0	.8					
F	CL	BR	1			
	70					
NH4	NO3	PO4	SIO2	SO4	CO3	HCO3
			236		183	150

REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

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RECORD 00047

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000788
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BEOWAWE
 NAME OF SAMPLE SOURCE.. MAIN GEYSER
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 40-33. N

COUNTRY NAME..... UNITED STATES
 COUNTY..... EUREKA
 LONGITUDE..... 116-35. W

SAMPLE INFORMATION

WATER SAMPLING TEMP.... BOILING

WATER ANALYSIS

W

ANALYST(S)..... S. C. DINSMORE, UNIV. NEV.
 TOTAL DISSOLVED SOLIDS... 1307. PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

MG	CA	SR	BA	CA+MG				
0	TRACE							
MN+3	MN(TOT)	FE+3	FE(TOT)	CU				
			TRACE					
ZN	HG	B	HBO2	AL	PB	AS	SB	U
				TRACE				
F	CL	BR	I					
	70							
NH4	NO3	PO4	SiO2	SO4	CO3	HCO3		
			418	91	TRACE	512		

OTHER SOLUTES & GASES NA + K 282 PPM.

COMMENTS: LAVA, FAULTED.

REFERENCES: NULAN AND ANDERSON, 1934, AM. J. SCI. 5 SER., V. 27, P. 215.

RECORD 00048

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 6

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000810
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BEOWAWE
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 40-33. N

COUNTRY NAME..... UNITED STATES
 COUNTY..... EUREKA
 LONGITUDE..... 116-35. W

TOWNSHIP RANGE SECTION 1/4 1/4
 31N 48E 17

OTHER LOCALITY INFORMATION: NORTHERLY OF 2 POOLS ON FLATS

SAMPLE INFORMATION

COLLECTION DATE..... 1952/09/16
 COLLECTOR(S)..... G. S. SIMMONS
 POINT OF COLLECTION..... NORTHERLY OF 2 POOLS AS FLATS
 WATER SAMPLING TEMP.... 87. C

OTHER CHEMICAL CHARACTERISTICS: CLEAR WHEN COLLECTED AND ANALYZED.

WATER ANALYSIS

W

ANALYSIS DATE..... 1955/04/13 ?
 SPECIFIC CONDUCTANCE..... 1040. UMHO/CM
 ALKALINITY..... 6. PPM
 TOTAL DISSOLVED SOLIDS... 1030 PPM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
1.2	239	19						
MG	CA	SR	BA	CA+MG				
.9	1.2							
MM+3	MM(TOT)	FE+3	FE(TOT)	CU				
	0		.02					
ZH	HG	B	HGG2	AL	PB	AS	SB	U
		.93						
F	CL	BR	I					
16	66							
NH4	NO3	PO4	SIO2	SO4	CO3	HC03		
	0	0	392	93	157	96		

REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS

RECORD 00049

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000811

CROSS INDEX NO..

RECORD TYPE..... B

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/04

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BEOWAWE

NAME OF SAMPLE SOURCE.. SMALL GEYSER

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 40-33 N

COUNTRY NAME..... UNITED STATES

COUNTY..... LANDER

LONGITUDE..... 116-35 W

SAMPLE INFORMATION

WATER SAMPLING TEMP.... BOILING

OTHER CHEMICAL CHARACTERISTICS: LUVA, FAULTED.

WATER ANALYSIS

W

ANALYST(S)..... CARNEGIE GEOPHYS. LAB

TOTAL DISSOLVED SOLIDS... 1208 PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

L1	NA	K	RB	CS	NA+K			
	239	33						
MG	CA	SR	BA	CA+MG				
0	2							
MN+3	MN(TOT)	FE+3	FE(TOT)	CU				
			TRACE					
ZN	BG	B	HBO2	AL	PB	AS	SB	U
		7.2		0		0		
F	CL	BR	I					
11	47							
O2	H2	CO2	SO2	H2S	H2	CH4		
				0				
NH4	NO3	PO4	S102	SO4	CO3	HCO3		
47			449	97	173	129		

OTHER SOLUTES & GASES S2 03 1 PPM.

REFERENCES: NOLAN AND ANDERSON, 1934, AM. J. SCI., 5 SER., V. 27, P. 215.

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RECORD 00050

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION 6.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000790
 CROSS INDEX NO.. MARP1P4
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/03
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD=AREA.. BEOWAWE
 NAME OF SAMPLE SOURCE.. BEOWAWE HOT SPRING
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 40-34. N

COUNTRY NAME..... UNITED STATES
 COUNTY..... EUREKA
 LONGITUDE..... 116-34. W

TOWNSHIP RANGE SECTION 1/4 1/4
 21N 48E 8 SE

MAP REFERENCE: DUNPHY, NEV. (15°); WINNEMUCCA, NEV. (2 DEG.)

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1972-73
 COLLECTOR(S)..... MARINER'S GROUP
 POINT OF COLLECTION..... NEAR ORIFICE OF SPRING
 WATER SAMPLING TEMP.... 98. C
 WATER FLOW RATE..... 1.67 L/S 100. L/MIN

DEPOSITS OR ALTERATION: SILICA APRON DEPOSITED.

WATER TREATMENT DATA: PRESSURE FILTERED THROUGH A .45 MICROMETRE MEMBRANE FILTER, DILUTED.

OTHER CHEMICAL CHARACTERISTICS: BOILING, VERY LOW CALCIUM, SUPERHEATED. ALKALINITY REPORTED AS CARBONATE AND BICARBONATE.

WATER ANALYSIS W

ANALYSIS DATE..... 1972-73
 ANALYST(S)..... BARNES GROUP
 PH 1)..... 8.98
 SPECIFIC CONDUCTANCE..... 1020. UMHO/CM2
 ALKALINITY..... 385. MG/L

ISOTOPIIC DATA

DEL D(18) OF WATER..... -14.76 0/00
 DEL D OF WATER..... -130.6 0/60

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K
1.3	230	16	.20		
MG	CA	SR	BA	CA+MG	
LI .1	1.0	.05			
MM+3	MM(101)	FE+3	FE(101)	CU	
	LI .02		LI .02	LI .01	

ZR	HC	B	HR02	AL	PB	AS	SB	U
	.0017	2.1		.082		.03		
F	CL	BR	1					
17	69	.2	.02					
NH4	NO3	PO4	SI02	SO4	CO3	HCO3		
.64		.15	320	130				

COMMENTS: LASALT AND ANDESITE FLOWS SURROUND THE SPRING
 REFERENCES: MARINER, R. H., RAPP, PRESSER, WILLEY, THE CHEMICAL COMPOSITION & ESTIMATED MINIMUM THERMAL RESERVOIR
 TEMPERATURES OF PRINCIPAL HOT SPRINGS OF NORTHERN & CENTRAL NEVADA. MARINER, PRESSER, RAPP, WILLEY, THE MINOR AND
 TRACE ELEMENTS, GAS, AND ISOTOPE COMPOSITIONS OF THE PRINCIPAL HOT SPRINGS OF NEVADA AND OREGON.

RECORD 00051

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000589
 CROSS INDEX NO.. CPG1941 MARP1P4
 RECORD TYPE..... E
 SAMPLE TYPE..... WELL

NAME..... SANFORD, LINDA J.
 DATE..... 76/03
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BEGWAVE
 NAME OF SAMPLE SOURCE.. "STEAM" WELL
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 40-33. N

COUNTRY NAME..... UNITED STATES
 COUNTY..... EUREKA
 LONGITUDE..... 116-35. W

TOWNSHIP RANGE SECTION 1/4 1/4
 31N 40E 17 NW

MAP REFERENCE: DUNPHY, NEV. (15 MIN.), WINNEMUCCA, NEV. (2 DEG)

SAMPLE INFORMATION

COLLECTION DATE..... 1972-73
 COLLECTOR(S)..... MARINER'S GROUP
 POINT OF COLLECTION..... NEAR ORIFICE OF WELL
 WATER SAMPLING TEMP....

WATER TREATMENT DATA: PRESSURE - FILTERED THROUGH A .45 MICROMETRE MEMBRANE, DILUTED

OTHER CHEMICAL CHARACTERISTICS: SILICA APRON DEPOSITED; BOILING, VERY LOW CALCIUM ALKALINITY REPORTED AS CARBONATE AND BICARBONATE.

WATER ANALYSIS

W

ANALYSIS DATE..... 1972-73
 ANALYST(S)..... BARNES GROUP
 PH 1)..... 9.38
 SPECIFIC CONDUCTANCE..... 1490. UMHO/CM
 ALKALINITY..... 667. MG/L

ISOTOPIC DATA

DEL D(18) OF WATER..... -11.07 0/00
 DEL D OF WATER..... -113.6 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
2.1	250	DE	.46	.3				
MG	CA	SR	BA	CA+MG				
.2	1.5	.07						
MM+3	MM(TOT)	FE+3	FE(TOT)	CU				
	LT .02		LT .02	LT .01				
ZN	BG	B	HB02	AL	PB	AS	SB	U
		2.5				.05		

F	CL	BR	I			
LT .05	70	.1	.02			
NR4	NR3	PO4	SI02	SO4	CO3	HCO3
.15		.31	500	64		

COMMENTS: BASALT AND ANDESITE FLOWS SURROUND THE WELL.
 REFERENCES: MARINER, R. H., RAPP, PRESSER, WILLEY, THE CHEMICAL COMPOSITION & ESTIMATED MINIMUM THERMAL RESERVOIR
 TEMPERATURES OF PRINCIPAL HOT SPRINGS OF NORTHERN & CENTRAL NEVADA. MARINER, PRESSER, RAPP, WILLEY, THE MINOR AND
 TRACE ELEMENTS, GAS, AND ISOTOPE COMPOSITIONS OF THE PRINCIPAL HOT SPRINGS OF NEVADA AND OREGON.

RECORD 00052

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION 1.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000938
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BEDWAVE
 NAME OF SAMPLE SOURCE.. SPRING #3
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 40-33. N

COUNTRY NAME..... UNITED STATES
 COUNTY..... FUREKA
 LONGITUDE..... 116-35. W

SAMPLE INFORMATION

SOURCE TYPE..... STREAM
 COLLECTION DATE..... 1957/09/01
 COLLECTOR(S)..... D. E. WHITE
 POINT OF COLLECTION..... NEAR END OF DISCHARGE STREAM
 OTHER CHEMICAL CHARACTERISTICS: COLLECTED AFTER WATER HAS FLOWED 70' VERTICALLY AND 260' HORIZONTALLY OVER SINTER SAND, CEMENTING IT AND COOLING

WATER ANALYSIS W

ANALYSIS DATE..... 1958/07/09
 ANALYST(S)..... H. C. WHITEHEAD
 PH 1)..... 9.4
 SPECIFIC CONDUCTANCE..... 1250. UMHO/CM
 ALKALINITY..... 8.0 PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

MG	CA	SR	BA	CA+MG		
1.0	1.6					
F	CL	BR	I			
	55					
NH4	NO3	PO4	SiO2	SO4	CO3	HCO3
			219		165	120

OTHER SOLUTES & GASES SiO2--COLORIMETRIC 219 PPM; SiO2--NAOH METHOD 340 PPM; SiO2--GRAVIMETRIC 353 PPM.
 REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS, MENLO PARK.

RECORD 00053

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 6

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000936
 CROSS INDEX NO..
 RECORD TYPE..... E
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BEOWAWE
 NAME OF SAMPLE SOURCE.. LARGE GEYSER POOL IN FLAT BELOW TERRACE
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... EUREKA
 LATITUDE..... 40-33. N LONGITUDE..... 116-35. W

SAMPLE INFORMATION

SOURCE TYPE..... POOL
 COLLECTION DATE..... 1957/09/01
 COLLECTOR(S)..... D. WHITE
 POINT OF COLLECTION..... LARGE GEYSER POOL IN FLAT BELOW TERRACE
 WATER SAMPLING TEMP.... 96. C
 WATER FLOW RATE..... 0.33 L/S 75. GAL/MIN
 DEPOSITS OR ALTERATION: H2S FROM BASE OF SINTER TERRACE ON ENE FAULT, ADJACENT TO TERTIARY ANDESITE.

WATER ANALYSIS

W

ANALYSIS DATE..... 1958/01/31
 ANALYST(S)..... H. C. WHITEHEAD
 SPECIFIC CONDUCTANCE.... 1050. UMHO/CM
 ALKALINITY..... 2. PPM TOTAL
 TOTAL DISSOLVED SOLIDS... 1000. PPM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
1.3	230	16						
MG	CA	SR	BA	CA+MG				
0	.8	0						
MM+3	MM(TOT)	FE+3	FE(TOT)	CU				
	0		.04					
ZN	HG	B	HB02	AL	PB	AS	SB	U
0		2.0		0	0	.02		
F	CL	BR	I					
15	30	.4	0					
NH4	H03	PO4	S102	S04	CU3	HCO3		
.5	.4	.07	373	89	149	116		

REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS, MENLO PARK.

RECORD 00054

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION F

SECTION D.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000935

CROSS INDEX NO..

RECORD TYPE..... D

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/04

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BEDWANE

NAME OF SAMPLE SOURCE.. POOL IN TERRACES

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 40-33. N

COUNTRY NAME..... UNITED STATES

COUNTY..... EUREKA

LONGITUDE..... 116-35. W

TOWNSHIP	RANGE	SECTION	1/4	1/4
21N	48E	17		

SAMPLE INFORMATION

SOURCE TYPE..... POOL IN TERRACES

COLLECTION DATE..... 1952/09/16

WATER SAMPLING TEMP.... 89. C

WATER ANALYSIS

W

ANALYSIS DATE..... 1955/04/04

ANALYST(S)..... MITCHELL

PH 1)..... 9.5

SPECIFIC CONDUCTANCE..... 1120. UMHO/CM

ALKALINITY..... 7. PPM TOTAL

TOTAL DISSOLVED SOLIDS... 1090. PPM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
1.2	235	20						
MG	CA	SR	BA	CA+MG				
1.2	.8							
MN+3	MN(TOT)	FE+3	FE(TOT)	CU				
	0		.04					
ZN	HG	P	HB02	AL	PB	AS	SB	U
		1.1						
F	CL	BR	I					
14	40							
NO3	NO3	PO4	SIO2	SU4	CO3	HCO3		
	.1	0	450	90	114	234		

COMMENTS: CLEAR WHEN COLLECTED.

REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

RECORD 00055

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION 1.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000934
 CROSS INDEX NO..
 RECORD TYPE..... E
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. GEOWAWE
 NAME OF SAMPLE SOURCE.. ACTIVE GEYSER, SOUTH END OF TERRACE
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... EUREKA
 LATITUDE..... 40-33. N LONGITUDE..... 116-35. W

TOWNSHIP RANGE SECTION 1/4 1/4
 31N 40E 17

OTHER LOCALITY INFORMATION: SOUTH END OF TERRACE

SAMPLE INFORMATION

SOURCE TYPE..... GEYSER
 COLLECTION DATE..... 1952/09/16
 COLLECTOR(S)..... G. S. SIMMONS
 WATER SAMPLING TEMP.... 95-99. C
 OTHER CHEMICAL CHARACTERISTICS: CLEAR WHEN COLLECTED.

WATER ANALYSIS

ANALYSIS DATE..... 1955/04/13
 ANALYST(S)..... MITCHELL
 PH 1)..... 9.8
 SPECIFIC CONDUCTANCE.... 1160. UMHO/CM
 ALKALINITY..... 9. PPM
 TOTAL DISSOLVED SOLIDS... 1180. PPM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

L1	NA	K	RB	CS	NA+K				
1.2	257	30							
MG	CA	SR	BA	CA+MG					
1.4	1.2								
BI+3	MI(TOT)	FE+3	FE(TOT)	CU					
	0		.02						
ZH	RG	B	HB02	AL	PB	AS	SB	U	
		2.2			0				
F	CL	BR	I						
14	50								
10-4	NO3	PO4	S102	S04	CO3	HC03			

.2

448

83

199

100

COMMENTS: 91% OF TOTAL DISSOLVED SOLIDS IS NA.
REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

RECORD 00056

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000933
 CROSS INDEX NO..
 RECORD TYPE..... R
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. BEUWAVE
 NAME OF SAMPLE SOURCE.. SPRING #40
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 40-33. N

COUNTRY NAME..... UNITED STATES
 COUNTY..... EUREKA
 LONGITUDE..... 116-35. W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1957/09/01
 WATER SAMPLING TEMP.... 94. C
 WATER FLOW RATE..... SEEPING

OTHER CHEMICAL CHARACTERISTICS: SEEPING DISCHARGE MILKY WHITE WITH SUSPENDED CLAY AND DIATOMS (?)

WATER ANALYSIS

W

ANALYSIS DATE..... 1958/03/07
 ANALYST(S)..... H. C. WHITEHEAD
 PH 1)..... 2.6
 SPECIFIC CONDUCTANCE.... 1840. UMHO/CM
 ALKALINITY..... 10. PPM
 TOTAL DISSOLVED SOLIDS... 1060. PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K				
.2	27	0.8							
MG	CA	SR	BA	CA+MG					
1.5	1.6								
BN+3	BN(TOT)	FE+3	FE(TOT)	CU					
	.05								
ZN	HG	B	HBO2	AL	PB	AS	SB	U	
		.12		13					
F	CL	BR	I						
.9	2								
MM4	NO3	PO4	SIO2	SO4	CO3	HCO3			
41	1.8		210	738	0	0			

OTHER SOLUTES & GASES FF + 2 9.8

COMMENTS: SOME SAMPLES DETERMINED IN SOLUTION.
REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

RECORD 00057

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION 5.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000920

CROSS INDEX NO..

RECORD TYPE..... 1

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/04

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BEOWANE

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 40-33. N

OTHER LOCALITY INFORMATION: EUREKA CO., NEVADA

COUNTRY NAME..... UNITED STATES

COUNTY..... EUREKA

LONGITUDE..... 116-35. W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

COLLECTION DATE..... 1958/05/25

COLLECTOR(S)..... J. FEIH

POINT OF COLLECTION..... 50 - 75 FT. DOWNSLOPE FROM ORIFICE

WATER SAMPLING TEMP.... 93. C

OTHER CHEMICAL CHARACTERISTICS: TEMPERATURE DATA FROM ORIFICE. SAMPLE TAKEN AT SOUTHERMOST VENT.

WATER ANALYSIS

W

ANALYSIS DATE..... 1958/12/18

ANALYST(S)..... J. P. SCHUCH

PH 1)..... 9.7

SPECIFIC CONDUCTANCE..... 1070.

UMHO/CM

TOTAL DISSOLVED SOLIDS... 817.

PPM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
1.5	232	22						
MG	CA	SR	BA	CA+MG				
0	0							
MN+3	MN(TOT)	FE+3	FE(TOT)	CU				
	0		.01					
ZN	MG	B	HBO2	AL	PB	AS	SB	U
		.57		0		.03		
F	CL	BR	I					
14	46	.3	0					
CO2	H2	CO2	SO2	H2S	H2	CH4		
				6.0				
HH4	NH3	PO4	SIO2	SO4	CO3	HCO3		
	0	.15	212	101	120	122		

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REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

RECORD 00058

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 6

SECTION P.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000921

CROSS INDEX NO..

RECORD TYPE..... 1

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/04

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BEOWAWE

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 40-33. N

COUNTRY NAME..... UNITED STATES

COUNTY..... EUREKA

LONGITUDE..... 116-35. W

SAMPLE INFORMATION

SOURCE TYPE..... HOT SPRING

COLLECTION DATE..... 1958/03/25

COLLECTOR(S)..... J. FETH

POINT OF COLLECTION..... 4' BELOW ORIFICE

WATER SAMPLING TEMP.... 97. C

WATER ANALYSIS

W

ANALYSIS DATE..... 1958/12/18

ANALYST(S)..... J. B. SCHUCH

PH 1)..... 9.3

SPECIFIC CONDUCTANCE.... 1090.

UMH/CM

AT

ALKALINITY..... 2.

PPM AS CaCO3

TOTAL DISSOLVED SOLIDS... 681.

PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K		
1.5	225	27					
MG	CA	SR	BA	CA+MG			
0	.2						
MM+5	BR(TOT)	FE+3	FE(TOT)	CU			
0			.02				
ZN	MG	B	HB02	AL	PB	AS	U
		1.2		.69		0	
F	CL	BR	J				
14	46	.2	.1				
O2	H2	CO2	SO2	H2S	H2	CH4	
				2.3			
MM6	MM3	MM4	SI02	SO4	CO3	HC03	
.6	0	.40	49	166	74	132	

REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

RECORD 00059

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000919
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... WELL

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. BEOWAWE
 NAME OF SAMPLE SOURCE.. NEVADA THERMAL WELL NO. 2

COUNTRY CODE..... US

COUNTRY NAME..... UNITED STATES

STATE/PROVINCE..... NEVADA

COUNTY..... EUREKA

LATITUDE..... 40-33. N

LONGITUDE..... 116-35. W

OTHER LOCALITY INFORMATION: WELL 6 MI. WSW BEOWAWE, EUREKA

SAMPLE INFORMATION

COLLECTION DATE..... 1960/09/09

COLLECTOR(S)..... D. WHITE AND G. SIGYALDASON

WATER

POINT OF COLLECTION.... CREST OF SINTER TERRACE 30 FT. S OF SPRING

WATER SAMPLING TEMP.... 96.7 C

WATER FLOW RATE..... 0.55 L/S 125. GAL/MIN

WATER ANALYSIS W

ANALYSIS DATE..... 1960/12/09

ANALYST(S)..... S. M. ROGERS

PH 1)..... 9.7

SPECIFIC CONDUCTANCE.... 1130. UMHO/CM

ALKALINITY..... 3. PPM AS CaCO3

TOTAL DISSOLVED SOLIDS... 1200. PPM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
1.6	232	30						
MG	CA	SR	BA	CA+MG				
.2	.8	.21						
MM+3	MM(TOT)	FE+3	FE(TOT)	CU				
	0		0					
ZN	HG	B	HBO2	AL	PB	AS	SB	U
		2.4		.66		0		
F	CL	BR	I					
15	49	0	0					
02	N2	CU2	SU2	H2S	H2	CH4		
				11				

NH4	NO3	PO4	SI02	SO4	CO3	HCO3
.4	0	.06	534	90	224	39

COMMENTS: SOME SAMPLES FIXED IN FIELD WITH H2SO4.
REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

RECORD 00060

GEOTHERMAL RESOURCES FILE (GEOOTHERM) REVISION P

SECTION 5.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000918

CROSS INDEX NO..

RECORD TYPE..... F

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 10/04

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOOTHERMAL FIELD-AREA.. BEOWAWE

COUNTRY CODE..... US

STATE/PROVINCE..... NEVADA

LATITUDE..... 40-33. N

OTHER LOCALITY INFORMATION: NO. 29 OF WHITE

COUNTRY NAME..... UNITED STATES

COUNTY..... EUREKA

LONGITUDE..... 116-35. W

SAMPLE INFORMATION

SOURCE TYPE..... POOL

COLLECTION DATE..... 1949/09/08

COLLECTOR(S)..... D. E. WHITE

POINT OF COLLECTION..... RELATED POOL ADJACENT TO GEYSER

WATER SAMPLING TEMP..... 96. C

WATER ANALYSIS

W

ANALYSIS DATE..... 1950/04/26

ANALYST(S)..... W. W. BRANNOCK

PH 11..... 9.54

SPECIFIC CONDUCTANCE..... 1015-1109 UMHO/CM

AT

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K				
1.8	241	29							
HC	CA	SR	BA	CA+MG					
LT 1	LT 1								
ZR	HC	6	HB02	AL	PB	AS	SB		U
		2.2				.1	0		
FL	CL	BR	1						
13	44								
HB4	NO3	PO4	SIO2	SO4	CO3	HC03			
			444	78	161	148			

OTHER SOLUTES & GASES S 6.0 PPM B = 0.66% OF EQ.
 REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

SITE: SALTON SEA, CA
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Salton Sea, CA (State/Private)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
SLC/Owner	Issue Prospecting/Exploration Permits	Developer	ASSUMED COMPLETED										
County Gov't	Issue Land Use Permits	Developer											
DOG	Issue Drilling Permits	Developer											
SLC/Owner	Acquire Leases	Developer											
Developer	Preliminary Geophysical Exploration	Developer											
Developer	Develop Utility Interest												
SLC/County Developer	Process EIR												
	Exploratory Drilling & Reservoir Evaluation												
	Flashed-to-Binary Technology Demonstrated												
Developer & Utility	Feasibility Study												
Producer (Developer) & Utility	Financial Negotiations												
Producer	Site Selection												
Utility	Prepare Environmental Data Statement	CPUC/County Gov't											
Producer & Utility	Preliminary Design												
Producer & Utility	Final Design												
Producer & Utility	Commitment to Development												
CERCDC/CPUC	Certify Plant & Site, Issue Permits	Producer & Utility											
County Gov't	Process EIR (Drilling)												
CPUC	Process EIR (Plant >50 MW)												
CPUC	Process EIR (Transmission Line)												
Producer	Development Drilling												
Utility	Plant Construction												
Utility	Install Transmission Line (16km)												

SITE: Salton Sea, CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (private or state) land is leased for a 50 MWe power plant.
- Utility is identified (Southern California Edison is interested in building a power plant).
- Location of the resource is well identified.
- Commitment to develop is contingent on a successful demonstration of flashed-to-binary technology.

Principal Milestones:

1-1
3

- Demonstrate flashed-to-binary technology December 1978
 Producer and Utility decide to proceed
 with development.
- Complete Environmental Impact Report January 1979
 (County)
- Complete feasibility study October 1979
- Select site, commit to development July 1980
- Start development drilling October 1982
- Start construction January 1983
- On line April 1985

SITE: Salton Sea, CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Salton Sea, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--(340°C)		X	3	78			
• High Temperature Down-Hole Measurement Equipment--(340°C)		X	3	78			
• Improved Geophysical Exploration Methods-- to define boundaries of reservoir	X	X	2	78			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to determining type and extent of field	X	X	4	78			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	78			

SITE: Salton Sea, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Technology--(high temperature) ($<340^{\circ}\text{C}$)		X	4	81			
• High Temperature Down-Hole Measurement Equipment		X	4	81			
• Injection Technology--(sands and soft rock)	X		1	83			
• Brine Injection Pumps--(33% TDS-hi temp)		X	2	82			
• Two Phase Flow Metering--(340°C & 33% TDS)		X	2	82			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of field where produced	X	X	2	81			
• Reservoir Engineering--to define best way to produce the reservoir	X	X	2	81			
• Brine Chemistry--control of extremely high mineral concentrations	X		1	82			
• Basic Understanding of Injection Process-- for this type of field	X	X	1	82			
<u>Environmental</u>							
• Injection Impact Prediction Technology--with regard to - triggering earth quakes - aquifer contamination	X		2	81			
• Subsidence Prediction Technology	X		2	81			

SITE: Salton Sea, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator Design--to minimize scaling, corrosion, erosion etc. with very high TDS brines	X		3	80			
• Waste Heat Handling--(to minimize consumptive use of water)		X	3	80			
<u>Supporting Technology</u>							
• Brine Chemistry--control of extremely high mineral concentrations in these brines	X		2	80			
• Spent Brine Purification--to make brine compatible with injection requirements	X		3	80			
• Process Pumps, Valves, Fittings, etc.--to be compatible with high TDS brines	X	X	3	80			
<u>Environmental</u>							
• Non-condensable Gas Control/Disposal	X		3	80			

SITE: Salton Sea, CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water TEMPERATURE, °C: 340 DEPTH, M: 1000
 High Salinity
 ROCK TYPE: Soft SYSTEM SIZE, MW: 50 TYPE: Flash

YEAR	1984	1985	1986	1987+		
CAPACITY FACTOR ASSUMED	.40	.47	.54	.60		
COST OF ELECTRICITY (MILLS/KWH)	31.5	26.8	23.3	21.0		

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ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS: 1.06	LIFE: 5
INJECTION WELLS: .13	LIFE: 10
PRODUCER PLANT: 1.70	LIFE: 10
GENERATING PLANT: 20.6	LIFE: 20
CAPITALIZED EXPLORATION: 3.5	LIFE: 20

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .451
 UTILITY: .563

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.059
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.206
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

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SITE: SALTON SEA, CA
DESCRIPTION AND DATA

SUMMARY

TEMPERATURE °C

Surface: 101

Subsurface: 340

TOTAL DISSOLVED SOLIDS (PPM): 250,000 Av.; 330,000 Max. (13)
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 2,759 (7)
TYPE OF OVERLAYING ROCK: Soft
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres:	95,824 (2)	
Total Federal Acres:	18,644 (1) (Bu.Rec.)	Total State and Private Acres: 76,370 (1)
Federal Acres Leased:		State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Numerous productive wells drilled. An experimental facility has been constructed to test geothermal fluids. Later tests may operate a 10 MWe generator. (16) As of June 1976, 650 MWe planned for 1986-95, predicated upon direct flash technology for hypersaline brines. (2)

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Numerous state and local regulations. (1A)

LAND USE AND POPULATION:

Irrigated land used for agriculture. Relatively sparse population with small population centers nearby. (6)

COMMENTS AND CRITICAL ISSUES:

Extremely flat topography sensitive to disturbance of runoff patterns. In seismically active area. (6)

SITE: Salton Sea, CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 33° 12' 00" N

REGION 1

LONGITUDE: 115° 36' 00" W

COUNTY: Imperial

ADJACENT COUNTIES: San Diego, Riverside, Yuma Az., Mexico

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Extremely flat area with average grade of .93-1.86 m/km (5-10 ft/ mile)(13)	Irrigated land used for agriculture			

SITE: Salton Sea, CA

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 101°C
Subsurface: 340°C

Geochemical
SiO₂:
Na-k-Ca:

TOTAL DISSOLVED SOLIDS (TDS): 250,000 ppm, average; 330,000 ppm maximum.⁽¹³⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 2759⁽⁷⁾

TYPE OF OVER LAYING ROCK: Shale-siltstone caprock underlain by arbosic sand (soft).

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY:

SITE: Salton Sea, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Salton Sea		95,824	18,644 ⁽¹⁾ (Bu Rec.)	76,370 ⁽¹⁾ (State & Private)	
LAND LEASED IN KGRA			None		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		13,344			

SITE: Salton Sea, CA

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>By July 1976, 24 wells of which 15 are operative were drilled within 17 square miles. Wells range in depth from 177 M - 2,240 M (590 - 8,100 feet) with average being 1,110 M (3,700 feet), and average flow rate of 207,000 kg/hr (460,000 lbs/hr). The shallow wells produce brines generally low in TDS, while the TDS in deeper holes goes to 330,000 ppm.⁽¹³⁾</p> <p>San Diego Gas and Electric Co. (SDG&E) is researching geothermal deposits in the Salton Sea area, where the SDG&E and ERDA have constructed an experimental facility to study high temperature, high brine geothermal fluids. No electricity is being produced during the early test phase, but later tests may operate a 10 MW generator.⁽¹⁶⁾</p>	<p>As of June 1976, Southern California Edison (SCE) was planning for 650 MWe of geothermal capacity between 1986-1995. This was to be predicated upon the successful development/test program of direct flash technology for hypersaline brines in Salton Sea area.⁽²⁾</p>

SITE: Salton Sea, CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>Production Permit must be issued by Imperial County (requires compliance with all other permits and regulations such as building, plumbing, electrical and construction permits). The most important and time-consuming requirement of the Production Permit is the Environmental Impact Report (EIR) which may require at least 10 months of lead time for data collection and report preparation.</p> <p>The State's District Air Pollution Control Board requires construction and operation permits.</p> <p>Imperial County requires underground installation of collection and reinjection pipes at geothermal sites. Air pollution standards are set by the Occupational Safety and Health Administration (OSHA) and by the California Air Resources Board.</p> <p>California Division of Oil and Gas (DOG) is responsible for determining that potable groundwater supplies are protected during oil-, gas-, and geothermal-field operations, and for assuming that subsidence will not occur.(13)</p> <p>In addition, the State Division of Industrial Safety requires a permit for liquid petroleum.(13)</p>		

SITE: Salton Sea, CA

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds Summer: from southeast at 13.7 kph (8.5 mph)
Winter: from north at 11.3 kph (7 mph) (13)

PRECIPITATION (ANNUAL): 5.8 cm (2.3 inches)

Average Temperature
Minimum: 12.2°C (54°F)
Maximum: 33.3°C (92°F)

Relative Humidity
(Seasonal Peaks)
Summer: 20% - 30%
Winter: 40%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	Alamo River 4.8 km (3 miles) east of site. Water table is only 1.5 meters (5 feet) deep. Irrigation canals throughout area.		Cresote bush, bur sage, saltbush, greasewood		

SITE: Salton Sea, CA
POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Niland	<16 km (10 miles)	800	<16 km (10 miles) from secondary (100 to 161 kv) line.(6)	Niland has a high- way running through it.(6) Nearest railroad access is approx. 6 miles.(6)	Few miles from Rail- road (rail service in Niland) 56 cm (22") or smaller gas pipeline within a few miles. 25 cm (10") or larger oil products pipeline within a few miles.(6)
El Centro (County Seat)	48 km (30 miles)				

RECORD 00024

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000294
 CROSS INDEX NO.. CF00471
 RECORD TYPE..... A

NAME..... J. RENNER
 DATE..... 74/12
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. SALTON SEA
 WARING FIGURE..... 8
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 33-12-00N

WARING NUMBER..... 162A
 COUNTRY NAME..... UNITED STATES
 COUNTY..... IMPERIAL
 LONGITUDE..... 115-36-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 11S 13E 22

BASE & MERIDIAN..... SAN BERNARDINO
 AVAILABLE MAPS OF AREA: NILAND 1:24000, OBSIDIAN BUTTE 1:24000

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 2.5 KM**2
 ELEVATION..... -7.0104E+01M -230. FT
 RESOURCE CATEGORY..... B
 PRESENT USE & DEVELOPMENTS: ABOUT 20 WELLS, 700 TO 2400 M. DEPTH, TEMPERATURES TO 360C IN HYP
 SURFACE THERMAL ACTIVITY..... HOT SPRING(S), FUMAROLE OR WARM VAPOR,
 NO. OF HOT SPRINGS..... 5

GEOTHERMAL CHARACTERISTICS

SPRING TEMPERATURES..... 72. C TO 101. C
 SPRING DESCRIPTION..... BOILING
 WELL INFORMATION
 MAXIMUM WELL TEMPERATURE..... 360. C TO 2100. M
 BOTTOM-HOLE TEMPERATURE..... 360.0 C TO 2100.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 300. C TO 360. C MEASURED
 BEST ESTIMATE..... 340.0 C
 SUBSURFACE AREA..... 23.0 KM**2 TO 104.0 KM**2
 BEST ESTIMATE..... 54.0 KM**2
 BASED ON: GEOLOGY, GEOPHYSICS, DRILLING
 DEPTH TO TOP OF RESERVOIR..... 700.00 M 0.700 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 1000.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2300.00 M 2.300 KM
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR..... 34,500 KM**3 TO 240,000 KM**3
 BEST ESTIMATE..... 108,000 KM**3
 POROSITY..... 0.15 TO 0.20
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

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RESERVES

TOTAL STORED HEAT.....	2.4697E+19 J	5.8999E+18 CAL	TO 2.0930E+20 J	4.9999E+19 CAL
BEST ESTIMATE.....	8.7902E+19 J	2.0999E+19 CAL	ABOVE 15.	C

GEOLOGY

GENERAL ROCK TYPES: SHALE -SILTSTONE CAPROCK UNDERLAIN BY ARKOSIC SAND

GEOPHYSICS

GRAVITY SURVEY INFORMATION: TEST MADE
 MAGNETIC SURVEY INFORMATION: TEST MADE
 OTHER GEOPHYSICAL INFORMATION: TEMPERATURE GRADIENT

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
 REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) HELGESON, H.C., 1968, GEOLOGIC AND THERMODYNAMIC CHARACTERISTICS OF THE SALTON SEA GEOTHERMAL SYSTEM:
 AM. JOUR. SCI., V. 266, NO. 3, P. 129-166.
- 2) MUEFLER, L.J.P., & WHITE, D.E., 1969, ACTIVE METAMORPHISM OF UPPER CENOZOIC SEDIMENTS IN SALTON SEA GEOTHERMAL
 FIELD & THE SALTON TROUGH, SOUTHEASTERN CALIFORNIA: GEOL. SOC. AMERICA BULL., V. 80, P. 157-182
- 3) WHITE, D.E., 1965, GEOTHERMAL ENERGY: U.S.G.S. CIRC. 519, 19 P.
- 4) MUNGER WELL HISTORIES

RECORD 00025

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION 6.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002072

GROSS INDEX NO..

RECORD TYPE..... 1

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 7/6/66

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SALTON SEA

NAME OF SAMPLE SOURCE.. FIELD #1

COUNTRY CODE..... US

COUNTRY NAME..... UNITED STATES

STATE/PROVINCE..... CALIFORNIA

COUNTY..... IMPERIAL

OTHER LOCALITY INFORMATION: SANDY BEACH, AEC. 1000 FT. OFFSHORE

SAMPLE INFORMATION

COLLECTION DATE..... 1968/09/10

WATER SAMPLING TEMP.... 32.4 C

OTHER CHEMICAL CHARACTERISTICS: SMALL AMOUNT. PRECIPITATE IN SAMPLE WHEN RECEIVED.

WATER ANALYSIS

W

ANALYST(S)..... R. BARNES

PH 1)..... 8.11

SPECIFIC CONDUCTANCE..... 44800. UMHO/CM

AT 25.

C

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
	10800	185						
MG	CA	SR	BA	CA+MG				
1050	880							
ZN	HG	B	HB02	AL	PB	AS	SB	U
		9.3						
F	CL	BR	I					
2.0	15300							
NH4	NO3	PO4	SI02	SO4	CO3	HCO3		
	.4		3.6	8140		191		

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

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RECORD 00026

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION F

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002071
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/06
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. SALTON SEA

NAME OF SAMPLE SOURCE.. FIELD #2

COUNTRY CODE..... US

COUNTRY NAME..... UNITED STATES

STATE/PROVINCE..... CALIFORNIA

COUNTY..... IMPERIAL

OTHER LOCALITY INFORMATION: SALTON SEA BEACH, 3 MI. SOUTH OF COUNTY LINE, 1000 FT. OFFSHORE

SAMPLE INFORMATION

COLLECTION DATE..... 1968/09/10

WATER SAMPLING TEMP.... 32.1 C

OTHER CHEMICAL CHARACTERISTICS: PRECIPITATE IN SAMPLE WHEN RECEIVED.

WATER ANALYSIS

W

ANALYST(S)..... R. BARNES

PH 1)..... 7.49

SPECIFIC CONDUCTANCE..... 44100. UMHO/CM

AT 25.

C

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
	10700	195						
MG	CA	SR	BA	CA+MG				
1050	645							
ZN	HG	B	HBO2	AL	PB	AS	SB	U
		9.0						
F	CL	BR	I					
2.2	15100							
NH4	NO3	PO4	SIO2	SO4	CO3	HCO3		
	.5		4.0	8110		197		

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, BENLO PARK

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SITE: STEAMBOAT SPRINGS, NV
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Steamboat Springs, NV (Federal/Private Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM/Owner BLM Developer	Lease Land Process EIA Preliminary Geophysical Exploration	Developer	ASSUMED COMPLETED										
BLM	Issue STG Drilling Permit	Developer	---										
USGS	Issue Drilling Permit	Developer	---										
County	Issue Use Permit	Developer	---										
Developer	Exploratory Drilling & Reservoir Evaluation												
Developer	Develop Utility Interest												
Developer & Utility	Feasibility Study												
Producer (Developer) & Utility	Financial Negotiations												
Producer	Site Selection												
Producer & Utility	Preliminary Design												
Producer & Utility	Final Design												
Producer & Utility	Commitment to Development												
Producer & Utility	Prepare Master Development Plan	BLM, USGS											
Utility	Prepare Environmental Data Statement	BLM, FPC, State DEQ											
BLM/FPC/State PUC	Certify Plant & Site, Issue Permits	Producer & Utility											
USGS	Process EIA (Drilling)	CEQ											
FPC	Process EIA (Plant)	CEQ											
FPC/State PUC	Process EIA (Transmission Line)	CEQ											
Producer	Development Drilling												
Utility	Plant Construction												
Utility	Install Transmission Line (16km)												

SITE: Steamboat Springs, NV

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal and private) land has been leased for a 50 MWe power plant -- it may be only marginally sufficient.
- Development status is prior to exploratory drilling.

Principal Milestones:

• Start exploratory drilling	July 1977
• Identify Utility	July 1978
• Complete feasibility study	April 1979
• Select site, commit to development	January 1980
• Start development drilling	April 1982
• Start construction	July 1982
• On line	October 1984

SITE: Steamboat Springs, NV

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Steamboat Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to define field boundaries		X	2	78			
• Drilling Techniques--(granite-210°C)		X	3	78			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	78			
• Data Analysis and Interpretation	X	X	3	78			
• Resource Characterization--with regard to determining type and extent of field	X	X	4	78			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	78			

SITE: Steamboat Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Technology--(granite)		X	4	81			
• Injection Technology--(granite)	X		1	83			
• Brine Injection Pumps--(high scale potential for this field)	X	X	(ID)	(ID)			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of field where produced	X	X	2	81			
• Reservoir Engineering--to define best way to produce this field.	X	X	2	81			
• Basic Understanding of Injection Process--for this type of field	X	X	1	82			
• Brine Chemistry--(high scaling potential)	X		1	82			
<u>Environmental</u>							
• Injection Impact Prediction Technology--with regard to	X		2	81			
- triggering seismic events							
- aquifer contamination							
(ID) Insufficient Data							

SITE: Steamboat Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator Design--to minimize scaling	X	X	2	80			
• Waste Heat Handling--poor water quality; potential shortage		X	2	80			
<u>Supporting Technology</u>							
• Brine Chemistry--scale control in process equipment		X	2	80			
• Spent Brine Purification Processes--for this type field (scale blocking has been observed)	X	X	2	80			
<u>Environmental</u>							
• Non-condensable Gas Control/Disposal			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Steamboat Springs, NV

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 210

DEPTH, M: 300

ROCK TYPE: Medium/
Hard

SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1984	1985	1986	1987+		
CAPACITY FACTOR ASSUMED	.40	.47	.54	.6		
COST OF ELECTRICITY (MILLS/KWH)	45.3	38.6	33.6	30.2		

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ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	2.70	LIFE:	10
INJECTION WELLS:	.55	LIFE:	20
PRODUCER PLANT:	7.65	LIFE:	20
GENERATING PLANT:	27.8	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .202
UTILITY: .757

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.144
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.278
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

SITE: STEAMBOAT SPRINGS, NV

DESCRIPTION AND DATA

SUMMARY

TEMPERATURE °C

Surface: 96

Subsurface: 210

TOTAL DISSOLVED SOLIDS (PPM): 2,500⁽⁴⁾
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 208⁽⁷⁾
TYPE OF OVERLAYING ROCK: Medium/Hard
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 300

DESCRIPTION OF KGRA

Total KGRA Acres: 8,914

Total Federal Acres: ~ 1/2

Federal Acres Leased: 1,548

Total State and Private Acres: ~ 1/2

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Numerous wells drilled.⁽⁴⁾ Some used for space heating.⁽²⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Public opinion is mixed. Negative reactions based on diversion of recreational use or possible additional growth in the community.⁽⁴⁾ Because of regulations, mild constraints and brief delays expected. Disposition of local administration is positive.^(1A)

LAND USE AND POPULATION:

Mountainous with many man-made intrusions. Suburban area with future plans for possible residential development. Steamboat Springs is used as a resort. Resource is in a mining district.⁽⁴⁾

COMMENTS AND CRITICAL ISSUES:

Steamboat Springs is a designated historical area.⁽⁴⁾ By August 1975, all exploration was on private land.^(1A)

SITE: STEAMBOAT SPRINGS, NV

SITE: Steamboat Springs, NV

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 39° 23' 00" N

REGION 4

LONGITUDE: 119° 45' 00" W

COUNTY: Washoe

ADJACENT COUNTIES: Humboldt, Pershing, Churchill, Lyon, Storey, Ormsby, OR. - Lake, CA. - Modoc,
Lassen, Sierra, Nevada, Placer

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Basin and Range type. Area is mountainous with many man-made intrusions.	Resource is in Virginia City mining district; Steamboat Springs is being used as a resort. Area is covered with numerous roads, power lines and other construction. ⁽⁴⁾	Possible residential development. ⁽⁴⁾		Numerous histor- ical and archeo- logical sites including petro- glyphs and open aboriginal camps in area - Steam- boat Springs is a designated historical site. (4)

SITE: Steamboat Springs, NV

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 96°C
Subsurface: 210°C⁽⁷⁾

Geochemical

SiO₂: 207°C
Na-k-Ca: 226°C

TOTAL DISSOLVED SOLIDS (TDS): 2500 ppm⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 208⁽⁷⁾

TYPE OF OVER LAYING ROCK: Granite and metamorphic rock type (medium-hard).

ESTIMATED DEPTH TO TOP OF RESERVOIR: 300 M (984 ft)

SEISMIC ACTIVITY:

SITE: Steamboat Springs, NV

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Steamboat Springs, KGRA		8,914	~4,450 ^(3III)	~4,450 ^(3III) (State & Private)	
LAND LEASED IN KGRA			1,548		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)			1,548		
\$/ACRE	LESSEE				
32.30	Phillips Pet. Co. & Gulf Oil				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 0					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE): 0					
SUBSURFACE AREA OF RESERVOIR		1,483			

SITE: Steamboat Springs, NV

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>In addition to several older wells, 6 wells drilled by Nevada Thermal Power Co. between 1954-1961 ranging in depth from 156-549 M (520-1,830 feet). Eight diamond drill holes shallower than 1,000 feet drilled by USGS.</p> <p>One well 217.5 M (725 feet) deep recorded 185°C (365°F); it flowed more than 775 lpm (200 gpm) for over two weeks, and then declined (probably due both to decline of pressure and deposition of calcite).⁽⁴⁾</p> <p>Many shallow wells used for space heating.⁽²⁾</p>	<p>Possible deep drill hole to test higher enthalpy regime; and possible continued drilling of hot water wells projected through 1977-1979.</p>

SITE: Steamboat Springs, NV

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>A use permit is required for geothermal activity on lands zoned in the county. Mild constraints and brief delays are to be expected. Disposition of the local administration is positive. (1A)</p>	<p>Public opinion on geothermal development is mixed. Negative reactions are based upon possible diverting of recreational land to industrial uses, and an unwanted possible growth in the community. (4)</p>	<p>Environmental Analysis Record of general area has been done. (4)</p>

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 20.3 - 40.6 cm (8 - 16 inches)⁽⁶⁾

Average Temperature

Minimum: -1.1 - 4.4°C (30-40°F)

Maximum: 15.6 - 21.1°C (60-70°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30 - 40%

Winter: 60 - 70%

8-17

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
Good, although particulate matter (dust) is generated by wind over farm- land and natural landscape. Auto- mobile-derived pollution can be severe in Reno area. (4)	Truckee River and Galena Creek are permanent streams. Washoe Lake. Groundwater of relatively poor quality. ⁽⁴⁾	Ambient noise level apt to be relatively high. ⁽⁴⁾	Cropland, riparian, desert scrub, pinon-juniper, grassland and conifer. Most plants in pros- pect area are drought-resis- tant with salt- bush, grease- wood, and shad- scale predominating. ⁽⁴⁾	79 species of mamal, over 250 species of birds and numerous species of fish. (No fish reported in water at Steamboat Springs) ⁽⁴⁾	Peregrine and Prairie Falcon, White-faced Ibis, Ferruginous Hawk, Osprey, and Spotted Bat in region, although none reported to inhabit the immediate Steam- boat Springs area. (4)

SITE: Steamboat Springs, NV

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

Steamboat Springs is in a relatively heavily populated area, although region is basically rural. (4)

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Reno	19 km (12 miles)	120,000 (in metropol- itan area)	Numerous <16 km (10 miles) ⁽⁴⁾	Numerous	Numerous (includes railroads, airport, crude oil, natural gas) all within 80.5 km (50 miles) ⁽⁶⁾
Virginia City	11 km (7 miles)				

SITE: COSO H.S., CA
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Coso H.S., CA (Federal/Navy Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

[illegible]

SITE: Coso H.S., CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Geothermal development will be carried out by the Navy -- probably by a developer under contract to the Navy. No significant development has yet taken place.
- An Environmental Impact Statement will be required. This has not yet been started.

Principal Milestones:

• Start development of EIS	April 1977
• Complete EIS, start exploratory drilling	October 1979
• Identify Utility	October 1980
• Complete feasibility study	July 1981
• Select site, commit to development	April 1982
• Start development drilling	July 1984
• Start construction	October 1984
• On line	January 1987

SITE: Coso H.S., CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Coso H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to define field boundaries		X	2	79			
• Drilling Techniques--(granite-220°C)		X	3	79			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	79			
• Data Analysis and Interpretation	X	X	3	79			
• Resource Characterization--with regard to determining type and extent of field	X		4	79			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	79			

SITE: Coso H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--(hard rock)		X	4	82			
• Brine Injection Pumps			(ID)	(ID)			
• Injection Technology--(granite)	X		1	84			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of field where produced	X	X	2	82			
• Reservoir Engineering--to define best way to produce this field	X	X	2	82			
• Basic Understanding of Injection Process--for this type of field	X	X	1	83			
• Brine Chemistry	X	X	1	83			
<u>Environmental</u>							
• Injection Impact Prediction--for this type field with regard to	X		2	81			
- triggering seismic events							
- aquifer contamination							
• Subsidence Prediction Technology	X		2	81			
(ID) Insufficient Data							

(C)
(1)

SITE: Coso H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator Design--to minimize scaling	X	X	2	81			
• Waste Heat Handling--surface water scarce; ground water potentially available.		X	2	81			
<u>Supporting Technology</u>							
• Brine Chemistry--scale control in process equipment		X	2	81			
• Spent Brine Purification Processes--for this type of field	X	X	2	81			
<u>Environmental</u>							
• Non-condensable Gas Control/Disposal			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Coso H.S., CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 220

DEPTH, M: 1000

ROCK TYPE: Medium/
Hard

SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1985	1986	1987	1988+		
CAPACITY FACTOR ASSUMED	.40	.47	.54	.60		
COST OF ELECTRICITY (MILLS/KWH)	46.8	39.8	34.7	31.2		

8-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	4.96	LIFE:	10
INJECTION WELLS:	.99	LIFE:	20
PRODUCER PLANT:	6.44	LIFE:	20
GENERATING PLANT:	26.4	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .240
UTILITY: .720

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.159
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.264
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

SITE: COSO H.S., CA

DESCRIPTION AND DATA

SUMMARY

TEMPERATURE °C

Surface: 95

Subsurface: 220

TOTAL DISSOLVED SOLIDS (PPM): 2,000
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 4,533⁽¹⁾
TYPE OF OVERLAYING ROCK: Medium/Hard
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres: 51,760

Total Federal Acres: 43,330 (16,690 BLM; 26,640 Navy) Total State and Private Acres: 8,430

Federal Acres Leased: State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

As of February 1977, 18 shallow temperature gradient wells drilled.⁽¹⁷⁾ The Navy, Bu.Rec., and USGS involved in development.⁽¹⁸⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Administrative constraints are stringent and may cause long delays.^(1A) Significant public opposition not expected.⁽⁴⁾

LAND USE AND POPULATION:

Desert area. Recreation, military and agricultural use. Agriculture declining because of lack of irrigation water.⁽⁴⁾ Rural population.

COMMENTS AND CRITICAL ISSUES:

Environmental study completed by Navy.⁽⁴⁾ Coso is surrounded by faults and may be seismically active.⁽⁴⁾ Tentative lease sale 11-78.⁽¹⁴⁾ Possible indications that dry steam may be available.^(1A)

SITE: COSO HOT SPRINGS, CA

SITE: Coso H.S., CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 36° 03' 00" N

REGION 1

LONGITUDE: 117° 47' 00" W

COUNTY: Inyo

ADJACENT COUNTIES: San Bernardino, Kern, Tulare, Fresno, Mono, NV - Esmeralda, Nye, Clark

LAND OWNERSHIP: 92% Federal owned in county primarily BLM
8% Private primarily by LA Dept. of Water and Power

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Typical desert	Recreation, military and agriculture. ⁽⁴⁾	Future growth is expected in recreation and tourism. Agricul- ture has been declin- ing because of a lack of irrigation water. All future development must occur outside the military reservation. (4)	No outstand- ing aesthetic qualities. ⁽⁴⁾ remote scenic beauty. ⁽¹⁰⁾	Area has been inhabited by the Piute Indians & many landmarks remain from the goldrush of the mid-1800s. ⁽⁴⁾

SITE: Coso H.S., CA

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 95°C
Subsurface: 220°C

Geochemical

SiO₂: 161°C
Na-k-Ca: 238°C

TOTAL DISSOLVED SOLIDS (TDS): 2,000 ppm⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 4533⁽¹⁾

TYPE OF OVER LAYING ROCK: 56.4 M (185 ft) of hematite-stained alluvium.
Granitic Basement (?) to top of reservoir.
Rhyolite volcanics.⁽⁴⁾

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY: Microearthquake activity is of swarm type indicating that tectonic forces are currently active. Much of Coso Range is enclosed by an arcuate faulting system that forms a rough oval. This structure is broken by a set of northeast and northwest trending, steeply dipping faults. The ring faulting along with structural subsidence suggests a caldera in the early stage of collapse.

SITE: Coso, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Coso Hot Springs		51,760	43,330	8,430 (State & Private)	
LAND LEASED IN KGRA			None		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		41,514			

SITE: Coso H.S., CA

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>25 shallow wells drilled in 1920's and 30's for a resort. (4)</p> <p>Navy drilled a shallow well in 1967 to 112.5M (375 ft) (4)</p> <p>There are possible indications that dry steam may be available. (1A)</p> <p>The Navy, BuRec and USGS are currently engaged in development activity. (18)</p> <p>As of February 1977, 18 shallow temperature gradient wells have been drilled. (17)</p>	

SITE: Coso, H.S., CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>On a local level, definitive procedures have been enacted to control geothermal activities. An environmental assessment is required prior to development and production. Administrative constraints on development are stringent and may cause long delays.(1A)</p>	<p>The public is relatively uninformed about geothermal energy, but significant public opposition to development is not expected.(4) However, the local administration has adopted a very cautious approach to all outside interference.(1A) It is predicted that one of the greatest difficulties will be overcoming court battles brought on by environmentalists due to remote scenic beauty of the area.(10)</p>	<p>Environmental study of the area has been done by the Navy.(4)</p>

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds Prevailing westerly winds
 Precipitation (Annual): 15.11 cm. (5.95 in.)

Average Temperature

Minimum: 3.89°C(39°F)

Maximum: 27.2°C(81°F)

Relative Humidity
 (Seasonal Peaks)

Summer: 10% - 20%

Winter: 30% - 50%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
Good but has deteriorated recently because of flow from the Los Angeles Basin. (4)	TDS of 1-2000 ppms including silicate content of 2-3000 ppm. Spring water is high- ly acidic & lacking chloride. Although surface water is scarce, (1A) some cooling water may be available from either the Los Angeles Aqueduct, which passes a few miles from site, or from ground water. (4)	Data on ambient noise is unavailable, but is probably very low. (4)	Desert scrub brush. (4)	Coyote, fox, rabbit, rat, squirrel, sparrow, lark, raven and various species of lizards. (4)	Owens Chub, Owen Pudfish, and the Mohave Ground Squirrel. (4)

SITE: Coso H.S., CA

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
China Lake	56 km (35 miles) south of site	13,500	~13 km (8 miles) from primary line (230-500 KV) ⁽⁶⁾ ~53 km (33 miles) from secondary line (100-161 KV) ⁽⁶⁾	US Highway 395 ~ 7 1/2 miles away (12 KM)	8Km (5 miles) from secondary railroad no gas and oil pipe- lines within 161 Km (100 miles)

RECORD 00002

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 6

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000250

CROSS INDEX NO.. CF00451

RECORD TYPE..... A

NAME..... J. A. CROWLEY, J. RENNER, D. WILLIAMS, D

ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. CUSD HOT SPRINGS

WARNING FIGURE..... 8

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

LATITUDE..... 36-03-00N

WARNING NUMBER..... 141-143

COUNTRY NAME..... UNITED STATES

COUNTY..... INYO

LONGITUDE..... 117-47-00W

TOWNSHIP RANGE SECTION 1/4 1/4
225 38E 4

BASE & MERIDIAN..... MT. DIAULO

AVAILABLE MAPS OF AREA: HAIWEE RESERVOIR 1:62,500

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 1.0 KM**2

ELEVATION..... 1097.28 M 3600. FT

RESOURCE CATEGORY..... B

PRESENT USE & DEVELOPMENTS: 1 SHALLOW WELL FLOWING TEMPERATURE 116C

SURFACE THERMAL ACTIVITY..... HOT SPRINGS, FUMAROLE OR WARM VAPOR

ASSOCIATED DEPOSITS..... SINTER

NO. OF HOT SPRINGS..... 10

GEOTHERMAL CHARACTERISTICS

SPRING TEMPERATURES..... 60. C TO 95. C

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 150. C TO 240. C ASSUMED

BEST ESTIMATE..... 220.0 C

SUBSURFACE AREA..... 114.0 KM**2 TO 1264.0 KM**2

BEST ESTIMATE..... 168.0 KM**2

BASED ON: GEOLOGY, GEOPHYSICS

DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM

BEST ESTIMATE..... 1000.00 M 1.000 KM

DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM

BEST ESTIMATE..... 3000.00 M 3.000 KM

THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM

BEST ESTIMATE..... 2000.00 M 2.000 KM

VOLUME OF RESERVOIR..... 171.000 KM**3 TO 3160.000 KM**3

BEST ESTIMATE..... 336.000 KM**3

COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 5.8181E+19 J 1.3899E+19 CAL TO 1.7999E+21 J 4.2999E+20 CAL

BEST ESTIMATE..... 1.7288E+20 J 4.1299E+19 CAL ABOVE 15. C

9-19

GEOLOGY

GENERAL ROCK TYPES: RHYOLITE VOLCANICS, GRANITE

GEOPHYSICS

GRAVITY SURVEY INFORMATION: TEST MADE

MAGNETIC SURVEY INFORMATION: TEST MADE

SEISMIC SURVEY INFORMATION: MICROEARTHQUAKES

ELECTRICAL RESISTIVITY: DC RESISTIVITY TEST MADE

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS

DATE..... 1975

TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975

REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) COMBS, JAMES, 1947A; HEAT FLOW STUDIES, COSO GEOTHERMAL AREA, CHINA LAKE, CALIF.: TEXAS UNIV. INST. GEOSCIENCES TECH. REPORT 1 & 2.
- 2) MOYLE, W.R., JR., 1974, TEMPERATURE & CHEMICAL DATA FOR SELECTED THERMAL WELLS & SPRINGS IN SOUTHEASTERN CALIF: U.S.G.S. WATER RES. INVS. 33-73
- 3) ROSS, C.P., & VATES, R.G., 1943, THE COSO QUICKSILVER DISTRICT, INYO COUNTY, CALIF: U.S.G.S. BULL. 936-Q P. Q395-Q416

RECORD 00003

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 5

SECTION 1.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000291

CROSS INDEX NO.. 0100451

RECORD TYPE..... 6

SAMPLE TYPE..... SURFACE

NAME..... J. A. CROWLEY, J. RENNER, D. WILLIAMS, D

DATE..... 00/00

ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. COSO HOT SPRINGS

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

LATITUDE..... 36-03.00 N

COUNTRY NAME..... UNITED STATES

COUNTY..... INYO

LONGITUDE..... 117-47.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

WATER ANALYSIS

PH 1)..... 8.50

SOLUTE ANALYSIS (WATER)

LI	BA	K	RB	CS	NA+K
	1630.00	244.00			
MG	CA	SR	BA	CA+MG	
	74.60				
F	CL	BR	I		
	3046.00				
NO4	NO3	PO4	SI02	SI04	CO3
			150.00	53.00	HCO3

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726
MOYLL, 1974

RECORD 00004

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 6

SECTION I.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002247
 CROSS INDEX NO..
 RECORD TYPE..... I
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/06
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. COSO HOT SPRINGS
 NAME OF SAMPLE SOURCE.. MAIN SPRING
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES
 COUNTY..... INYO

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 WATER SAMPLING TEMP.... HOT

WATER ANALYSIS

W

ANALYSIS DATE..... 1910
 ANALYST(S)..... F. M. EATON
 TOTAL DISSOLVED SOLIDS... 2754. PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA 61	K 12	RB	CS	NA+K		
MG 34	CA 59	SR	BA	CA+MG			
NN+3	NN(TOT)	FE+3	FE(TOT) 83	CU			
ZN	HG	B 0	HBO2	AL 56	PB	AS	SB
F	CL 40	BR	I				U
NN4	NN3 0	PO4 TRACE	SIO2 411	SO4 1400	CO3 0		HCO3

OTHER SOLUTES & GASES H 12 PPM

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK
 WARING, 1915

RECORD 00005

GEO THERMAL RESOURCE FILE (GEO THERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002246

CDSS INDEX NO...

RECORD TYPE..... B

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/06

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEO THERMAL FIELD-AREA... COSO HOT SPRINGS

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

OTHER LOCALITY INFORMATION: 12 MILES EAST OF HATWEE

COUNTRY NAME..... UNITED STATES

COUNTY..... INYO

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

COLLECTOR(S)..... WARING, USGS

WATER SAMPLING TEMP.... SCALDING

WATER FLOW RATE..... SMALL

OTHER CHEMICAL CHARACTERISTICS: HIGH SULFATE AND SILICA. TINY CRYSTALS OF PYRITE ARE FORMED.

WATER ANALYSIS

W

ANALYSIS DATE..... 1910

ANALYST(S)..... F. M. EATON

TOTAL DISSOLVED SOLIDS... 2188. PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
	EL	12						
MG	CA	SR	EA	CA+MG				
54	59							
MM+3	MM(TOT)	FE+3	FE(TOT)	CU				
			83					
ZN	HG	B	HB02	AL	PB	AS	SB	U
			0	56				
F	CL	LR	I					
	40							
MM4	MM5	PO4	SI02	SO4	CO3	HCO3		
	0	TRACE	41	1400	6			

OTHER SOLUTES & GASES H 12 PPM,

COMMENTS: RECENT LAVA, OVER GRANITE

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

WARING, 1915

MAIN SPRINGS: EATON ANALYSIS SAME LOCALITY: OSCAR LOEW. ANAL., 1976

RECORD 00006

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 6

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002125

CROSS INDEX NO..

RECORD TYPE..... B

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/06

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. COSO HOT SPRINGS

NAME OF SAMPLE SOURCE.. MAIN SPRING

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES

COUNTY..... INYO

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

POINT OF COLLECTION..... MAIN SPRING

WATER ANALYSIS

TOTAL DISSOLVED SOLIDS... 2754. PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
TRACE	49	11						
HG	CA	SR	BA	CA+MG				
2.4	45							
MN+3	MN(101)	FE+3	FE(101)	CU				
			172					
ZN	HG	B	HBO2	AL	PB	AS	SB	U
				201				
F	CL	BR	I					
	TRACE							
NH4	NO3	PO4	SIG2	SO4	CO3	HCO3		
TRACE	TRACE			2306	0			

OTHER SOLUTES & GASES TRACE OF P PRESENT.

COMMENTS: TOTAL DISSOLVED SOLIDS RECORDED AS SOLIDS.

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MERED PARK

RECORD 00007

GEOHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002248

CROSS INDEX NO..

RECORD TYPE..... 1

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/06

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. COSO HOT SPRINGS

NAME OF SAMPLE SOURCE.. COSO MINERAL WATER

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES

COUNTY..... INYO

SAMPLE INFORMATION

WATER SAMPLING TEMP.... HOT

WATER ANALYSIS

W

ANALYST(S)..... E. F. WILLIAMS, MAAS LABORATORIES, LOS ANGELES

TOTAL DISSOLVED SOLIDS... 8362.9 PPM

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K				
	579.25	43.48							
MG	CA	SR	BA	CA+MG					
1030.6	66.91								
MN+3	MN(TOT)	FE+3	FE(TOT)	CU					
	1.50		9.52						
ZN	HG	B	NB02	AL	PB	AS	SB	U	
				302.31					
F	CL	BR	I						
	231								
NH4	NB3	PO4	SIO2	SO4	CO3	HCO3			
		1.04	456	6043					

COMMENTS: LAVA AND TUFF OVER GRANITE

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

FRASER ET AL., CALIF. JOURNAL MINES & GEOL., V. 38, P. 239, 1942

9-25

SITE: LONG VALLEY, CA
ANALYSIS OF POSTULATED DEVELOPMENT

10-1

SITE: Long Valley, CA (Federal Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM/USFS	Process EIS	CEQ	} ASSUMED COMPLETED										
BLM/USFS	Lease Land	Developer											
BLM/USFS	Issue STG Drilling Permit	Developer											
County Government	Issue Land Use Permit	Developer											
USGS	Issue Drilling Permit	Developer											
Developer	Preliminary Geophysical Exploration												
	Utility Interest Identified												
Developer	Exploratory Drilling and Reservoir Evaluation												
Developer and Utility	Feasibility Study												
Producer (Developer) and Utility	Financial Negotiations												
Producer and Utility	Site Selection												
Producer and Utility	Commitment to Development												
Producer and Utility	Design (Preliminary, Final)												
Producer and Utility	Prepare Master Development Plan	BLM, USGS											
Utility	Prepare Environmental Data Statement	BLM, USGS, CPUC, CERCDC											
BLM, FPC, CPUC, CERCDC	Certify Plant and Site, Issue Permits	County Government											
USGS	Process EIS (Drilling)	Producer and Utility											
FPC, CPUC	Process EIS (Plant)	CEQ											
FPC, CPUC	Process EIS (Transmission Line)	CEQ											
Producer	Development Drilling												
Utility	Plant Construction												
Utility	Install Transmission Line												

SITE: Long Valley, CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal) land has been leased for a 50 MWe power plant.
- Exploratory drilling phase has not yet started.
- A utility is interested in building a power plant.

Principal Milestones:

• Start exploratory drilling	October 1977
• Complete feasibility study	July 1979
• Select site, commit to development	April 1980
• Start development drilling	July 1982
• Start construction	October 1982
• On line	January 1985

SITE: Long Valley, CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Long Valley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to define field boundaries		X	2	79			
• Drilling Techniques--(Rhyolitic Volcanics)		X	3	79			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	79			
• Data Analysis and Interpretation	X	X	3	79			
• Resource Characterization--with regard to determining type and extent of field	X	X	4	79			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	79			

SITE: Long Valley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--(med-hard rock)		X	4	82			
• Brine Injection Pumps			(ID)	(ID)			
• Injection Technology--(volcanics)	X		1	84			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of this field when produced	X	X	2	82			
• Reservoir Engineering--to define best way to produce this field	X	X	2	82			
• Basic Understanding of Injection Process--for this type of field	X	X	1	83			
• Brine Chemistry--for control of scaling and of heavy metals (As & B) in brines	X		1	83			
<u>Environmental</u>							
• Injection Impact Prediction--for this type of field with regard to	X		2	81			
- triggering seismic events							
- aquifer contamination							
• Subsidence Prediction Technology			2	81			
• Control and Disposal of Heavy Metal Brines			2	81			
(ID) Insufficient Data							

SITE: Long Valley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>							
• Steam Separator Design--to minimize scaling	X	X	2	81			
• Waste Heat Handling--to minimize contamination from possible heavy metal concentration in condensate.	X		2	81			
<u>Supporting Technology</u>							
• Brine Chemistry--scale control in process equipment; control of heavy metal concentration in brine		X	2	81			
• Spent Brine Purification Processes--for this type of field	X		2	81			
<u>Environmental</u>							
• Non-condensable Gas Control/Disposal			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Long Valley, CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 220

DEPTH, M: 1000

ROCK TYPE: Medium/
Hard

SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1985	1986	1987	1988+		
CAPACITY FACTOR ASSUMED	.40	.47	.54	.6		
COST OF ELECTRICITY (MILLS/KWH)	46.8	39.8	34.7	31.2		

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ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	4.96	LIFE:	10
INJECTION WELLS:	.99	LIFE:	20
PRODUCER PLANT:	6.44	LIFE:	20
GENERATING PLANT:	26.4	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .240
UTILITY: .720

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.159
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.264
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

10-9

SITE: LONG VALLEY, CA

DESCRIPTION AND DATA

SITE: Long Valley, CA

SUMMARY

TEMPERATURE °C

Surface: 94

Subsurface: 220

TOTAL DISSOLVED SOLIDS (PPM): 1-2,000⁽⁴⁾
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 4,923⁽⁷⁾
TYPE OF OVERLAYING ROCK: Medium/Hard
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres: 455,256

Total Federal Acres: 392,096 (103,690 BLM; 288,406 Total State and Private Acres: 63,160

Federal Acres Leased: 5,483 Forest Serv.) State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Numerous wells drilled. Comprehensive investigation of resource by USGS.⁽⁴⁾ City of Burbank to start exploratory drilling in April 1976. If successful, installation of a 50 MWe plant is planned.⁽¹⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Administrative constraints are stringent. Lengthy delays have occurred.^(1A,2) Public reaction generally negative, although county official reaction is positive.^(1A)

LAND USE AND POPULATION:

Rural area, low population. Primarily recreation and tourism with some mining and agriculture. Focus on increasing recreation and tourism.⁽⁴⁾

COMMENTS AND CRITICAL ISSUES:

Sample air quality ppm exceeded state standards.⁽⁴⁾ Highly scenic area. Southern California Edison concerned that projected peak loads will exceed existing transmission capabilities and wants to transfer part of load to geothermal space heating.⁽¹⁾

SITE: LONG VALLEY, CA

SITE: Long Valley, CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 37° 40' 00" N

REGION 1

LONGITUDE: 118° 52' 00" W

COUNTY: Mono

ADJACENT COUNTIES: Inyo, Fresno, Madera, Mariposa, Tuolumne, Apline. NV-Douglas, Lyon, Mineral,
Esmerelda

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Site is east of the Sierra Nevada Mountains. Long Valley is a major, well-recognized collapse structure. (caldera) 16 Km (10 miles) wide by 32 Km (20 miles) long, (4) little slope.	Primarily recreation, with some timbering, mining and agriculture.(4)	Focus on increasing recreation and tourism. (Conservation is prime concern). Geothermal land is zoned as "general purpose".(4)	Highly scenic.(4)	Old Indian habitation sites and petroglyphs. (4)

10-12

SITE: Long Valley, CA

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 94°C
Subsurface: 220°C

Geochemical

SiO₂: 219°C
Na-k-Ca: 238°C

TOTAL DISSOLVED SOLIDS (TDS): TDS of 1-2,000 ppm. Silicate content of 1-300 ppm⁽⁴⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 4923⁽⁷⁾

TYPE OF OVER LAYING ROCK: Rhyolitic volcanics (medium-hard).

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY: Seismic noise and microearthquake studies indicate a relatively constant and relatively minor level of seismicity.⁽⁴⁾

SITE: Long Valley, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Mono-Long Valley		455,256	392,096	63,160 (State & Private)	
LAND LEASED IN KGRA			5,483		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
290.90	Republic Geothermal				
52.02	Geothermal Resources Intl.				
10.17	Geothermal Resources Intl.				
TENTATIVE LEASE SALE DATES					
1977	7/21 (BLM and USGS) ⁽¹⁴⁾				
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 4			8,232		
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE): 0					
SUBSURFACE AREA OF RESERVOIR		55,599			

10-14

SITE: Long Valley, CA

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>Approximately 20 shallow (less than 1000 ft. deep) wells were drilled in early 1960's, primarily in Casa Diablo area. Max. Temp. of 177°C (350°F); and flow rates of 500 GPM were encountered. Development was halted by the difficulties with disposal of arsenic/boron laden water and by the implementation of new environmental requirements.(4)</p> <p>Long Valley has been the scene of intensive, comprehensive geotechnical investigation by USGS. Data available does not indicate a significant thermal anomaly: If one exists, it is probably limited to the immediate vicinity of the caldera.(4)</p> <p>Electrical/electromagnetic surveys, seismic noise and microearthquake studies have been made.(4)</p> <p>By 1975, approximately 10 holes were drilled in a limited area by Magma Power; surface exploration was continuing; although drilling was delayed because of environmental and leasing questions.(2)</p> <p>Aeromagnetic survey has been done.(1A)</p> <p>Several wells ≥300 meters (1000 feet) have been drilled with temperature, flow and chemical information acquired.(1A)</p>	<p>In June 1976, probable continued drilling and testing of wells was projected through 1979. A possible decision to construct a power plant was projected for 1980-1985; if so, further drilling and testing of wells.(2)</p> <p>Southern California Edison Co. interested in Long Valley area where they may be partnered with Magma Energy Corp. Southern Cal. is concerned that projected peak-loads will exceed existing transmission capabilities, and wants to transfer part of load to geothermal space-heating (Mammoth Lakes Village).(1)</p> <p>The City of Burbank was to start exploratory drilling in April 1976. If successful, installation of 50 MWe plant is planned.(1)</p>

10-15

SITE: Long Valley, CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>The local administration has enacted definitive procedures for geothermal activity. An EIS is required for exploration with review by several state agencies to obtain a land use permit.^(1A)</p> <p>Administrative constraints on geothermal development are stringent. Requirements pose significant constraints and delays.^(1A)</p>	<p>Public reaction to geothermal development is generally negative, although county officials are encouraging development for taxation purposes and because it represents a good example of an optimum means of using a resource.⁽⁴⁾ The local private interest groups and the Sierra Club pose the most significant constraints.^(1A)</p>	<p>Two EIS's have been prepared.⁽⁴⁾</p> <p>Potential Forest Service lands predicted for leasing in FY 1977.⁽¹⁾</p>

10-16

SITE: Long Valley, CA

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 81.3-121.9 cm. (32-48 in.)

Average Temperature

Minimum: -12.2 to -6.7 °C (10-20°F)

Maximum: 15.6 to 21.1°C (60-70°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30 - 40%

Winter: 60-70%

10-17

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
In each of 3 samples, particulates exceeded the standards of the State Air Resources Board. From a 3 week sample, oxidant content exceeded the standards for 11 hours, and hydro-carbon content exceeded standards for 7 days. Particulate source unknown, possibly motor vehicles. ⁽⁴⁾	Crowley Lake, Mono Lake, Owens River and other permanent streams in area (potential sources of cooling water). ⁽⁴⁾	May be as high as 90-95 dbA (from trucks) ⁽⁴⁾	Sage, bitter and rabbit brush, pinon and juniper. ⁽⁴⁾	Sage grouse, mule deer, black bear, pine martin, ground squirrel and owl. Hot creek has brown, rainbow and brook trout. ⁽⁴⁾	Four plants and Bighorn Sheep, Wolverine, Spotted Bat, Bald Eagle, Owens Chub and Prairie and Peregrine Falcon. (Only the chub might be affected by geothermal development.) ⁽⁴⁾

SITE: Long Valley, CA

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Bishop	48 km (30 miles)	3500 (4)	32 km (20 miles) (4)	Interstate 395 5 km (3 miles) from site. (6)	none within 160 km (100 miles). (6)
Mammoth Lakes	8 km (5 miles)	900 (500 in winter season) (4)			
Tom's Place	24 km (15 miles)	150			

RECORD 00011

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 6

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000286
 CROSS INDEX NO.. CF00431
 RECORD TYPE..... A

NAME..... J. RENNER, J. A. CROWLEY
 DATE..... 75/05
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY
 WARNING FIGURE..... 8
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 37-40-00N

WARNING NUMBER..... 123-126
 COUNTRY NAME..... UNITED STATES
 COUNTY..... MONG
 LONGITUDE..... 118-52-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 03S 28E 35

BASE & MERIDIAN..... MT. DIABLO
 AVAILABLE MAPS OF AREA: MT. MORRISON 1:62,500

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 10.0 KM**2
 ELEVATION..... 2164.08 M 7100. FT
 RESOURCE CATEGORY..... B
 PRESENT USE & DEVELOPMENTS: ABOUT 10 WELLS DRILLED
 SURFACE THERMAL ACTIVITY..... HOT SPRINGS, FUMAROLE OR WARM VAPOR
 ASSOCIATED DEPOSITS..... SINTER
 NO. OF HOT SPRINGS..... 40

GEOTHERMAL CHARACTERISTICS

SPRING TEMPERATURES..... 60. C TO 94. C

WELL INFORMATION

MAXIMUM WELL TEMPERATURE..... 181. C TO 300. M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 200. C TO 250. C ASSUMED
 BEST ESTIMATE..... 220.0 C
 SUBSURFACE AREA..... 40.0 KM**2 TO 230.0 KM**2
 BEST ESTIMATE..... 225.0 KM**2
 BASED ON: GEOLOGY, GEOPHYSICS
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 1600.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR..... 60.000 KM**3 TO 575.000 KM**3
 BEST ESTIMATE..... 450.000 KM**3
 POROSITY..... 0.07 TO 0.23
 BEST ESTIMATE..... 0.15

COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

10-19

RESERVES

TOTAL STORED HEAT.....	2.8046E+19 J	6.6999E+18 CAL	TO 3.3906E+20 J	8.0999E+19 CAL
BEST ESTIMATE.....	2.3023E+20 J	5.4999E+19 CAL	ABOVE 15.	C

GEOLOGY

GENERAL ROCK TYPES: PLEISTOCENE RHYOLITIC VOLCANICS

GEOPHYSICS

MAGNETIC SURVEY INFORMATION: TEST MADE
 SEISMIC SURVEY INFORMATION: SEISMIC NOISE, P-DELAY, MICROEARTHQUAKES
 ELECTRICAL RESISTIVITY: TEST MADE
 OTHER GEOPHYSICAL INFORMATION: AMT, HEAT FLOW, TEMPERATURE GRADIENT

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
 REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) BAILLY, P.A., 1974, PRELIMINARY GEOLOGIC MAP AND CROSSSECTIONS OF THE CASA DIABLO GEOTHERMAL AREA, LONG VALLEY CALDERA, MONO COUNTY, CALIFORNIA: U.S.GEOL.SURVEY OPEN-FILE REPORT.
 - 2) HOOVER, D.B., AND OTHERS, 1974, EVALUATION OF AUDIO-MAGNETOTELLURIC TECHNIQUES AS A RECONNAISSANCE EXPLORATION TOOL IN LONG VALLEY, MONO AND INYO COUNTIES, CALIF.: U.S.G.S. OPEN-FILE REPORT
 - 3) LEWIS, R.E., 1974, DATA ON WELLS, SPRINGS, & THERMAL SPRINGS IN LONG VALLEY, MONO COUNTY, CALIF: U.S.G.S. OPEN-FILE REPORT
 - 4) STANLEY, W.D., & OTHERS, 1974, PRELIMINARY RESULTS OF DEEP ELECTRICAL STUDIES IN THE LONG VALLEY CALDERA, MONO & INYO COUNTIES, CALIF.: USGS OPEN-FILE REPORT
- WILLEY, L.M., & OTHERS, 1973, GEOCHEMISTRY OF THERMAL WATERS IN LONG VALLEY, CALIF.(ABS): EOS (AM. GEOPHYS. UNION TRANS.) V.54, NO.11, P. 1212

RECORD 00012

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION C

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000287

CROSS INDEX NO... CPG0431

RECORD TYPE..... F

SAMPLE TYPE..... SURFACE

NAME..... J. RENNER, J. A. CROWLEY

DATE..... 75/05

ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

LATITUDE..... 37-40.00 N

COUNTRY NAME..... UNITED STATES

COUNTY..... MCNO

LONGITUDE..... 118-52.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

WATER SAMPLING TEMP.... 94.0

C

WATER ANALYSIS

W

PH 1)..... 9.20

SOLUTE ANALYSIS (WATER)

LI	NA	K	RB	CS	NA+K			
2.8	590.00	45.00						
MG	CA	SR	LA	CA+MC				
	0.90							
Zn	HS	B	HBO2	AL	PB	AS	SB	U
		15						
F	CL	BR	I					
	280.00							
NO4	NO3	PO4	SIO2	S04	CO3	HCO3		
			340.00	130.00		450.00		

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726

WILLEY ETAL 1974 (NAGRA RITCHIE 45)

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RECORD 00013

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION E

SECTION E.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002422
 CROSS INDEX NO..
 RECORD TYPE..... F
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/06
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. LONG VALLEY
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES
 COUNTY..... MENDOCINO

TOWNSHIP RANGE SECTION 1/4 1/4
 20N 14W 7 NE

OTHER LOCALITY INFORMATION: EAST SIDE OF BRANCH OF EEL RIVER, 6.8 MILES SOUTH OF LAYTONVILLE

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1957/03/22
 COLLECTOR(S)..... E. H. BAILEY
 WATER SAMPLING TEMP.... 16.75 C
 WATER FLOW RATE..... 0.035224 L/S 8. GAL/MIN
 OTHER CHEMICAL CHARACTERISTICS: CARBONATED, SCANT OIL FILM.

WATER ANALYSIS

ANALYSIS DATE..... 1958/05/28
 ANALYST(S)..... H. C. WHITEHEAD
 PH 1)..... 6.5
 SPECIFIC CONDUCTANCE..... 3960. UMHO/CM
 ALKALINITY..... 1040. PPM AS CaCO3

AT 25. C

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
0	552	5.0						
MG	CA	SR	BA	CA+MG				
44	344							
ZN	MG	B	HB02	AL	PB	AS	SB	U
		120						
F	CL	BR	I					
	842							
NH4	NO3	PO4	SIO2	SO4	CO3	HC03		
			97	6	0	1160		

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-22

RECORD 00014

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002451

CROSS INDEX NO..

RECORD TYPE..... F

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/07

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY

NAME OF SAMPLE SOURCE.. HOT SPRING # 7422

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

OTHER LOCALITY INFORMATION: MAMMOTH

COUNTRY NAME..... UNITED STATES

COUNTY..... MONO

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

WATER SAMPLING TEMP.... 86. C

WATER FLOW RATE..... 0.000353 L/S .01 CFS

WATER ANALYSIS

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

L1	NA 354.6	K	RB	CS	NA+K			
PC 0.6	CA 15.4	SR	BA	CA+MG				
Zn	MG 10.18	B	HB02	AL	PB	AS	SB	U
F 11.5	CL 211.6	BR	I					
HH4	NO3	PO4	S102 92	SO4 67.25	CO3	HCO3 633.6		

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-23

RECORD 00015

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 6

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002430

CROSS INDEX NO..

RECORD TYPE..... 6

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/07

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. LONG VALLEY

NAME OF SAMPLE SOURCE.. GEYSER #3180

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES

COUNTY..... MONO

TOWNSHIP	RANGE	SECTION	1/4	1/4
35	26E	25	SE	W

SAMPLE INFORMATION

WATER SAMPLING TEMP....	91.	C		
WATER FLOW RATE.....	0.000071	L/S	.002	CFS

WATER ANALYSIS

PH 1)..... W 8.4

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RD	CS	NA+K			
	368.7							
MG	CA	SR	BA	CA+MG				
6.9	19.0							
ZN	HG	B	HB02	AL	PB	AS	SB	U
		11.3						
F	CL	BR	I					
	226.9							
NH4	NO3	PO4	SI02	SO4	CO3	HC03		
				96.1		497.2		

COMMENTS: WHAT METHOD FOR PH?

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-24

RECORD 00016

GEOHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 6002459
 CROSS INDEX NO..
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/07
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY
 NAME OF SAMPLE SOURCE.. MONO HOT SPRING
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES
 COUNTY..... MONO

OTHER LOCALITY INFORMATION: NE OF LEE VINING, EAST OF BLACK POINT, NW SHORE OF MONO LAKE

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1957/09/20
 COLLECTOR(S)..... J. FETH
 POINT OF COLLECTION..... AT CONCRETE TROUGH WITH PIPE DISCHARGE
 WATER SAMPLING TEMP.... 62.2 C
 DEPOSITS OR ALTERATION: VOLCANIC CINDER FLAT
 OTHER CHEMICAL CHARACTERISTICS: CHLORIDE CORRELATION FOR BR PLUS I

WATER ANALYSIS

W

ANALYSIS DATE..... 1957/12/27
 ANALYST(S)..... J. P. SCHUCH
 PH 1)..... 8.0
 SPECIFIC CONDUCTANCE..... 1960. UMHO/CM
 ALKALINITY..... 54. PPM AS CaCO3
 TOTAL DISSOLVED SOLIDS... 1190. PPM SOLIDS

AT 25. C

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
	450	6.7						
MG	CA	SR	BA	CA+MG				
4.6	14							
MM+3	MM(TOT)	FE+3	FE(TOT)	CU				
			0					
ZN	MG	B	MMO2	AL	PB	AS	SR	U
		7.4						
F	CL	LR	I					
1.3	524	2.1	.4					
MM4	MM3	MM4	SI02	MM4	CO3	MMO3		
1.9	2.0		73	92	0	430		

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-25

RECORD 00017

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION 6.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002458
 CROSS INDEX NO..
 RECORD TYPE..... E
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/07
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY
 NAME OF SAMPLE SOURCE.. HOT CREEK SPRINGS
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES
 COUNTY..... MONO

TOWNSHIP RANGE SECTION 1/4 1/4
 3S 29E 31 NE

OTHER LOCALITY INFORMATION: 1 MI. SE OF GEYSER

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1957/05/07
 COLLECTOR(S)..... DON E. WHITE
 WATER SAMPLING TEMP.... HOT
 WATER FLOW RATE..... 0.006806 L/S 2. GAL/MIN
 OTHER CHEMICAL CHARACTERISTICS: SO4 DETERMINATION IS TURBIDIMETRIC

WATER ANALYSIS

ANALYSIS DATE..... 1958/05/28
 ANALYST(S)..... J. P. SCHUCH
 PH 1)..... 6.6
 SPECIFIC CONDUCTANCE..... 1490. UMHO/CM AT 25. C
 ALKALINITY..... 48. PPM AS CaCO3

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
2.0	317	19						
MG	CA	SR	BA	CA+MG				
.5	18							
ZN	MG	B	HB02	AL	PB	AS	SB	U
		B.2						
F	CL	BR	I					
	172							
NH4	NO3	PO4	SI02	SO4	CO3	HC03		
			118	80	0	497		

COMMENTS: FROM ALLUVIUM, PROBABLY IN RHYOLITE.

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-26

SECTION F.- CHEMICAL ANALYSIS

RECORD NO..... 0002455

CROSS INDEX NO..

RECORD TYPE..... B

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE 76/07

ORGANIZATION.. USGS

GEOHERMAL FIELD-AREA.. LONG VALLEY

NAME OF SAMPLE SOURCE.. HUT CREEK SPRINGS

COUNTRY CODE..... US

STATE / PROVINCE CALIFORNIA

COUNTRY NAME..... UNITED STATES

COUNTY..... MONO

TOWNSHIP	RANGE	SECTION	1/4	1/4
----------	-------	---------	-----	-----

DRYSHIT	WASH	30
JS	2BL	25

OTHER LOCALITY INFORMATION: BIG NW POOL IN HOT CREEK

SOURCE TYPE..... POOL

COLLECTION DATE..... 1957/05/07

COLLECTOR(S).....DUN WHITE

POINT OF COLLECTION..... SE CORNER

WATER SAMPLING TEMP..... 85-93. C

WATER FLOW RATE..... NO DISCHARGE

DEPOSITS OR ALTERATION: SINTER AND TRA

OTHER CHEMICAL CHARACTERISTICS: NO EVIDENCE OF H₂S IN FIELD

[illegible]

ANALYSIS DATE..... 1958/03/24

ANALYSIS(S)..... WHITEHEAD AND SCRUCH

Ph 1)..... 6.1

SPECIFIC CONDUCTANCE.....	1760.	UMHU/CM
---------------------------	-------	---------

ALKALINITY.....	20.	PPM AS CaCO_3
-----------------	-----	------------------------

	PPM	SUM
TOTAL DISSOLVED SOLIDS...	1100.	

AT 25. C

UNITS USED..... PPM

LI	NA	K	RB	CS	NA•K
2.6	36.3	22			

MG	CA	SR	PA	CA+MG
0.2	7.6			

ZH	HG	LG	HGG2	AL	PB	AS	SB	U
----	----	----	------	----	----	----	----	---

F	CL	BR	I
11	245		

NO ₂	NO ₂	PO ₄	SiO ₂	SO ₄	CO ₃	HCO ₃
	2		110	107	0	454

10-27

REFERENCES: PERSONAL FILE OF DEN WHITE, USGS, MENLO PARK

10-28

RECORD 00019

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002454

CROSS INDEX NO..

RECORD TYPE..... B

SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.

DATE..... 76/07

ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY

NAME OF SAMPLE SOURCE.. HOT CREEK SPRINGS

COUNTRY CODE..... US

STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES

COUNTY..... MONO

TOWNSHIP RANGE SECTION 1/4 1/4
3S 28E 35 NW

MAP REFERENCE: MT. MORRISON SHEET

OTHER LOCALITY INFORMATION: NORTH OF FISH HATCHERY

SAMPLE INFORMATION

SOURCE TYPE..... POOL

COLLECTION DATE..... 1954/09/05

COLLECTOR(S)..... D. F. HEWETT, USGS

WATER ANALYSIS

W

ANALYSIS DATE..... 1954/11/22

ANALYST(S)..... HENRY KRAMER

PH 1)..... 7.35

SPECIFIC CONDUCTANCE..... 1815. UMHO/CM

AT 25.

C

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
2.2	376.	23.2						
MG	CA	SR	BA	CA+MG				
0	8.0	.48						
ZN	HC	B	HEO2	AL	PB	AS	SB	U
		11.1						
F	CL	BR	I					
5.0	258.							
HF4	HO3	PO4	SIO2	SO4	CO3	HC03		
	.80		126.	118.	0	475.		

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-29

RECORD 00020

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0002453
 CROSS INDEX NO..
 RECORD TYPE..... 1
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/07
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY
 NAME OF SAMPLE SOURCE.. HOT CREEK SPRINGS
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES
 COUNTY..... MONG

TOWNSHIP RANGE SECTION 1/4 1/4
 35 28E 25 NW

OTHER LOCALITY INFORMATION: SOUTH BANK OF CREEK IN CANYON

SAMPLE INFORMATION

SOURCE TYPE..... GEYSER
 COLLECTION DATE..... 1957/05/17
 COLLECTOR(S)..... D. WHITE
 WATER SAMPLING TEMP.... 93. C
 WATER FLOW RATE..... .32-.63 L/S 5-10. GAL/MIN
 OTHER CHEMICAL CHARACTERISTICS: COLORIMETRIC CHECKED GRAVIMETRICALLY

WATER ANALYSIS

ANALYSIS DATE..... 1958/01/31
 ANALYST(S)..... C. WHITEHEAD
 PH 1)..... 8.3
 SPECIFIC CONDUCTANCE..... 1620. UMHO/CM AT 25. C
 ALKALINITY..... 12. PPM AS CaCO_3
 TOTAL DISSOLVED SOLIDS... 1110. PPM SOLIDS

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K				
1.7	350	20							
MG	CA	SR	BA	CA+MG					
0.2	4.4								
MN+3	MN(TOT)	FE+3	FE(TOT)	CU					
	0		.04	0					
ZN	HG	B	BB02	AL	PB	AS	SB	U	
.01		10		0	0				
F	CL	BR	I						
10	200	.7	.4						
NH4	NH3	PO4	SIO2	SO4	CO3	HC03			

10-30

.1 0 131 90 7.9 497
REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-31

RECORD 00021

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 1002452
 CROSS INDEX NO..
 RECORD TYPE..... L
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/07
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. LONG VALLEY
 NAME OF SAMPLE SOURCE.. GEYSER SPRING
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES
 COUNTY..... MONO

TOWNSHIP RANGE SECTION 1/4 1/4
 35 26E 25 NE

OTHER LOCALITY INFORMATION: SOUTH SIDE OF HOT CREEK, ADJOINING STREAM

SAMPLE INFORMATION

SOURCE TYPE..... POOL AT GEYSER
 COLLECTION DATE..... 1954/09/05
 COLLECTOR(S)..... D. F. HEWETT
 POINT OF COLLECTION..... AT THE POOL
 WATER SAMPLING TEMP.... BOILING
 DEPOSITS OR ALTERATION: NO SINTER
 OTHER CHEMICAL CHARACTERISTICS: PERPETUAL SPROUTER

WATER ANALYSIS

ANALYSIS DATE..... 1954/11/22
 ANALYST(S)..... HENRY KRAMER
 PH 1)..... 7.75
 SPECIFIC CONDUCTANCE..... 1665. UMHO/CM

AT 25. C

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	RB	CS	NA+K			
1.8	352.	21						
MG	CA	SR	BA	CA+MG				
0	0.6	.6						
ZN	MG	B	HB02	AL	PR	AS	SB	U
		9.0						
F	CL	BR	1					
5.0	205.							
NH4	NH3	PO4	SiO2	SO4	CO3	HC03		
	.70		137	86.	.0	532.		

REFERENCES: PERSONAL FILE OF DON WHITE, USGS, MENLO PARK

10-32

SITE: SURPRISE VALLEY, CA
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Surprise Valley, CA (Federal/State/Private Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
SLC/Owner	Issue Prospecting/ Exploration	Developer	ASSUMED COMPLETED										
County Government	Issue Land Use Permit	Developer											
BIM	Issue STG Drilling Permit	Developer											
USGS/DOG	Issue Drilling Permit	Developer											
BIM/SLC/Owner	Lease Land	Developer											
Developer	Preliminary Geophysical Exploration												
BIM/SLC/County	Process EIA/EIS/EIR	CEQ											
Developer	Exploratory Drilling and Reservoir Evaluation												
Developer	Develop Utility Interest												
Developer and Utility	Feasibility Study												
Producer (Developer) and Utility	Financial Negotiations												
Producer	Site Selection												
Producer and Utility	Commitment to Development												
Producer and Utility	Design (Preliminary, Final)												
Producer and Utility	Prepare Master Development Plan	BIM,USGS											
Utility	Prepare Environmental Data Statement	BIM,FPC, CPUC, CERCDC County Government											
BIM, FPC, CPUC, CERCDC	Certify Plant and Site, Issue Permits	Producer and Utility											
USGS, County	Process EIA/EIS/EIR (Drilling)	CEQ											
FPC, CPUC	Process EIA/EIS/EIR (Plant & Transmission Line)	CEQ											
Producer Utility	Development Drilling												
Utility	Plant Construction												
Utility	Install Transmission Line												

SITE: Surprise Valley, CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Adequate land (Federal, state or private) may be leased for a 50 MWe plant--it may be marginally adequate.
- Exploratory drilling is underway.
- Stringent administrative constraints will slow development.

Principal Milestones:

• Identify utility	April 1978
• Complete feasibility study	January 1979
• Select site, commit to development	October 1979
• Start development drilling	January 1983
• Start construction	April 1983
• On line	July 1985

SITE: Surprise Valley, CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the Primary Technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Surprise Valley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- optimized to identification and character- ization of this type of field		X	2	78			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	78			
• Data Analysis and Interpretation	X	X	3	78			
• Basic Understanding of the Geothermal Process--at depth for rock formations (i.e., valley fill with rhyolite flows and plugs) similar to this location	X	X	3	78			

SITE: Surprise Valley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods--to aid in determining field boundaries in this type of rock formation Drilling Techniques--(valley fill with rhyolite flows and plugs) <u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Resource Characterization--with regard to determining type and extent of field Basic Understanding of the Geothermal Process--in the earth for this type of field 		X	2	79			
		X	3	79			
		X	2	79			
	X	X	3	79			
	X		4	79			
	X		4	79			

SITE: Surprise Valley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
● Drilling Techniques--(Valley fill with rhyolite flows and plugs, temperature <175°C)		X	4	82			
● High Temperature, Deep-well, Down-hole Pumps	X		2	83			
● Brine Injection Pumps--low to medium salinity brines	?	?	2	83			
● Brine Deaerators	?	?	2	83			
● Injection Technology--for this type of field	X		2	83			
<u>Supporting Technology</u>							
● Brine Chemistry--with regard to hole plugging during injection	X		2	83			
● Instrumentation and Control--with regard to injection process	X		2	83			
● Resource Characterization--with regard to behavior of field when produced	X	X	1	82			
● Reservoir Engineering--with regard to best way to produce field	X	X	1	82			
● Basic Understanding of Injection Process--for this type of field	X	X	2	83			
<u>Environmental</u>							
● Injection Impact Prediction Technology							
* Further investigation required to obtain requirements for this site.							

SITE: Surprise Valley, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation of inlet temperatures between 170°C-180°C	X		2	81			
• Working Fluid Selection Technique--(or fluid Development Program)	X		2	81			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (170°C-180°C)	X	X	2	81			
• Secondary Fluid Condensers--water is scarce, available water highly alkaline	X	X	2	81			
• Waste-Heat Handling--water scarce area	X	X	2	81			
<u>Supporting Technology--Binary Concepts</u>							
• Brine Chemistry--scale control in process equipment		X	3	81			
• Waste Brine Purification--for this type field		X	3	81			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		4	80			

SITE: Surprise Valley, CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 175

DEPTH, M: 1000

ROCK TYPE: Medium/
Hard

SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1985	1986	1987	1988+		
CAPACITY FACTOR ASSUMED	.50	.60	.65	.7		
COST OF ELECTRICITY (MILLS/KWH)	57.1	47.6	43.9	40.8		

11-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	6.94	LIFE:	10
INJECTION WELLS:	1.32	LIFE:	20
PRODUCER PLANT:	9.03	LIFE:	20
GENERATING PLANT:	38.1	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.173
UTILITY: 1.283

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.208
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.381
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

11-11

SITE: SURPRISE VALLEY, CA

DESCRIPTION AND DATA

SITE: Surprise Valley, CA

SUMMARY

TEMPERATURE °C

Surface: 174

Subsurface: 175

TOTAL DISSOLVED SOLIDS (PPM): 1,500^(1A)
ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 2,102⁽⁷⁾
TYPE OF OVERLAYING ROCK: Medium/Hard
ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres: 72,446⁽⁹⁾
Total Federal Acres: 33,852⁽¹⁾ (31,972 BLM: 1,880 Total State and Private Acres: 32,399⁽¹⁾
Federal Acres Leased: 10,584⁽¹⁾ USFS) State and Private Acres Leased:

GEOTHERMAL DEVELOPMENT STATUS:

Numerous wells drilled.^(4,2)

LOCAL AND STATE ATTITUDE TOWARD GEOTHERMAL DEVELOPMENTS:

Stringent administrative constraints cause delays.^(1A) Public opinion is mixed.⁽⁴⁾ Possible conflict between BLM and county for control of activities on Federal lands.^(1A)

LAND USE AND POPULATION:

Mountain valley with grazing, farming and lumbering. Sparsely populated with several small towns nearby.

COMMENTS AND CRITICAL ISSUES:

As of August 1975, all exploration has occurred on private lands.^(1A) Environmental Impact Report completed.⁽⁴⁾ Water supply is limited.⁽⁴⁾

11-13

1" = 8 mi.

SITE: SURPRISE VALLEY, CA

SITE: Surprise Valley, CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 41° 40' 00" N

REGION 1

LONGITUDE: 120° 12' 00" W

COUNTY: Modoc

ADJACENT COUNTIES: Lassen, Shasta, Siskiyou, OR-Klamath, Lake, NV-Washoe

LAND OWNERSHIP 70% Federal (USFS &BLM)
OF COUNTY: 25% Private
5% State

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Mountain valley trending north- south ⁽⁴⁾	Grazing, farming, lumbering on mountain sides. ⁽⁴⁾		The area is not of high aesthetic quality. ⁽⁴⁾	Historical sites (i.e. Fort Bidwell, the Applegate Trail) exist in area. ⁽⁴⁾

SITE: Surprise Valley, CA

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 174°C
Subsurface: 175°C

Geochemical

SiO₂: 174°C
Na-k-Ca: 159°C

TOTAL DISSOLVED SOLIDS (TDS): 1500^(1A)

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 2102⁽⁷⁾

TYPE OF OVER LAYING ROCK: The Surprise Valley fault is a major structural feature paralleling the western side of the valley. The vertical displacement of this fault may be as much as 3658 M (12,000 ft), and the valley fill is at least 2134 M (7000 ft) in thickness. There are also young rhyolite flows and plugs in the northern half of the valley in association with further hot spring occurrence.⁽⁴⁾

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY: Geologically, Surprise Valley is a down-dropped fault block (graben) with up-lifted fault blocks (horsts) forming the mountain ranges to the east and west. Structure such as this is typical of the Basin and Range province to the east; however, the sedimentary and volcanic stratigraphic section is typical of the Modoc Plateau to the west. Surprise Valley, then, lies in a transition zone between provinces.⁽⁴⁾

The lack of erosion on the fault scarp and the existence of uneroded landslide scars suggest recent (perhaps within 10,000 years) major movement.⁽⁴⁾

SITE: Surprise Valley, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Lake City - Surprise Valley		72,446	33,852	32,339 (State & Private)	
LAND LEASED IN KGRA			10,584		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
21.53	So. Union Prod. Co.				
18.74	Getty Oil Co.				
12.75	Getty Oil Co.				
7.75	Getty Oil Co.				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		30,888			

SITE: Surprise Valley, CA

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>By August 1975, Gulf Oil drilled three wells in area with the greatest well depth at 1371M (4,500 ft).⁽⁴⁾</p> <p>By early 1976, approximately seven holes were drilled across several square miles by Magma Power and Gulf Oil, and sites were approved for three additional holes.⁽²⁾</p>	

SITE: Surprise Valley, CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>The local administration has adopted definitive procedures for geothermal activity. An Environmental Assessment (EA) or possibly an EIS (if required) must be done to obtain a land use permit. An EIS is required for development and production.(1A)</p> <p>Administrative constraints are stringent, causing delays in development.(1A)</p>	<p>Public opinion is mixed but no significant opposition is expected.(4) However, the disposition of the county administration has been described as "cautious". The county is anticipating a potential conflict with BLM for control of geothermal activities on federal lands.(1A)</p>	<p>Environmental Impact Report pertaining to geothermal exploration is available.(4)</p>

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 32.7 cm (12.88 inches)

Average Temperature

Minimum: -1.7°C (29°F)

Maximum: 22.8°C (73°F)

Relative Humidity
(Seasonal Peaks)

Summer: 30% - 40%

Winter: 70%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
Very good. (4)	Poor. Limited supply. Three lakes exist but are alkaline, several seasonal saline lakes on valley floor. (4)		Sagebrush, bitterbush, juniper and (4) various grasses.	deer, antelope, rabbit, dove, quail, pheasant, grouse, eagle, and duck. (4)	8 varieties of plants, 4 birds (bald eagle, Osprey, Peregrine & Prairie Falcons), 2 fish (Shortnose and Modoc Suckers). (4)

SITE: Surprise Valley, CA
POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Cedarville	~ 32 Km (20 miles)	800	48 Km (30 miles) from transmission lines.(4)	State Highway 299 < 16 Km (10 miles) from site.(6)	~ 40 Km (25 miles) from primary rail- road.(6)
Lake City	~ 16 Km (10 miles)	100			
Reno	322 Km (200 miles)	70,000			

RECORD 00027

GEOTHERMAL RESOURCES FILE (GEOTHERM)-REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000276
 CROSS INDEX NO.. C100381
 RECORD TYPE..... A

NAME..... J. RENNER, C. BROOK, D. WILLIAMS
 DATE..... 75/02
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. SURPRISE VALLEY
 WARNING FIGURE..... 8
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 41-40-00N

WARNING NUMBER..... 14
 COUNTRY NAME..... UNITED STATES
 COUNTY..... MONOC
 LONGITUDE..... 120-12-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 44N 15E 24 NW SE

BASE & MERIDIAN..... MT. DIABLO
 AVAILABLE MAPS OF AREA: CEDARVILLE 1:62,500

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 1.0 KM**2
 ELEVATION..... 1365.50 M 4480. FT
 RESOURCE CATEGORY..... B
 PRESENT USE & DEVELOPMENTS: 4 WELLS DEEPEST 1370M
 SURFACE THERMAL ACTIVITY..... HOT SPRINGS
 ASSOCIATED DEPOSITS..... SINTER
 NO. OF HOT SPRINGS..... 7

GEOTHERMAL CHARACTERISTICS

SPRING TEMPERATURES..... 49. C TO 97. C
 WELL INFORMATION
 MAXIMUM WELL TEMPERATURE..... 160. C TO 1155. M
 BOTTOM-HOLE TEMPERATURE..... TO 1370.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 116. C TO 225. C ASSUMED
 BEST ESTIMATE..... 175.0 C
 SUBSURFACE AREA..... 40.6 KM**2 TO 250.0 KM**2
 BEST ESTIMATE..... 125.0 KM**2
 BASED ON: GEOLOGY, GEOPHYSICS
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 1000.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR..... 60.000 KM**3 TO 625.000 KM**3
 BEST ESTIMATE..... 250.000 KM**3
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

11-21

TOTAL STORED HEAT.....	1.4232E+19 J	3.3999E+18 CAL	TO 3.6836E+20 J	8.7999E+19 CAL
BEST ESTIMATE.....	1.0046E+20 J	2.3999E+19 CAL	ABOVE 15.	C

GEOLOGY

GENERAL ROCK TYPES: QUATERNARY ALLUVIUM, TERTIARY OR POSSIBLY PLEISTOCENE VOLCANICS

GEOPHYSICS

GRAVITY SURVEY INFORMATION: TEST MADE

MAGNETIC SURVEY INFORMATION: TEST MADE

ELECTRICAL RESISTIVITY: DC RESISTIVITY TEST MADE

OTHER GEOPHYSICAL INFORMATION: AMT

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS

DATE..... 1975

TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975

REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) CHAPMAN, R.D., AND BISHOP, C.C., 1968, ALTURAS SHEET: CALIFORNIA DIV. MINES & GEOLOGY, BOUGUER GRAVITY MAP OF CALIFORNIA
- 2) DUFFIELD, W.A., & FOURNIER, R.O., 1974, RECONNAISSANCE STUDY OF THE GEOTHERMAL RESOURCES OF MODOC COUNTY, CALIF.: U.S.G.S. OPEN-FILE REPORT.
- 3) GAY, T.L., JR., & AUNE, R.A., COMPILERS, 1958, GEOLOGIC MAP OF CALIFORNIA, ALTURAS SHEET: CALIF. DIV. MINES & GEOLOGY
- 4) WARING, G.A., 1965, THERMAL SPRINGS OF THE U.S. AND OTHER COUNTRIES OF THE WORLD - A SUMMARY: USGS PROF. PAPER 492

WHITE & OTHERS, 1965, CHEMICAL COMPOSITION OF SUBSURFACE WATERS, IN FLEISCHER, M., ED., DATA OF GEOCHEMISTRY: USGS PROF. PAPER 440-F

RECORD 00028

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000852
 CROSS INDEX NO.. RELOPI
 RECORD TYPE..... R
 SAMPLE TYPE..... SURFACE

NABL..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SURPRISE VALLEY
 NAME OF SAMPLE SOURCE.. LEONARDS HOT SPRINGS
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 41-35.9 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MODOC
 LONGITUDE..... 120-05.5 W

TOWNSHIP RANGE SECTION 1/4 1/4
 43N 16E 13 NE NE

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 SAMPLE NO..... 4
 COLLECTION DATE..... 1973/07/25
 COLLECTOR(S)..... MARSHALL J. REED
 WATER FLOW RATE..... 2.50 L/S 150. L/MIN
 WATER TREATMENT DATA: PRESSURE-FILTERED THROUGH A .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: ALTITUDE 1390 M

WATER ANALYSIS

W

ANALYST(S)..... REED, RAPP, PRESSER, WILLEY
 PH 11..... 7.82
 SPECIFIC CONDUCTANCE..... 2.59 UMHO/CM
 TOTAL DISSOLVED SOLIDS... 1180 MG/L

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	Rb	CS	NA+K			
.13	236	8.5	.03					
MG	CA	SR	BA	CA+MG				
.6	26							
MN+3	MN(TOT)	FE+3	FE(TOT)	CU				
	.09							
ZN	MG	B	HB02	AL	PB	AS	SB	U
LT .005		7.6						
P	CL	LR	I					
5.2	220							
NH4	NO3	PO4	SI02	SO4	CO3	HCO3		
			110	390	1	82		

11-23

COMMENTS: SURPRISE VALLEY IS A GRAVEN WITH ACCUMULATED SEDIMENTS AND VOLCANIC DEBRIS
REFERENCES: REED, MARSHALL J., THE CHEMISTRY OF THERMAL WATER IN SELECTED GEOTHERMAL AREAS OF CALIFORNIA, REPORT
NO. 1815

RECORD 00029

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION 1.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000853
 CROSS INDEX NO.. RECD001
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAML..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. SURPRISE VALLEY
 NAME OF SAMPLE SOURCE.. SEYFERTH HOT SPRINGS
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 41-36.9 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MODOC
 LONGITUDE..... 120-06.1 W

TOWNSHIP RANGE SECTION 1/4 1/4
 45N 16E 12 NW NW

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 SAMPLE NO..... 3
 COLLECTION DATE..... 1973/07/26
 COLLECTOR(S)..... MARSHALL J. REED
 WATER SAMPLING TEMP.... 85.4 C
 WATER FLOW RATE..... 8.33 L/S 500. L/MIN
 WATER TREATMENT DATA: PRESSURE-FILTERED THROUGH A .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: ALTITUDE 1417 M.

WATER ANALYSIS

ANALYST(S)..... W M. J. REED, RAPP, PRESSER, WILLEY
 PH 1)..... 7.66
 SPECIFIC CONDUCTANCE.... 3.28 UMHO/CM
 TOTAL DISSOLVED SOLIDS... 1110. MG/L

ISOTOPIC DATA

DEL D(18) OF WATER..... -14.05 0/00
 DEL D OF WATER..... -121.2 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K				
.15	306	9.0	.04						
MG	CA	SR	BA	CA+MG					
LT .1	28								
MN+3	MN(TOT)	FE+3	FE(TOT)	CU					
	.01								
ZN	HG	B	BB02	AL	PB	AS	SB	U	
LT .005		7.6							

11-25

F	CL	BR	1			
5.4	220					
HI4	NO3	PC4	SI02	SO4	CO3	HCO3
			110	370	0	63

COMMENTS: SURPRISE VALLEY IS A GRABEN WITH ACCUMULATED SEDIMENTS AND VOLCANIC DEBRIS
REFERENCES: REED, MARSHALL J., THE CHEMISTRY OF THERMAL WATER IN SELECTED GEOTHERMAL AREAS OF CALIFORNIA, REPORT
NO. TR15.

RECORD 00030

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION B

SECTION E.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000851
 CROSS INDEX NO.. REED01
 RECORD TYPE..... L
 SAMPLE TYPE..... WELL

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SURPRISE VALLEY
 NAME OF SAMPLE SOURCE.. HOT SPRINGS HOTEL
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 41-31.9 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MOHOC
 LONGITUDE..... 120-04.5 W

TOWNSHIP RANGE SECTION 1/4 1/4
 42N 17E 6 NE SW

SAMPLE INFORMATION

SAMPLE NO..... 5
 COLLECTION DATE..... 1973/07/27
 COLLECTOR(S)..... MARSHALL J. REED
 WATER SAMPLING TEMP.... 98.1 C
 WATER FLOW RATE..... 5.00 L/S 300. L/MIN
 WATER TREATMENT DATA: PRESSURE-FILTERED THROUGH A .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: DEPTH 27 M., ALTITUDE 1372 M

WATER ANALYSIS

W

ANALYST(S)..... MARSHALL J. REED
 PH 1)..... 8.40
 SPECIFIC CONDUCTANCE..... 2.66 UMHO/CM

ISOTOPIC DATA

DEL O(18) OF WATER..... -13.61 0/00
 DEL D OF WATER..... -117.0 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K				
.10	280	5.5	.03						
HC	CA	SR	BA	CA+MG					
LI .1	16								
MN+3	NN(TOT)	FE+3	FL(TOT)	CU					
	LI .01								
ZN	HC	B	HCO2	AL	PB	AS	SB	U	
.014		5.7							
F	CL	BR	I						
5.1	200								

11-27

HL4	HL3	FD4	S102	SD4	CO3	HEU3
			100	020	2	57

COMMENTS: SURRISE VALLEY IS A GRABEN WITH ACCUMULATED SEDIMENTS AND VOLCANIC DEBRIS
 REFERENCES: REED, MARSHALL J., THE CHEMISTRY OF THERMAL WATER IN SELECIED GEOTHERMAL AREAS OF CALIFORNIA, REPORT
 NO. TR15

RECORD 00031

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000850
 CROSS INDEX NO.. REED001
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SURPRISE VALLEY
 NAME OF SAMPLE SOURCE.. MENLO HOT SPRINGS
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 41-16.0 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MODOC
 LONGITUDE..... 120-04.5 W

TOWNSHIP RANGE SECTION 1/4 1/4
 39N 17E 7 NE NE

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 SAMPLE NO..... 6
 COLLECTION DATE..... 1973/08/23
 COLLECTOR(S)..... MARSHALL J. REED
 WATER SAMPLING TEMP.... 57.4 C
 WATER FLOW RATE..... 8.33 L/S 500. L/MIN
 WATER TREATMENT DATA: PRESSURE-FILTERED THROUGH A .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: ALTITUDE 1204 M.

WATER ANALYSIS

W

ANALYST(S)..... REED, RAPP, PRESSER, WILLEY
 PH 1)..... 8.91
 SPECIFIC CONDUCTANCE..... .808 UMHO/CM
 TOTAL DISSOLVED SOLIDS... 370. MG/L

ISOTOPIC DATA

DEL D(18) OF WATER..... -15.30 0/00
 DEL D OF WATER..... -112.3 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
LI .02	100	1.4	LI .01					
MC	CA	SR	BA	CA+MC				
LI .1	5.1							
MM+3	MM(100)	FE+3	FE(100)	CU				
	LI .01							
ZN	HG	B	HM+2	AL	PB	AS	SB	U
LI .05		.93						

11-29

1	CL	LR	1			
3.8	25					
NH4	NO3	PO4	SiO2	SO4	CO3	HCO3
			53	120	34	27

COMMENTS: SURPRISE VALLEY IS A GRABEN WITH ACCUMULATED SEDIMENTS AND VOLCANIC DEBRIS.
REFERENCES: REED, MARSHALL J., THE CHEMISTRY OF THERMAL WATER IN SELECTED GEOTHERMAL AREAS OF CALIFORNIA, REPORT NO. TR15.

RECORD 00032

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 1

SECTION 6.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 000277
 CROSS INDEX NO.. C000381
 RECORD TYPE..... 6
 SAMPLE TYPE..... SURFACE

NAME..... J. RENNER, C. BROOK, D. WILLIAMS
 DATE..... 75/02
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. SURPRISE VALLEY
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 41-40.00 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MODOC
 LONGITUDE..... 120-12.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 WATER SAMPLING TEMP.... 86.0 C
 WATER FLOW RATE..... 0.049998 L/S 3.0 L/MIN

WATER ANALYSIS

ANALYSIS DATE..... 1973

SOLUTE ANALYSIS (WATER)

LI	NA	K	RB	CS	NA+K
	343.00	16.30			
MG	CA	SR	BA	CA+MG	
	11.00				
F	CL	BR	I		
	223.00				
NH4	NO3	PO4	SiO2	SO4	CO3
			182.00	330.00	HC03
					124.00

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726
 DUFFIELD & FOURNIER 1974 (MUD VOLCANO AREA)

11-31

RECORD 00033

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 0

SECTION E.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 000029
 CROSS INDEX NO.. REED001
 RECORD TYPE..... B
 SAMPLE TYPE..... WELL

NAME..... SANFORD, LINDA J.
 DATE..... 7/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SURPRISE VALLEY
 NAME OF SAMPLE SOURCE.. WELL AT FORT BIDWELL RESERVATION
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 41-51.7 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MODOC
 LONGITUDE..... 120-09.5 W

TOWNSHIP..... RANGE..... SECTION..... 1/4 1/4
 46N 16E 17 NW NE

SAMPLE INFORMATION

SAMPLE NO..... 1
 COLLECTION DATE..... 1973/07/26
 COLLECTOR(S)..... MARSHALL J. REED
 WATER SAMPLING TEMP..... 45.1 C
 WATER FLOW RATE..... 6.67 L/S 400. L/MIN
 WATER TREATMENT DATA: PRESSURE - FILTERED THROUGH A .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: ALTITUDE 1414 M.

WATER ANALYSIS

ANALYST(S)..... M. J. REED, RAPP, PRESSER, WILLEY
 PH 1)..... 7.85
 SPECIFIC CONDUCTANCE..... .733 UMHO/CM
 TOTAL DISSOLVED SOLIDS... 458. MG/L

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
.63	110	9.5	.01					
MG	CA	SR	EA	CA+MG				
	4.2							
MM+3	BN(TOT)	FE+3	FE(TOT)	CU				
	LT .01							
ZN	HG	B	HEU2	AL	PB	AS	SB	U
LT .005		.61						
F	CL	BR	I					
2.2	31							
MM4	RO3	PO4	SIO2	SO4	CO3	HC03		
			82	86	1	131		

11-32

COMMENTS: SURPRISE VALLEY IS A GRAFEN WITH ACCUMULATED SEDIMENTS AND VOLCANIC DEBRIS
REFERENCES: REED, MARSHALL J., THE CHEMISTRY OF THERMAL WATER IN SELECTED GEOTHERMAL AREAS OF CALIFORNIA, REPORT
NO. TR15

RECORD 00034

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 000028
 CROSS INDEX NO.. REEDGP1
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SURPRISE VALLEY
 NAME OF SAMPLE SOURCE.. POOL AT LAKE CITY MUD EXPLOSION
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA

COUNTRY NAME..... UNITED STATES
 COUNTY..... MODOC

TOWNSHIP	RANGE	SECTION	1/4	1/4
64N	15E	24	SW	NE

SAMPLE INFORMATION

SOURCE TYPE..... POOL
 SAMPLE NO..... 2
 COLLECTION DATE..... 1973/08/16
 COLLECTOR(S)..... MARSHALL J. REED
 WATER SAMPLING TEMP.... 96.5 C
 WATER FLOW RATE..... 0.0000E+00 L/S 0. L/MIN
 WATER TREATMENT DATA: PRESSURE-FILTERED THROUGH .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: ALTITUDE 1366 M.

WATER ANALYSIS

ANALYST(S)..... REED, RAPP, PRESSER, WILLEY
 PH 1)..... 7.64
 SPECIFIC CONDUCTANCE.... 3.74 UMHO/CM
 TOTAL DISSOLVED SOLIDS... 1210 MG/L

ISOTOPIC DATA

DEL D(18) OF WATER..... -14.79 0/00
 DEL D OF WATER..... -113.0 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
.24	320	15	.08					
MG	CA	SR	BA	CA+MG				
LI .1	7.7							
MG+3	BR(TOT)	FE+3	FE(TOT)	CU				
LI .01								
ZN	MG	P	BR02	AL	PB	AS	SB	U
LI .005		.61						
F	CL	BR	I					

11-34

7.6	270					
NO4	NO3	NO4	SIO2	SO4	CO3	HCO3
			200	320	0	112

COMMENTS: SURPRISE VALLEY IS A GRABEN WITH ACCUMULATED SEDIMENTS AND VOLCANIC DEBRIS.
 REFERENCES: KLEU, MARSHALL J., THE CHEMISTRY OF THERMAL WATER IN SELECTED GEOTHERMAL AREAS OF CALIFORNIA, REPORT
 NO. TR 15

SITE: COVE FORT/SULPHURDALE, UT
ANALYSIS OF POSTULATED DEVELOPMENT

12-1

SITE: Cove Fort/Sulphurdale, Utah (Federal Lands)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM BLM BLM Developer	Process EIA/EIS Issue STG Drilling Permit Lease Land Preliminary Geophysical Exploration	CEQ Developer Developer	} ASSUMED COMPLETED										
USGS Developer	Issue Drilling Permit Exploratory Drilling and Reservoir Evaluation	Developer	—	—	—								
Developer Developer and Utility	Develop Utility Interest Feasibility Study			—	—								
Developer and Utility	Financial Negotiations				—								
Producer (Developer) and Utility	Site Selection				—								
Producer and Utility	Commitment to Development					Δ							
Producer and Utility	Design (Preliminary, Final)					—	—						
Producer and Utility	Prepare Master Development Plan	BLM, USGS				—							
Utility	Prepare Environmental Data Statement	BLM, FPC				—							
BLM, FPC	Certify Plant and Site, Issue Permits	Producer and Utility				—	—	—					
USGS	Process EIA/EIS (Drilling)	CEQ				—	—	—					
FPC	Process EIA/EIS (Plant)	CEQ				—	—	—					
FPC	Process EIA/EIS (Transmission Line)	CEQ				—	—	—					
Producer Utility Utility	Development Drilling Plant Construction Install Transmission Line							—	—	—			

SITE: Cove Fort/Sulphurdale, UT

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal) land is leased for a 50 MWe power plant.
- Exploratory drilling could commence in the near future.

Principal Milestones:

• Issue drilling permit, start exploratory drilling	October 1977
• Identify utility	October 1978
• Complete feasibility study	July 1979
• Select site, commit to development	April 1980
• Start development drilling	July 1982
• Start construction	October 1982
• On line	January 1985

SITE: Cove Fort-Sulphurdale, UT

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the Primary Technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Cove Fort/Sulphurdale, UT

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS*	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> • Improved Geophysical Exploration Methods--optimized to identification and characterization of geothermal fields in volcanic rock 	X	X	2	78			
<u>Supporting Technology</u> <ul style="list-style-type: none"> • Data Gathering and Processing • Data Analysis and Interpretation • Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location 	X	X	3	78			
	X	X	3	78			
* Status of exploration operations at this site needs further investigation.							

SITE: Cove Fort/Sulphurdale, UT

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods-- to aid in determining field boundaries in this type of rock formation Drilling Techniques--(volcanic rocks) <u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Resource Characterization--with regard to determining type and extent of field Basic Understanding of the Geothermal Process--in the earth for this type of field 		X	2	79			
		X	3	79			
		X	2	79			
	X	X	3	79			
	X		4	79			
	X		4	79			

SITE: Cove Fort/Sulphurdale, UT

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY • NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--(sedimentary rock, with recent volcanics, temperature <200°C)		X	4	82			
• High Temperature, Deep-well Down-hole Pumps	X		2	83			
• Brine Injection Pumps	(ID)		2	83			
• Brine Deaerators	?	?	2	83			
• Injection Technology--volcanic rocks	X		2	83			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	X		2	83			
• Instrumentation and Control--with regard to injection process	X		2	83			
• Resource Characterization--with regard to behavior of field when produced	X	X	1	82			
• Reservoir Engineering--with regard to best way to produce field	X	X	1	82			
• Basic Understanding of Injection Process-- for this type of field	X	X	2	83			
<u>Environmental</u>							
• Injection Impact Prediction Technology*	X		1	82			
<hr/>							
(ID) Insufficient Data							
* Further investigation required to obtain requirements for this site.							

SITE: Cove Fort/Sulphurdale, UT

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperatures between 190°C-200°C	X		2	81			
• Working Fluid Selection Technique--(or fluid Development Program)	X		2	81			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (190°C-200°C)	X	X	2	81			
• Secondary Fluid Condensers*	?	?	2	81			
• Waste-heat Handling*	?	?	2	81			
<u>Supporting Technology--Binary Concepts</u>							
• Brine Chemistry*		X	3	81			
• Waste Brine Purification--for this type field*		X	3	81			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		4	80			
* Further investigation required to obtain requirements for this site.							

SITE: Cove Fort/Sulphurdale, UT

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 200

DEPTH, M: 1500

ROCK TYPE: Medium/
Hard

SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1985	1986	1987	1988+		
CAPACITY FACTOR ASSUMED	.5	.6	.65	.7		
COST OF ELECTRICITY (MILLS/KWH)	58.1	48.4	44.7	41.5		

12-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	9.72	LIFE:	10
INJECTION WELLS:	2.09	LIFE:	20
PRODUCER PLANT:	7.30	LIFE:	20
GENERATING PLANT:	36.8	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.042
UTILITY: 1.236

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.226
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.368
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

12-11

SITE: COVE FORT/SULPHURDALE, UT

DESCRIPTION AND DATA

SITE: Cove Fort-Sulphurdale, UT

SUMMARY

TEMPERATURE °C

Surface:

Subsurface: 200

TOTAL DISSOLVED SOLIDS (PPM):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 274⁽⁷⁾

TYPE OF OVERLAYING ROCK: Medium/Hard

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 15,000

DESCRIPTION OF KGRA

Total KGRA Acres: 24,874⁽⁸⁾

Total Federal Acres:

Total State and Private Acres:

Federal Acres Leased: 19,409

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Surface exploration underway,⁽²⁾ with exploratory drilling likely to begin in early 1977.⁽¹⁸⁾

12-12

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Beaver County: Positive administrative attitude. As of August 1975, no regulations or constraints.^(1A)

LAND USE AND POPULATION:

Forest and open woodland with some grazing, in area of low and high mountains.⁽⁶⁾ Adjacent to National Forest. Sparse population.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

SCALE 1:1,000,000

SITE: COVE FORT-SULPHURDALE, UT

SITE: Cove Fort Sulphurdale, UT

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 38° 36' 00" N

REGION 4

LONGITUDE: 112° 33' 00" W

COUNTY: Millard and Beaver

ADJACENT COUNTIES: Iron, Garfield, Piute, Seiver, Sanpete, Jaub; Nevada: White Pine and Lincoln

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Plains with low and high mountains	Adjacent to Fishlake National Forest. Forest and open woodland some grazing. ⁽⁶⁾			

12-14

SITE: Cove Fort Sulphurdale, UT

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface:
Subsurface: 200°C

Geochemical
SiO₂:
Na-k-Ca:

TOTAL DISSOLVED SOLIDS (TDS):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 274⁽⁷⁾

TYPE OF OVER LAYING ROCK: Sediments and recent volcanics. (Medium-hard).⁽⁸⁾ May be a vapor-dominated geothermal system.⁽⁷⁾

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1500 M (4921 ft)⁽⁸⁾

SEISMIC ACTIVITY: There has been some seismic activity in the area.⁽⁶⁾

12-15

SITE: Cove Fort, UT

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Cove Fort - Sulphurdale		24,874			
LAND LEASED IN KGRA			19,409		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
361.87	Union Oil Co.				
361.85	Union Oil Co.				
325.68	Union Oil Co.				
171.45	Union Oil Co.				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		3,707			

SITE: Cove Fort Sulphurdale, UT

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>Surface exploration underway,⁽²⁾ with exploratory drilling likely to begin in early 1977.⁽¹⁸⁾</p>	

SITE: Cove Fort Sulphurdale, UT

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>As of August 1975, there were no local regulations or legislation for geothermal. There were virtually no constraints at the country level.(1A)</p>	<p>Beaver Co.: Administration is very pro-geothermal.(1A)</p>	

SITE: Cove Fort Sulphurdale, UT

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): ⁽⁶⁾ 20.3 - 40.6 centimeters (8-16 inches)

Average Temperature

Minimum: -6.7 to -1.1°C (20-30°F)

Maximum: 21.1 to 26.7°C (70-80°F)

Relative Humidity

(Seasonal Peaks)

Summer: 40 - 50%

Winter: 70 - 80%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	Surface and ground- water available. ⁽⁶⁾		Juniper-pinyon woodland and great basin sagebrush. ⁽⁶⁾		

SITE: Cove Fort Sulphurdale, UT
POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Manderfield	24 Km (15 miles)	70	80 Km (50 miles) to primary lines (230-500 KV). ⁽⁶⁾	Interstate Routes 70 and 15 at the site. ⁽⁶⁾	Primary railroad within 24 Km (15 miles) of site. (6)
Beaver	40 Km (25 miles)	1,548			
Kanosh	19 Km (12 miles)	12,499			

RECORD 00193

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000736
 CROSS INDEX NO.. CPG2681
 RECORD TYPE..... A

NAME..... J. RENNER
 DATE..... 75/06
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. COVE FORT - SULPHURDALE
 COUNTRY CODE..... US
 STATE/PROVINCE..... UTAH
 LATITUDE..... 38-36-00N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MILLARD (& BEAVER)
 LONGITUDE..... 112-33-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 25S 06W 32

BASE & MERIDIAN..... SALT LAKE
 AVAILABLE MAPS OF AREA: COVE FORT 1:62,500

GENERAL DESCRIPTION

ELEVATION..... 1950.72 M 6400. FT
 RESOURCE CATEGORY..... 0
 SURFACE THERMAL ACTIVITY..... FUMAROLE OR WARM VAPOR,
 NO. OF HOT SPRINGS..... NONE

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 100. C TO 240. C ASSUMED
 BEST ESTIMATE..... 200.0 C
 SUBSURFACE AREA..... 12.0 KM**2 TO 75.0 KM**2
 BEST ESTIMATE..... 15.0 KM**2
 BASED ON: OCCURRENCE OF SULFUR DEPOSITS
 DEPTH TO TOP OF RESERVOIR.....
 BEST ESTIMATE..... 1500.00 M 1.500 KM
 DEPTH TO BOTTOM OF RESERVOIR..
 BEST ESTIMATE..... 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR.....
 BEST ESTIMATE..... 1500.00 M 1.500 KM
 VOLUME OF RESERVOIR..... 18.000 KM**3 TO 112.500 KM**3
 BEST ESTIMATE..... 22.500 KM**3
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 4.1860E+16 J 9.9999E+17 CAL TO 6.2786E+19 J 1.4999E+19 CAL
 BEST ESTIMATE..... 1.0465E+19 J 2.4999E+18 CAL ABOVE 15. C

GEOLOGY

GENERAL ROCK TYPES: PALEOZOIC SEDIMENTS, TERTIARY VOLCANICS

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975

12-21

TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) HINTZE, L.F., 1963, GEOLOGIC MAP OF SOUTHWESTERN UTAH: UTAH STATE LAND BOARD
- 2) LEE, W.T., 1907, SULPHUR AND PYRITE-THE COVE CREEK SULPHUR BEDS, UTAH: U.S.G.S. BULL. 13
- 3) RODRIGUEZ, E.L., 1960, ECONOMIC GEOLOGY OF THE SULPHURDALE, UTAH: UTAH UNIV., M.S. THESIS

RECORD 00194

GEOHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000727
 CROSS INDEX NO.. CF02681
 RECORD TYPE..... I
 SAMPLE TYPE..... SURFACE

NAME..... J. RENNER
 DATE..... 75/06
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. COVE FORT - SULPHURDALE
 COUNTRY CODE..... US
 STATE/PROVINCE..... UTAH
 LATITUDE..... 38-36.00 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... MILLARD (E BEAVER)
 LONGITUDE..... 112-33.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING

WATER ANALYSIS W

SOLUTE ANALYSIS (WATER)

LI	NA	K	RB	CS	NA+K 144	
MG	CA 158.00	SR	BA	CA+MG		
F	CL 79.00	BR	I			
NH4	NO3	PO4	SIO2 124.00	SO4 7602.00	CO3	HCO3

OTHER SOLUTES & GASES FREE S=3.6

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726
 LEE, 1967

12-23

SITE: CASTLE CREEK, ID
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Castle Creek, Idaho

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM USGS BLM/Owner BLM County	Issue STG Drilling Permit Issue Drilling Permit Lease Land Process EIA/EIS Issue Use Permit	Developer Developer Developer CEQ Developer	ASSUMED COMPLETED										
Developer	Exploratory Drilling & Reservoir Evaluation												
Developer	Develop Utility Interest												
Developer & Utility	Feasibility Study												
Producer (De- veloper) & Utility	Financial Negotiations												
Producer	Site Selection												
Producer & Utility	Preliminary Design Final Design												
Producer & Utility	Commitment to Development												
Producer & Utility Utility	Prepare Master Development Plan Prepare Environmental Data Statement	BLM, USGS BLM, FPC, State DEQ											
BLM/FPC/ State PUC USGS FPC FPC/State PUC	Certify Plant & Site, Issue Permits Process EIA/EIS (Drilling) Process EIA/EIS (Plant) Process EIA/EIS (Trans- mission Line)	Producer & Utility CEQ CEQ CEQ											
Producer Utility Utility	Development Drilling Plant Construction Install Transmission Line (40km)												

SITE: Castle Creek, ID

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions;

- Adequate (Federal) land leased for a 50 MWe power plant.
- Some recent exploratory drilling.

Principal Milestones:

• Start exploratory drilling and
reservoir evaluation	April 1977
• Identify utility	April 1978
• Complete feasibility study	January 1979
• Select site, commit to development	October 1979
• Start development drilling	January 1982
• Start construction	April 1982
• On line	July 1984

SITE; Castle Creek, ID

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Castle Creek, ID

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS *	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
<ul style="list-style-type: none"> Improved Geophysical Exploration Methods--optimized to identification and characterization of geothermal fields in basaltic and volcanic rock 	X	X	2	79			
<u>Supporting Technology</u>							
<ul style="list-style-type: none"> Data Gathering and Processing 		X	2	79			
<ul style="list-style-type: none"> Data Analysis and Interpretation 	X	X	3	79			
<ul style="list-style-type: none"> Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location 	X	X	3	79			
* Status of exploration operations at this site needs further investigation.							

SITE: Castle Creek, ID

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
Primary Technology							
<ul style="list-style-type: none"> Improved Geophysical Exploration Methods--to aid in determining field boundaries in this type of rock formation Drilling Techniques 		X	2 (ID)	80 (ID)			
Supporting Technology							
<ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Resource Characterization--with regard to determining type and extent of field Basic Understanding of the Geothermal Process--in the earth for this type of field 		X	2	80			
	X	X	3	80			
	X		4	80			
	X		4	80			
(ID) Insufficient Data							

SITE: Castle Creek, ID

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>			(ID)	(ID)			
• Drilling Techniques			(ID)	(ID)			
• Brine Injection Pumps							
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of this field when produced	X	X	2	83			
• Reservoir Engineering--to define best way to produce this field	X	X	2	83			
• Basic Understanding of Injection Process--for this type of field	X	X	1	84			
• Brine Chemistry			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Castle Creek, ID

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u> <ul style="list-style-type: none"> • Steam Separators • Waste Heat Handling 			(ID)	(ID)			
<u>Supporting Technology</u> <ul style="list-style-type: none"> • Brine Chemistry • Spent Brine Purification Processes 			(ID)	(ID)			
<u>Environmental</u> <ul style="list-style-type: none"> • Non-condensable Gas Control/Disposal 			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Castle Creek, ID

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 200

DEPTH, M: 1000**

ROCK TYPE: Medium** SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1985	1986	1987	1988+		
CAPACITY FACTOR ASSUMED	.5	.6	.65	.7		
COST OF ELECTRICITY (MILLS/KWH)	50.6	42.2	39.0	36.2		

13-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS: 5.28	LIFE: 10
INJECTION WELLS: 1.12	LIFE: 20
PRODUCER PLANT: 7.19	LIFE: 20
GENERATING PLANT: 36.80	LIFE: 30
CAPITALIZED EXPLORATION: 3.50	LIFE: 30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.158
UTILITY: 1.233

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.171
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.368
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

** Assumed.

13-11

SITE: CASTLE CREEK, ID

DESCRIPTION AND DATA

SITE: Castle Creek, ID

SUMMARY

TEMPERATURE °C

Surface:

Subsurface: >200⁽¹⁹⁾

TOTAL DISSOLVED SOLIDS (PPM):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS):

TYPE OF OVERLAYING ROCK:

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS):

DESCRIPTION OF KGRA

Total KGRA Acres: 79,722⁽⁹⁾

Total Federal Acres:

Federal Acres Leased:

Total State and Private Acres:

State and Private Acres Leased:

GEOTHERMAL DEVELOPMENT STATUS:

One non-producing well drilled to 3,353 M (11,000 ft.).⁽¹⁹⁾

13-12

LOCAL AND STATE ATTITUDE TOWARD GEOTHERMAL DEVELOPMENTS:

LAND USE AND POPULATION:

Grazed desert shrubland and irrigated land of considerable relief. Sparse population.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

SITE: CASTLE CREEK, ID

1" = 8 mi.

SITE: Castle Creek, ID

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: REGION 3

LONGITUDE:

COUNTY: Owyhee and Elmore⁽⁶⁾

ADJACENT COUNTIES: Twin Falls, Gooding, Camas, Boise, Boise City⁽⁶⁾

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Tablelands, considerable relief. ⁽⁶⁾	Grazed desert shrubland and irrigated land. ⁽⁶⁾			

SITE: Castle Creek, ID

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface:
Subsurface: $>200^{\circ} \text{C}^{(19)}$

Geochemical

SiO₂:
Na-k-Ca:

TOTAL DISSOLVED SOLIDS (TDS):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS):

TYPE OF OVER LAYING ROCK:

ESTIMATED DEPTH TO TOP OF RESERVOIR:

SEISMIC ACTIVITY:

SITE: Castle Creek, ID

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Castle Creek		79,722			
LAND LEASED IN KGRA			20,623 ⁽¹¹⁾		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
35.6	The Anschutz Corp.				
12.47	Phillips Petroleum Co.				
8.09	Nancy P. Anschutz				
8.09	Nancy P. Anschutz		1,720		
			2,480		
			2,475		
			2,218		
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR					

SITE: Castle Creek, ID

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>3,353 M (11,000 ft.) hole drilled by Occidental. (Hole is not a production well.) (19)</p>	

SITE: Castle Creek, ID

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)

SITE: Castle Creek, ID

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 18.4 cm (7.26 inches)

Average Temperature

Minimum: -1.7°C (29.4°F) (5)

Maximum: 24.6°C (76.5°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30%

Winter: 70% (6)

13-19

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
			Saltbush, grease wood, sagebrush. (6)		

SITE: Castle Creek, ID

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Grand View	< 16 Km (10 miles)	200 ⁽⁶⁾	< 8 Km (5 miles) from secondary (100-161 Kv) transmission lines. Hydroelec- tric plant nearby on Snake River. ⁽⁶⁾	< 19 Km (12 miles) from U.S. Rte. 30. (6)	< 40 Km (25 miles) from primary rail line. ⁽⁶⁾ < 40-48 Km (25-30 miles) from major ($\geq$ 25.4 cm or 10 inches) petro- leum products pipe- line. < 16 Km (10 miles) from minor ($\leq$ 55.9 cm or 22 inch) natural gas pipeline. (6)
Mountain Home	~ 40 Km (25 miles)	50			

SITE: SODA LAKE, NV

ANALYSIS OF POSTULATED DEVELOPMENT

14-1

SITE: Soda Lake, Nevada

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BIM	Process EIA/EIS	CEQ	ASSUMED COMPLETED										
BIM	Lease Land	Developer											
BIM	Issue STG Drilling Permit	Developer											
USGS	Issue Drilling Permit	Developer											
Developer	Preliminary Geophysical Exploration												
Developer	Exploratory Drilling and Reservoir Evaluation												
Developer	Develop Utility Interest												
Developer and Utility	Feasibility Study												
Producer (Developer) and Utility	Financial Negotiations												
Producer	Site Selection												
Producer and Utility	Commitment to Development												
Producer and Utility	Design (Preliminary, Final)												
Producer and Utility	Prepare Master Development Plan	BIM, USGS											
Utility	Prepare Environmental Data Statement	BIM, FPC											
BIM, FPC	Certify Plant and Site, Issue Permits	State DEQ											
USGS	Process EIA/EIS (Drilling)	Producer and Utility											
FPC	Process EIA/EIS (Plant)	CEQ											
FPC	Process EIA/EIS (Transmission Line)	CEQ											
Producer	Development Drilling												
Utility	Plant Construction												
Utility	Install Transmission Line												

SITE: Soda Lake, NV

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Inadequate (Federal) land leased for a 50 MWe power plant.
No scheduled Federal KGRA lease sale before FY 1979.
Sufficient Federal land will be leased for a 50 MWe
power plant by the end of FY 1979
- Some recent exploratory drilling (1974)
- EIA/EIS has been prepared.

Principal Milestones:

14-3

• Start preparation for Federal KGRA
land leasing	April 1977
• Complete preliminary geophysical
exploration	January 1979
• Sufficient Federal land leased,
start exploratory drilling	July 1979
• Identify utility	July 1980
• Complete feasibility study	April 1981
• Select site, commit to development	January 1982
• Start development drilling	July 1984
• Start construction	October 1984
• On line	January 1987

SITE: Soda Lake, NV

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the Primary Technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Soda Lake, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS*	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods--optimized to identification and characterization of geothermal fields similar in type to this location	X	X	2	79			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	79			
• Data Analysis and Interpretation	X	X	3	79			
• Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location	X	X	3	79			
* Status of exploration operations at this site needs further investigation.							

SITE: Soda Lake, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING*	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to aid in determining field boundaries in this type of rock formation		X	2	80			
• Drilling Techniques**	?	?	3	80			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	80			
• Data Analysis and Interpretation	X	X	3	80			
• Resource Characterization--with regard to determining type and extent of field	X		4	80			
• Basic Understanding of the Geothermal Process--in the earth for type of field at this site	X		4	80			
<p>* Status of development at this site needs further investigation.</p> <p>** Further investigation required to obtain requirements for this site</p>							

SITE: Soda Lake, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--temperature <165°C		X	4	83			
• High Temperature, Deep-well Down-hole Pumps	X		2	84			
• Brine Injection Pumps	(ID)		2	84			
• Brine Deaerators	?	?	2	84			
• Injection Technology--for this type field	X		2	84			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	(ID)		2	84			
• Instrumentation and Control--with regard to injection process	X		2	84			
• Resource Characterization--with regard to behavior of field when produced	X	X	1	83			
• Reservoir Engineering--with regard to best way to produce field	X	X	1	83			
• Basic Understanding of Injection Process--for this type of field	X	X	2	84			
<u>Environmental</u>							
• Injection Impact Prediction Technology	X		1	83			
(ID) Insufficient Data							

* Further investigation required to obtain requirements for this site.

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SITE: Soda Lake, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperatures between 160°C-170°C	X		2	82			
• Working Fluid Selection Technique--(or Fluid Development Program)	X		2	82			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (160°C-170°C)	X	X	2	82			
• Secondary Fluid Condensers*	?	?	2	82			
• Waste-heat Handling	?	?	2	82			
<u>Supporting Technology--Binary Concepts</u>							
• Brine Chemistry*		X	3	82			
• Waste Brine Purification*		X	3	82			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		4	81			
* Further investigation required to obtain requirements for this site.							

SITE: Soda Lake, NV

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 165

DEPTH, M: 500

ROCK TYPE: Medium/
Hard

SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1985	1986	1987	1988+		
CAPACITY FACTOR ASSUMED	.5	.6	.65	.7		
COST OF ELECTRICITY (MILLS/KWH)	59.4	49.5	45.7	42.4		

14-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	7.38	LIFE:	10
INJECTION WELLS:	1.55	LIFE:	20
PRODUCER PLANT:	9.89	LIFE:	20
GENERATING PLANT:	39.05	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.254
UTILITY: 1.308

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.223
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.391
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

14-11

SITE: SODA LAKE, NV

DESCRIPTION AND DATA

SITE: Soda Lake, NV

SUMMARY

TEMPERATURE °C

Surface: 90

Subsurface: 165

TOTAL DISSOLVED SOLIDS (PPM):

Low⁽¹⁹⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 96

TYPE OF OVERLAYING ROCK:

Hard

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS):

500

DESCRIPTION OF KGRA

Total KGRA Acres: 225,211⁽⁹⁾

Total Federal Acres:

Total State and Private Acres:

Federal Acres Leased:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Several holes have been drilled.⁽¹⁹⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

LAND USE AND POPULATION:

Plains with low mountains and possible standing water in lowlands. Grazed desert shrubland and irrigated land, with rural population.

COMMENTS AND CRITICAL ISSUES:

In seismically active area.⁽⁶⁾

KEY		1974 APPLICATIONS	
	Known geothermal resources area - Showing water temperature °F		COMPETITIVE INT. + 30%
	Lands valuable prospectively for geothermal resources		1 LEASE APPLICATION
	Hot spring 178		2 LEASE APPLICATIONS
	Hot spring 98		3 LEASE APPLICATIONS
	Hot spring 129		4 OR MORE LEASE APPLICATIONS
	Location questionable		APPLICATIONS IN MORE THAN ONE MONTH
	Well 172		
	Well 178		

1" = 8 mi.

SITE: SODA LAKE, NV

SITE: Soda Lake, NV

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 39° 34' 00" N

REGION 4

LONGITUDE: 118° 49' 00" W

COUNTY: Churchill

ADJACENT COUNTIES: Lyon, Washoe, Pershing, Lander, Nye, Mineral⁽⁶⁾

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Plains with low mountains with a relief of 305-915 M (1,000-3,000 feet). Possible standing water covering 10-50% of low-lands. ⁽⁶⁾	Grazed desert shrubland and irrigated land. ⁽⁶⁾			

SITE: Soda Lake, NV

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 90°C
Subsurface: 165°C

Geochemical
SiO₂: 165°C
Na-k-Ca: 161°C

TOTAL DISSOLVED SOLIDS (TDS): Low⁽¹⁹⁾

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 96

TYPE OF OVER LAYING ROCK: Quaternary Alluvium between two centers of Quaternary Basaltic Eruptions.⁽⁸⁾

ESTIMATED DEPTH TO TOP OF RESERVOIR: 500M (1,640 feet)⁽⁸⁾

SEISMIC ACTIVITY: Area is within the tectonically active Stillwater Range and has experienced several earthquakes which have caused considerable damage (buildings shifted off foundations and ground badly cracked).⁽⁶⁾

SITE: Soda Lake, NV

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Stillwater-Soda Lake		225,211			
LAND LEASED IN KGRA			13,259		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
45.12	Phillips Petroleum Co.				
40.32	Chevron Oil Co.				
5.99	Union Oil Co.				
4.77	Phillips Petroleum Co.		2,472		
TENTATIVE LEASE SALE DATES			2,320		
1977			843		
1978			2,528		
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		1,236			

14-16

SITE: Soda Lake, NV

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>Several "good" holes have been drilled. (19)</p>	

SITE: Soda Lake, NV

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)

SITE: Soda Lake, NV

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 13.6 cm (5.34 inches)

Average Temperature

Minimum: -1.1°C (29.9°F)

Maximum: 22.5°C (72.4°F)

Relative Humidity

(Seasonal Peaks)

Summer: 20-30%

Winter: 50-60%

14-19

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
			Saltbush, grease- wood, tule marshes. (6)		

SITE: Soda Lake, NV

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Fallon	< 16 Km (10 miles)	2,734 ⁽⁶⁾	750 Kv transmis- sion line within several miles of site. ⁽⁶⁾	< 8 Km (5 miles) from U.S. Rte. 50 and U.S. Rte. 95. (6)	Primary rail < 16 Km (10 miles) from site. 15 to 20 cm (6-8 inches) petroleum products pipeline < 16 Km (10 miles) from site. ⁽⁶⁾ ≤ 56 cm (22 inches) gas line < 16 Km (10 miles) from site.

RECORD 00073

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION B

SECTION A.- GEOHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000600
 CROSS INDEX NO.. 0602001
 RECORD TYPE..... A

NAME..... E. A. JOHNSON, J. RENNER
 DATE..... 75/02
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SODA LAKE
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 39-34-00N

COUNTRY NAME..... UNITED STATES
 COUNTY..... CHURCHILL
 LONGITUDE..... 118-49-00W

TOWNSHIP..... RANGE..... SECTION..... 1/4 1/4
 ZON..... 20E..... 20

BASIC MERIDIAN..... MT. DIABLO
 AVAILABLE MAPS OF AREA: SODA LAKE 1:62,500

GENERAL DESCRIPTION

ELEVATION..... 1200.91 M 3940. FT
 RESOURCE CATEGORY..... B
 SURFACE THERMAL ACTIVITY..... FUMAROLE OR WARM VAPOR,

GEOHERMAL CHARACTERISTICS

TOTAL NATURAL HEAT FLUX..... 1.4651E+07 J/S 3.5000E+06 CAL/S
 WELL INFORMATION
 MAXIMUM WELL TEMPERATURE..... 90. C TO 1. M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 120. C TO 165. C ASSUMED
 BEST ESTIMATE..... 165.0 C
 SUBSURFACE AREA..... 2.0 KM**2 TO 10.0 KM**2
 BEST ESTIMATE..... 5.0 KM**2
 BASED ON: GEOLOGY, TEMP GRADIENT
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 500.00 M 0.500 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM
 BEST ESTIMATE..... 2500.00 M 2.500 KM
 VOLUME OF RESERVOIR..... 3.000 KM**3 TO 25.000 KM**3
 BEST ESTIMATE..... 12.500 KM**3
 COMMENTS: DEPTH TO BOTTOM OF RESERVOIR IS ASSUMED.

RESERVES

TOTAL STORED HEAT..... 7.9530E+17 J 1.8999E+17 CAL TO 9.6274E+18 J 2.2999E+18 CAL
 BEST ESTIMATE..... 4.6042E+18 J 1.0999E+18 CAL ABOVE 15. C

GEOLOGY

GENERAL ROCK TYPES: QUATERNARY ALLUVIUM BETWEEN TWO CENTERS OF QUATERNARY BASALTIC ERUPTIONS

14-21

PRIMARY REFERENCE:

AUTHOR..... D.C. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
 REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) MARIER, R.D., AND OTHERS, 1975, THE MINOR & TRACE ELEMENTS, GAS, & ISOTOPE COMPOSITIONS OF THE PRINCIPAL HOT SPRINGS OF NEVADA & OREGON: U.S.G.S. OPEN-FILE REPORT (AUGUST 1975)
- 2) OLWISTED, F.H., AND OTHERS, 1975, PRELIMINARY HYDROGEOLOGIC APPRAISAL OF SELECTED HYDROTHERMAL SYSTEMS IN NORTHERN & CENTRAL NEVADA: U.S.G.S. OPEN-FILE REPORT 75-56

RECORD 00074

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 3

SECTION 02- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000001
 CROSS INDEX NO.. 000001
 RECORD TYPE..... 1
 SAMPLE TYPE..... SURFACE

NAME..... E. A. JOHNSON, J. RENNER
 DATE..... 75/02
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. SODA LAKE
 COUNTRY CODE..... US
 STATE/PROVINCE..... NEVADA
 LATITUDE..... 39-34.00 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... CHURCHILL
 LONGITUDE..... 118-49.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 WATER SAMPLING TEMP.... 90.0 C

WATER ANALYSIS

ANALYSIS DATE..... 1974
 PH 1)..... 7.90

SOLUTE ANALYSIS (WATER)

LI	NA	K	RB	CS	NA+K			
1.4	1000.00	48.00						
MG	CA	SR	BA	CA+MG				
	82.00							
ZN	HC	B	HF02	AL	PB	AS	SB	U
		5.7						
F	CL	BR	I					
	1500.00							
NH4	NO3	PO4	SI02	SO4	CO3	HCO3		
			160.00	360.00		138.00		

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726
 MARINER AND OTHERS, 1975

14-23

RECORD 00075

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 000021 NAME..... SANFORD, LINDA J.
 CROSS INDEX NO.. MARKIP4 DATE..... 76/04
 RECORD TYPE..... E ORGANIZATION.. USGS
 SAMPLE TYPE..... WELL

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. SODA LAKE
 NAME OF SAMPLE SOURCE.. SHALLOW RESEARCH WELL (SODA LAKE)2 5
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... CHURCHILL

TOWNSHIP RANGE SECTION 1/4 1/4
 20N 26E 32 NE

MAP REFERENCE: SODA LAKE, NEV. (15°); RENO, NEV. (12 DEG.)

SAMPLE INFORMATION

COLLECTION DATE..... 1972
 COLLECTOR(S)..... BARNES GROUP
 WATER TREATMENT DATA: PRESSURE-FILTERED THROUGH A .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED.

WATER ANALYSIS

W

ANALYSIS DATE..... 1972-74
 ANALYST(S)..... BARNES GROUP

ISOTOPIIC DATA

DEL O(18) OF WATER..... -14.56 0/00
 DEL D OF WATER..... -111.3 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
			LT .02	LT .1				
BR+3	BR(TOT)	FE+3	FE(TOT)	CU				
	LT .02		LT .02	LT .01				
ZN	BG	E	BR02	AL	PB	AS	SB	U
	LT .0001			.003				
NO4	NO3	PO4	SIO2	SO4	CO3	HCO3		
.39								

REFERENCES: MAKINER, PRESSER, RAPP, WILLEY, THE MINOR AND TRACE ELEMENTS GAS, AND ISOTOPE COMPOSITIONS OF THE PRINCIPAL HOT SPRINGS OF NEVADA AND OREGON.

RECORD 00076

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION D.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000822
 CROSS INDEX NO.. NARP1P4
 RECORD TYPE..... L
 SAMPLE TYPE..... WELL

NAME..... SANFORD, LINDA J.
 DATE..... 76/04
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. SODA LAKE
 NAME OF SAMPLE SOURCE.. SHALLOW RESEARCH WELL (SODA LAKE), 4
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... CHURCHILL
 LATITUDE..... 39-33.8 N LONGITUDE..... 118-51.2 W

TOWNSHIP RANGE SECTION 1/4 1/4
 20N 28E 28 SW

MAP REFERENCE: SODA LAKE, NEV. (15'); RENO, NEV. (2 DEG.)

SAMPLE INFORMATION

SAMPLE NO..... ID 4
 COLLECTION DATE..... 1972
 COLLECTOR(S)..... BARNES GROUP
 POINT OF COLLECTION..... NEAR ORIFICE OF WELL
 WATER SAMPLING TEMP.....

WATER TREATMENT DATA: PRESSURE-FILTERED THROUGH A .45 MICROMETRE MEMBRANE, PORTION ACIDIFIED, DILUTED

WATER ANALYSIS

W

ANALYSIS DATE..... 1972-74
 ANALYST(S)..... BARNES GROUP

ISOTOPIC DATA

DEL D(18) OF WATER..... -13.46 0/00
 DEL D OF WATER..... -109.3 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K
			.27	.2	
MG	CA	SR	BA	CA+MG	
		LI .05			
MG+3	MG(TOT)	FE+3	FE(TOT)	CU	
	.07		.05	.01	
ZN	NO	B	HEC2	AL	PB AS SB U
	.0003			.003	
MG4	NO3	PO4	SIO2	SO4	CO3 HCO3
2.06					

REFERENCES: MARINER, PEISSER, RAPP, WILLEY, THE MINOR AND TRACE ELEMENT, GAS, AND ISOTOPE COMPOSITIONS OF THE

14-25

PRINCIPAL HOT SPRINGS OF NEVADA AND OREGON.

14-26

SITE: EAST MESA, CA
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: East Mesa, CA (Federal Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
County Government	Issue Land Use Permit	Developer	} ASSUMED COMPLETED										
BIM	Issue STC Drilling Permit	Developer											
USGS	Issue Drilling Permit	Developer											
BIM	Lease Land	Developer											
Developer	Preliminary Geophysical Exploration												
BIM	Process EIA/EIS	CEQ											
Developer	Exploratory Drilling and Reservoir Evaluation												
Developer	Develop Utility Interest												
Developer and Utility	Feasibility Study												
Producer	Financial Negotiations												
(Developer and Utility)													
Producer	Site Selection												
Producer and Utility	Commitment to Development												
Producer and Utility	Design (Preliminary, Final)												
Producer and Utility	Prepare Master Development Plan	BIM, USGS											
Utility	Prepare Environmental Data Statement	BIM, FPC, CPUC, CERCDC											
County Government													
BIM, FPC, CPUC, CERCDC	Certify Plant and Site, Issue Permits	Producer and Utility											
USGS	Process EIA/EIS (Drilling)	CEQ											
FPC	Process EIA/EIS (Drilling)	CEQ											
FPC	Process EIA/EIS (Transmission Line)	CEQ											
Producer	Development Drilling												
Utility	Plant Construction												
Utility	Install Transmission Line												

SITE: East Mesa, CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal) land is leased for a 50 MWe plant.
- Development activity is going on.

Principal Milestones:

• Identify utility	April 1978
• Complete feasibility study	January 1979
• Select site, commit to development	October 1979
• Start development drilling	January 1982
• Start construction	April 1982
• On line	July 1984

SITE: East Mesa, CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

The timing information for the East Mesa site is based on the schedule for this site as shown. It is recognized that development at this site may be accelerated by virtue of the installation and operation of the Geothermal Component Test Facility.

SITE: East Mesa, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--sedimentary rock, temperature <180°C		X	4	82			
• High Temperature, Deep-well Down-hole Pumps	X		2	83			
• Brine Injection Pumps--brines with TDS- 2500 PPM	?	X	2	83			
• Brine Deaerators	?	X	2	83			
• Injection Technology--sedimentary rocks	X		2	83			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	X		2	83			
• Instrumentation and Control--with regard to injection process	X		2	83			
• Resource Characterization--with regard to behavior of field when produced	X	X	1	82			
• Reservoir Engineering--with regard to best way to produce field	X	X	1	82			
• Basic Understanding of Injection Process-- for this type of field	X	X	2	83			
<u>Environmental</u>							
• Injection Impact Prediction Technology--with regard to	X		1	83			
- aquifer contamination							
- triggering seismic events							
• Subsidence Prediction Technology	X		1	83			

SITE: East Mesa, CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperatures between 170°C-180°C	X		2	81			
• Working Fluid Selection Technique--(or Fluid Development Program)	X		2	81			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (170°C-180°C	X	X	2	81			
• Secondary Fluid Condensers--to operate where cooling water is scarce	X	X	2	81			
• Waste-heat Handling--arid semi-desert, water scarce area	X	X	2	81			
<u>Supporting Technology--Binary Concepts</u>							
• Brine Chemistry--scale control in process equipment		X	3	81			
• Waste Brine Purification--for this type field	?	X	3	81			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		4	80			

SITE: East Mesa, CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 180

DEPTH, M: 1000

ROCK TYPE: Soft

SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1985	1986	1987	1988+		
CAPACITY FACTOR ASSUMED	.5	.6	.65	.7		
COST OF ELECTRICITY (MILLS/KWH)	50.4	42.0	38.8	36.0		

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	3.77	LIFE:	10
INJECTION WELLS:	.79	LIFE:	20
PRODUCER PLANT:	8.11	LIFE:	20
GENERATING PLANT:	37.8	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.051
UTILITY: 1.273

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.162
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.378
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

15-9

SITE: EAST MESA, CA

DESCRIPTION AND DATA

SITE: East Mesa, CA

SUMMARY

TEMPERATURE °C

Surface:

Subsurface: 180

TOTAL DISSOLVED SOLIDS (PPM): 2500

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 487⁽¹⁾

TYPE OF OVERLAYING ROCK: Soft

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres: 38,365⁽⁹⁾

Total Federal Acres: 32,725⁽¹⁾ (Bu.Rec.)

Federal Acres Leased: 11,770⁽¹⁵⁾

Total State and Private Acres: 4,840⁽¹⁾

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

Nine wells have been drilled.⁽¹⁷⁾ U.S. Bureau of Reclamation is operating a multiple flashed-steam water desalination plant.⁽¹⁾ One application to construct a 10 MWe plant has been filed recently and a separate request to construct a 35 MWe plant (under an ERDA grant) is being prepared.⁽¹⁴⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Numerous state and local regulations.^(1A)

LAND USE AND POPULATION:

Flat irrigated land and desert shrubland. Rural area near population centers.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

Natural water shortage exists in area.

15-11

SITE: EAST MESA, CA

SITE: East Mesa, CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 32° 47' 00" N

REGION 1

LONGITUDE: 115° 15' 00" W

COUNTY: Imperial

ADJACENT COUNTIES: San Diego, Riverside, Yuma AZ, Mexico

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Flat. (6)	Irrigated land and desert shrubland mostly ungrazed. (6)			

SITE: East Mesa, CA

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface:
Subsurface: 180°C⁽⁷⁾

Geochemical
SiO₂:
Na-k-Ca:

TOTAL DISSOLVED SOLIDS (TDS): 2500 PPM

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 487⁽¹⁾

TYPE OF OVER LAYING ROCK: Deltaic river sediments (soft).

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY:

SITE: East Mesa, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: East Mesa		38,365	32,725 ⁽¹⁾ (Bu Rec)	4,840 ⁽¹⁾ (State & Private)	
LAND LEASED IN KGRA			11,770		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
169.80	Republic Geothermal				
130.91	Republic Geothermal & City of Burbank				
3.27	Republic Geothermal				
2.25	Magma Power Co.				
TENTATIVE LEASE SALE DATES					
1977					
1978	9/21 USFS & BLM ⁽¹⁴⁾				
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 8			18,399		
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE): 0					
SUBSURFACE AREA OF RESERVOIR		6,919			

15-14

GEOTHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>U.S. Bureau of Reclamation is operating a multiple flashed-steam water desalination pilot plant to investigate the potential of using geothermal waters as a source of fresh water for the Colorado River. Two desalting plants, a multistage flash distillation unit, and a vertical tube evaporator distillation unit are being used. Each unit is designed to produce 151,416-378,541 liters (20,000-50,000 gallons) of distilled water per day.⁽¹⁾</p> <p>The City of Burbank exploratory drilling of 1975 failed to produce water hot enough for electric power.⁽¹⁾</p> <p>Five deep test wells more than 1,800 meters (5,500 feet) in depth were completed by August 1975. Included were 3 wells drilled by Republic Geothermal on their Federal leases (with reservoir evaluation expected to continue beyond 1975).⁽¹⁾</p> <p>As of February 1977, a total of 9 wells were drilled.⁽¹⁷⁾</p>	<p>As of August 1975, an ERDA field test facility to evaluate development components was planned for the Bureau of Reclamation East Mesa site.⁽¹⁾</p> <p>Magma Power Co. has applied for a permit to construct a 10 MWe geothermal power plant for research and development at East Mesa on Federal land. Republic Geothermal Corp. is preparing a request to construct a 35 MWe plant, under an ERDA grant.⁽¹⁴⁾</p>

SITE: East Mesa, CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)

15-16

SITE: East Mesa, CA

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 20.3 cm (< 8 inches)⁽⁶⁾

Average Temperature

Minimum: 10.0 to 15.6°C (50-60°F)

Maximum: 32.2 to 37.8°C (90-100°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30%

Winter: 40-50%

15-17

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	Available water used primarily for irrigation. ⁽⁶⁾		Creosote, bush- bur sage. ⁽⁶⁾		

SITE: East Mesa, CA

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Holtville	11 Km (7 miles)	3,686 ⁽⁶⁾	Secondary (<161Kv) lines at or near site.	Interstate 8, 8 Km (5 miles) from site. ⁽⁶⁾	None. ⁽⁶⁾
El Centro	26 Km (16 miles)	19,280			
Heber	26 Km (16 miles)	800			

RECORD 00008

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION E

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000300
 CROSS INDEX NO.. 000501
 RECORD TYPE..... A

NAME..... J. RENNER, J. P. CALZIA
 DATE..... 74/12
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. EAST MESA
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 32-47-00N

COUNTRY NAME..... UNITED STATES
 COUNTY..... IMPERIAL
 LONGITUDE..... 115-15-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 16S 17E 6 SE

BASE & MERIDIAN..... SAN BERNARDINO
 AVAILABLE MAPS OF AREA: HOLTVILLE EAST, 124000

GENERAL DESCRIPTION

ELEVATION..... 7.62 M 25. FT
 RESOURCE CATEGORY..... B
 PRESENT USE & DEVELOPMENTS: 5 DEEP WELLS 1500 TO 2450M
 SURFACE THERMAL ACTIVITY..... NO VISIBLE MANIFESTATION, FOUND BY HEAT FLOW ANOMALY, FOUND BY RESISOMALY, FOUND BY DRILLING

GEOTHERMAL CHARACTERISTICS

WELL INFORMATION

MAXIMUM WELL TEMPERATURE..... 200. C TO 2450. M
 BOTTOM-HOLE TEMPERATURE..... 200.0 C TO 2450.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 150. C TO 225. C ASSUMED
 BEST ESTIMATE..... 180.0 C
 SUBSURFACE AREA..... 5.0 KM**2 TO 56.0 KM**2
 BEST ESTIMATE..... 28.0 KM**2
 BASED ON: 8 F/100 FT. GRAD. BUR REC. 1972
 DEPTH TO TOP OF RESERVOIR..... 700.00 M 0.700 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 1000.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 2000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2300.00 M 2.300 KM
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR..... 7.500 KM**3 TO 128.000 KM**3
 BEST ESTIMATE..... 56.000 KM**3

COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 2.5116E+18 J 5.9999E+17 CAL TO 6.7390E+19 J 1.6099E+19 CAL
 BEST ESTIMATE..... 2.3023E+19 J 5.4999E+18 CAL ABOVE 15. C

GEOLOGY

15-19

GENERAL ROCK TYPES: COLORADO RIVER DELTIC DEPOSITS

GEOPHYSICS

GRAVITY SURVEY INFORMATION: TEST MADE

SEISMIC SURVEY INFORMATION: SEISMIC NOISE, MICROEARTHQUAKES

ELECTRICAL RESISTIVITY: DC RESISTIVITY TEST MADE

OTHER GEOPHYSICAL INFORMATION: HEAT FLOW, TEMPERATURE GRADIENT

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS

DATE..... 1975

TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975

REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) DUTCHER, L.C. AND OTHERS, 1972, PRELIMINARY APPRAISAL OF GROUND WATER IN STORAGE WITH REFERENCE TO GEOTHERMAL RESOURCES IN THE IMPERIAL VALLEY AREA, CALIFORNIA: U.S.G.S. CIRC. 649, 57 P.
- 2) U.S. BUREAU OF RECLAMATION, 1972, GEOTHERMAL RESOURCE INVESTIGATION, IMPERIAL VALLEY, CALIFORNIA DEVELOPMENTAL CONCEPTS: U.S. DEPT. INT. BUR. RECLAMATION, 58P.
- 3) U.S. BUREAU OF RECLAMATION, 1973, GEOTHERMAL RESOURCE INVESTIGATIONS, IMPERIAL VALLEY, CALIF., SPECIAL REPORT, TEST WELL MESA 6-1: U.S. DEPT. INT., BUR. RECLAMATION

16-1

SITE: MICKEY H.S., OR
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Mickey H.S., Oregon (Federal Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BIM/USFS BIM/USFS	Process EIA/EIS Lease Land	CEQ Developer	} ASSUMED COMPLETED										
BIM/USFS USGS Developer	Issue STG Drilling Permit Issue Drilling Permit Preliminary Geophysical Exploration	Developer Developer	—	—									
Developer	Exploratory Drilling and Reservoir Evaluation				—	—							
Developer Developer Developer and Utility	Develop Utility Interest Feasibility Study				—	—							
Producer (Developer) and Utility	Financial Negotiations					—	—						
Producer Producer and Utility	Site Selection Commitment to Development						Δ						
Producer and Utility	Design (Preliminary, Final)						—	—					
Producer and Utility	Prepare Master Development Plan	BIM/USFS, USGS					—	—					
Utility	Prepare Environmental Data Statement	BIM/USFS, FPC					—	—					
BIM, FPC	Certify Plant and Site, Issue Permits	Producer, Utility						—	—				
USGS FPC FPC	Process EIA/EIS (Drilling) Process EIA/EIS (Plant) Process EIA/EIS (Transmission Line)	CEQ CEQ CEQ						— — —	— — —				
Producer Utility Utility	Development Drilling Plant Construction Install Transmission Line									— — —	— — —		

SITE: Mickey H.S., OR

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Extensive (Federal) leasing--may be sufficient to develop two 50 MWe power plants.
- No development yet. Development will be slowed by lack of developed infrastructure.

Principal Milestones:

- Issue drilling permit, start exploratory drilling January 1979
- Identify utility January 1980
- Complete feasibility study October 1980
- Select site, commit to development July 1981
- Start development drilling July 1985
- Start construction October 1985
- On line January 1988

SITE; Mickey H.S., OR

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Mickey H.S., OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS*	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
<ul style="list-style-type: none"> Improved Geophysical Exploration Methods--optimized to identification and characterization of geothermal fields in basaltic and volcanic rock 	X	X	2	78			
<u>Supporting Technology</u>							
<ul style="list-style-type: none"> Data Gathering and Processing 		X	2	78			
<ul style="list-style-type: none"> Data Analysis and Interpretation 	X	X	3	78			
<ul style="list-style-type: none"> Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location 	X	X	3	78			
<p>* Status of exploration operations at this site needs further investigation.</p>							

SITE: Mickey H.S., OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods-- to aid in determining field boundaries in this type of rock formation Drilling Techniques--(basaltic rocks) <u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Resource Characterization--with regard to determining type and extent of field Basic Understanding of the Geothermal Process--in the earth for this type of field 		X	2	79			
		X	3	79			
		X	2	79			
	X	X	3	79			
	X		4	79			
	X		4	79			

SITE: Mickey H.S., OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--(med-hard rock)		X	4	82			
• Brine Injection Pumps			(1D)	(1D)			
<u>Supporting Technology</u>							
• Resource Characterization--with regard to behavior of this field when produced	X	X	2	82			
• Reservoir Engineering--to define best way to produce this field	X	X	2	82			
• Basic Understanding of Injection Process-- for this type of field	X	X	1	83			
• Brine Chemistry			(1D)	(1D)			
(1D) Insufficient Data							

SITE: Mickey H.S., OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u> <ul style="list-style-type: none"> • Steam Separators • Waste Heat Handling 			(ID)	(ID)			
<u>Supporting Technology</u> <ul style="list-style-type: none"> • Brine Chemistry • Spent Brine Purification Processes 			(ID)	(ID)			
<u>Environmental</u> <ul style="list-style-type: none"> • Non-condensable Gas Control/Disposal 			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Mickey H.S., OR

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 210

DEPTH, M: 1000**

ROCK TYPE: Medium** SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1986	1987	1988	1989+		
CAPACITY FACTOR ASSUMED	.4	.47	.54	.60		
COST OF ELECTRICITY (MILLS/KWH)	47.4	40.3	35.1	31.6		

6-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	3.77	LIFE:	10
INJECTION WELLS:	.88	LIFE:	20
PRODUCER PLANT:	7.65	LIFE:	20
GENERATING PLANT:	27.8	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .232
UTILITY: .757

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	9
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.158
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.278
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

** Assumed.

16-11

SITE: MICKEY H.S., OR

DESCRIPTION AND DATA

SITE: Mickey H.S., OR

SUMMARY

TEMPERATURE °C

Surface: 73

Subsurface: 210

TOTAL DISSOLVED SOLIDS (PPM):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 157⁽⁷⁾

TYPE OF OVERLAYING ROCK:

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS):

DESCRIPTION OF KGRA

Total KGRA Acres:

Total Federal Acres:

Federal Acres Leased:

Total State and Private Acres:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

No known development.

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

LAND USE AND POPULATION:

Unpopulated area, plains with high mountains, may be some grazing.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

Remote with no transportation or utilities nearby.⁽⁶⁾ Same KGRA as Hot Lake, OR.

1" = 8 mi.

SITE: MICKEY H.S., OR

SITE: Mickey H.S., OR

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 42° 40' 30" N

REGION 3

LONGITUDE: 118° 20' 42" W

COUNTY: Harney

ADJACENT COUNTIES: Malheur, Grant, Crook, Lake, Humboldt, NV

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Plains with high mountains.(6)	Desert shrubland with some grazing. (6)			

SITE: Mickey H.S., OR

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 73°C⁽⁷⁾
Subsurface: 210°C⁽⁷⁾

Geochemical

SiO₂: 180°C
Na-k-Ca: 207°C

TOTAL DISSOLVED SOLIDS (TDS):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 152⁽⁷⁾

TYPE OF OVER LAYING ROCK:

ESTIMATED DEPTH TO TOP OF RESERVOIR:

SEISMIC ACTIVITY:

SITE: Mickey H.S., OR

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Alvord		176,835			
LAND LEASED IN KGRA			13,921		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
17.90	Chevron Oil Co.				
10.56	Republic Geothermal				
7.17	Al-Aquitaine Exploration				
6.03	Mapco		2,016		
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		1,483			

16-16

SITE: Mickey H.S., OR

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>No known development.</p>	

SITE: Mickey H.S., OR

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)

16-18

SITE: Mickey H.S., OR

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 20.3 - 40.6 cm (8 - 16 inches)

Average Temperature

Minimum: -12.2 to -6.7°C (10-20°F)

Maximum: 26.7 to 32.2°C (80-90°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30-40%

Winter: 70-80%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	In area of consolidated volcanic rock (chiefly basalt) aquifer, adjacent to sand and gravel unconsolidated aquifer. Malheur Lake 80 Km (50 miles) north of site, where there is some irrigation. Alvord Lake 40 Km (25 miles) south of site.(6)		Saltbrush, grease wood.(6)		

SITE: Mickey H.S., OR
POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Frenchglen	52 Km (32 miles)	20 ⁽⁶⁾	> 8 Km (5 miles) to 750 Kv DC lines. No other primary or secondary (< 161 Kv) lines in area. ⁽⁶⁾	Interstate 95, 40 Km (25 miles) from site. State Highway 78, 40 Km (25 miles) from site. ⁽⁶⁾	None.
Princeton	64 Km (40 miles)	10 ⁽⁶⁾			

SITE: MORGAN SPRINGS, CA
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Morgan Springs, CA

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM/USFS	Process EIS	CEQ	—	—	—								
BLM/USFS/ Owner	Lease Land	Developer	—	—	—								
County	Issue Land Use Permit	Developer			—								
Government					—								
BLM	Issue STC Drilling Permit	Developer			—								
USGS/DOG	Issue Drilling Permit	Developer			—								
SLC/Owner	Issue Prospective/Exploration Permits	Developer			—								
Developer	Preliminary Geophysical Exploration				—								
Developer	Exploratory Drilling and Reservoir Evaluation					—	—	—					
Developer	Develop Utility Interest						—	—					
Developer and Utility	Feasibility Study						—	—					
Producer (Developer) and Utility	Financial Negotiations							—					
Producer	Site Selection							—					
Producer and Utility	Commitment to Development							—					
Producer and Utility	Design (Preliminary, Final)							—					
Producer and Utility	Prepare Master Development Plan	BLM, USGS						—					
Utility	Prepare Environmental Data Statement	BLM, FPC, CPUC, CERCDC						—					
		County Government						—					
BLM, RPC, CPUC, CERCDC	Certify Plant and Site, Issue Permits	Producer and Utility						—					
USGS	Process EIS (Drilling)	CEQ						—					
FPC/CPUC	Process EIS (Plant)	CEQ						—					
FPC/CPUC	Process EIS (Transmission Line)	CEQ						—					
Producer	Development Drilling									—	—	—	—
Utility	Plant Construction									—	—	—	—
Utility	Install Transmission Line									—	—	—	—

SITE: Morgan Springs, CA

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- No known leasing
- No development activity. Opposition to development is expected. Reservoir may be connected with Mt. Lassen National Forest.
- EIS will be required

Principal Milestones:

• Start processing EIS	April 1977
• Complete EIS, lease land	October 1979
• Issue drilling permits, start exploratory drilling	October 1980
• Identify utility	October 1981
• Complete feasibility study	July 1982
• Select site, commit to development	April 1983
• Start development drilling	July 1985
• Start construction	October 1985
• On line	January 1987

SITE: Morgan Springs, CA

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Direct Flash Concepts
- Supporting Technology--Direct Flash Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the primary technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Morgan H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS*	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods--optimized for identification and characterization of geothermal fields in volcanic rock. 	X	X	2	78			
<u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing 		X	2	78			
<ul style="list-style-type: none"> Data Analysis and Interpretation 	X	X	3	78			
<ul style="list-style-type: none"> Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location 	X	X	3	78			
* Status of Exploration Operations at this site needs further investigation.							

SITE: Morgan H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods--to aid in determining field boundaries in this type of rock formation Drilling Techniques--(volcanic rocks) <u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Resource Characterization--with regard to determining type and extent of field Basic Understanding of the Geothermal Process--in the earth for this type of field 		X	2	79			
		X	3	79			
		X	2	79			
	X	X	3	79			
	X		4	79			
	X		4	79			

SITE: Morgan H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> • Drilling Techniques--(volcanic rock) • Brine Injection Pumps 		X	4 (1D)	82 (1D)			
<u>Supporting Technology</u> <ul style="list-style-type: none"> • Resource Characterization--with regard to behavior of this field when produced • Reservoir Engineering--to define best way to produce this field • Basic Understanding of Injection Process--for this type of field • Brine Chemistry 	X	X	2	82			
	X	X	2	82			
	X	X	1 (1D)	83 (1D)			
(1D) Insufficient Data							

SITE: Morgan H.S., CA

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Direct Flash Concepts</u>			(ID)	(ID)			
• Steam Separators			(ID)	(ID)			
• Waste Heat Handling							
<u>Supporting Technology</u>							
• Brine Chemistry			(ID)	(ID)			
• Spent Brine Purification Processes			(ID)	(ID)			
<u>Environmental</u>							
• Non-condensable Gas Control/Disposal			(ID)	(ID)			
(ID) Insufficient Data							

SITE: Morgan Springs, CA

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 210

DEPTH, M: 1000

ROCK TYPE: Medium

SYSTEM SIZE, MW: 50

TYPE: Flash

YEAR	1986	1987	1988	1989+		
CAPACITY FACTOR ASSUMED	.4	.47	.54	.60		
COST OF ELECTRICITY (MILLS/KWH)	47.4	40.3	35.1	31.6		

17-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	3.77	LIFE:	10
INJECTION WELLS:	.88	LIFE:	20
PRODUCER PLANT:	7.65	LIFE:	20
GENERATING PLANT:	27.8	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: .232
UTILITY: .757

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.158
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.278
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

* 1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

17-11

SITE: MORGAN SPRINGS, CA

DESCRIPTION AND DATA

SITE: Morgan Springs, CA

SUMMARY

TEMPERATURE °C

Surface: 95

Subsurface: 210

TOTAL DISSOLVED SOLIDS (PPM):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 132⁽⁷⁾

TYPE OF OVERLAYING ROCK:

Medium

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres:

Total Federal Acres:

Federal Acres Leased:

Total State and Private Acres:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Opposition may occur due to scenic quality of land.

LAND USE AND POPULATION:

Sparsely populated; Federal land adjacent to National Forest. Forest and woodland.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

High scenic value. Concern that reservoir continues into the National Park.

SITE: MORGAN SPRINGS, CA

SITE: Morgan Springs, CA

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 40° 23' 00" N

REGION 1

LONGITUDE: 121° 31' 00" W (8)

COUNTY: Tehama⁽⁸⁾

ADJACENT COUNTIES: Mendocino, Trinity, Shasta, Plumas, Butte, Glenn⁽⁶⁾

LAND OWNERSHIP: Federal--National Forest⁽⁶⁾

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Low and high mountains with more than 75% of gentle slope. ⁽⁶⁾	Forest and woodland, grazed. ⁽⁶⁾		High scenic value. (Next to Lassen National Park). ⁽⁶⁾	

SITE: Morgan Springs, CA

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 95°C
Subsurface: 210°C

Geochemical

SiO₂: 190°C
Na-k-Ca: 229°C

TOTAL DISSOLVED SOLIDS (TDS):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 132⁽⁷⁾

TYPE OF OVER LAYING ROCK: Quaternary volcanic rock, mostly dacites and andesites

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY:

SITE: Morgan Springs, CA

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Lassen		78,641			
LAND LEASED IN KGRA			None		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979 May (USFS & GLM) ⁽¹⁴⁾					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: -----					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		1,236			

SITE: Morgan Springs, CA
GEOTHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT

17-17

SITE: Morgan Springs, CA

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
Public opposition may occur due to scenic quality of the land.		

SITE: Morgan Springs, CA

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 130.8 cm (51.5 inches)

Average Temperature

Minimum: -1.1°C (30°F) (5)

Maximum: 17.2°C (63°F)

Relative Humidity
(Seasonal Peaks)

Summer: 40-50%

Winter: 60-70% (6)

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
			Mixed conifer forest. (6)		

SITE: Morgan Springs, CA

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Mineral ⁽⁶⁾	8-16 Km (5-10 miles)	125 ⁽⁶⁾	16-24 Km (10-15 miles) to primary transmission lines. (6)	State Highway No. 36 ~ 3 Km (2 miles) (6)	Approximately 48 Km (30 miles) to major 61 cm (24") gas pipeline. 80 Km (50 miles) to minor 20-25 cm (8"-10") crude oil and prod- ucts pipeline. 40-48 Km (25-30 miles) from primary railroad. ⁽⁶⁾

RECORD 00022

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000278 NAME..... D. E. WHITE
 CROSS INDEX NO.. LF00391 DATE..... 75/03
 RECORD TYPE..... A ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. MORGAN SPRINGS
 WARING FIGURE..... 8 WARING NUMBER..... 33
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... CALIFORNIA COUNTY..... TEHAMA
 LATITUDE..... 40-23-00N LONGITUDE..... 121-31-00W

TOWNSHIP RANGE SECTION 1/4 1/4
 29N 04E 11

BASE & MERIDIAN..... MT. DIABLO
 AVAILABLE MAPS OF AREA: LASSEN VOLC. NAT. PARK SPECIAL 1:62,500

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 3.0 KM**2
 ELEVATION..... 1554.48 M 5100. FT
 RESOURCE CATEGORY..... b
 SURFACE THERMAL ACTIVITY..... HOT SPRINGS, GEYSERS
 ASSOCIATED DEPOSITS..... SINTER
 NO. OF HOT SPRINGS..... 25

GEOTHERMAL CHARACTERISTICS

NATURAL SURFACE DISCHARGE..... 5.83 L/S 3.5000E+02 L/MIN ESTIMATED
 SPRING TEMPERATURES..... TO 95. C
 SPRING DESCRIPTION..... WARM

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 180. C TO 220. C ASSUMED
 BEST ESTIMATE..... 210.0 C
 SUBSURFACE AREA..... 2.0 KM**2 TO 50.0 KM**2
 BEST ESTIMATE..... 5.0 KM**2
 BASED ON: SURFACE ACTIVITY, MAY BE MUCH LARGER
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 1000.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR..... 3.000 KM**3 TO 125.000 KM**3
 BEST ESTIMATE..... 10.000 KM**3

COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 1.2558E+18 J 2.9999E+17 CAL TO 6.4460E+19 J 1.5399E+19 CAL
 BEST ESTIMATE..... 5.0228E+18 J 1.1999E+18 CAL ABOVE 15. C

17-21

GEOLOGY

GENERAL ROCK TYPES: QUATERNARY VOLCANIC ROCKS, MOSTLY DACITES, ANDESITES

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
DATE..... 1975
TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) WARING, G.A., 1965, VIOLENT MUD-VOLCANO ERUPTION OF LAKE CITY HOT SPRINGS, NORTHEASTERN CALIFORNIA: GEOL. SOC. AMERICA BULL., V-66, NO-9, P.1109-1130
- 2) D.E. WHITE, UNPUBLISHED DATA

RECORD 00023

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION F

SECTION F.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000279
 CROSS INDEX NO.. 0100391
 RECORD TYPE..... F
 SAMPLE TYPE..... SURFACE

NAME..... D. E. WHITE
 DATE..... 75/03
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. MORGAN SPRINGS
 COUNTRY CODE..... US
 STATE/PROVINCE..... CALIFORNIA
 LATITUDE..... 40-23.00 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... TEHAMA
 LONGITUDE..... 121-31.00 W

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 WATER FLOW RATE..... 1.59 L/S 95.4 L/MIN

WATER ANALYSIS

PH 11..... 30.00

SOLUTE ANALYSIS (WATER)

LI NA K RE CS NA+K
 1398.00 196.00

MG CA SR BA CA+MG
 79.00

F CL ER I
 2430.00

NH4 H03 P04 S102 S04 CO3 HCO3
 233.00 79.00 52.00

REFERENCES: WHITE & OTHERS, ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S. - 1975, U.S.G.S. CIRCULAR 726
 WHITE, UNPUBLISHED DATA

17-23

SITE: SULPHUR H.S., NV
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Sulphur H.S., Nevada

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM BLM	Process EIA/EIS Lease Land	CEQ Developer	} ASSUMED COMPLETED										
BLM	Issue STG Drilling Permit	Developer	---										
USGS	Issue Drilling Permit	Developer		---									
Developer	Preliminary Geophysical Exploration			---									
Developer	Exploratory Drilling and Reservoir Evaluation			---									
Developer	Develop Utility Interest			---									
Developer and Utility Producer (Developer) and Utility Producer	Feasibility Study				---								
Producer	Financial Negotiations					---							
Producer and Utility	Site Selection					---							
Producer and Utility	Commitment to Development						Δ						
Producer and Utility	Design (Preliminary, Final)						---	---					
Producer and Utility	Prepare Master Development Plan	BLM, USGS					---						
Utility	Prepare Environmental Data Statement	BLM, FPC, State DEQ					---						
BLM, FPC	Certify Plant and Site, Issue Permits	Producer & Utility						---					
USGS	Process EIA/EIS (Drilling)	CEQ						---					
FPC	Process EIA/EIS (Plant)	CEQ						---					
FPC	Process EIA/EIS (Transmission Line)	CEQ						---					
Producer Utility Utility	Development Drilling								---				
	Plant Construction									---			
	Install Transmission Line										---		

SITE: Sulphur Springs, NV

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- One (Federal) lease of 3,059 acres may be adequate for a 50 MWe plant.
- No known development.

Principal Milestones:

• Issue drilling permit, start exploratory drilling	April 1978
• Identify utility	April 1979
• Complete feasibility study	January 1980
• Select site, commit to development	October 1980
• Start development drilling	January 1983
• Start construction	April 1983
• On line	July 1985

SITE: Sulphur Springs, NV

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the Primary Technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Sulphur Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS *	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- optimized to identification and character- ization of geothermal fields in granitic rock	X	X	2	78			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	78			
• Data Analysis and Interpretation	X	X	3	78			
• Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location	X	X	3	78			
* Status of exploration operations at this site needs further investigation.							

SITE: Sulphur Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to aid in determining field boundaries in this type of rock formation		X	2	79			
• Drilling Techniques--(granitic rocks)		X	3	79			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	79			
• Data Analysis and Interpretation	X	X	3	79			
• Resource Characterization--with regard to determining type and extent of field	X		4	79			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	79			

SITE: Sulphur Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--granitic rock, temperature <190°C		X	4	82			
• High Temperature, Deep-well, Down-hole Pumps	X		2	83			
• Brine Injection Pumps	(ID)		2	83			
• Brine Deaerators	?	?	2	83			
• Injection Technology--granitic rocks	X		2	83			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	?		2	83			
• Instrumentation and Control--with regard to Injection process	X		2	83			
• Resource Characterization--with regard to behavior of field when produced	X	X	1	82			
• Reservoir Engineering--with regard to best way to produce field	X	X	1	82			
• Basic Understanding of Injection Process--for this type of field	X	X	2	83			
<u>Environmental</u>							
• Injection Impact Prediction Technology							
(ID) Insufficient Data							
* Further investigation required to obtain requirements for this site.							

SITE: Sulphur Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperatures between 190°C-200°C	X		2	81			
• Working Fluid Selection Technique--(or fluid Development Program)	X		2	81			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (190°C-200°C)	X	X	2	81			
• Secondary Fluid Condensers*	X	X	2	81			
• Waste-heat Handling	X	X	2	81			
<u>Supporting Technology-Binary Concepts</u>							
• Brine Chemistry*		X	3	81			
• Waste Brine Purification--for this type field*		X	3	81			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		4	80			
<p>* Further investigation required to obtain requirements for this site.</p>							

SITE: Sulphur H.S., NV

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 190

DEPTH, M: 500

ROCK TYPE: Hard

SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1986	1987	1988	1989+		
CAPACITY FACTOR ASSUMED	.5	.6	.65	.7		
COST OF ELECTRICITY (MILLS/KWH)	53.1	44.2	40.8	37.9		

18-9

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS: 6.03	LIFE: 10
INJECTION WELLS: .94	LIFE: 20
PRODUCER PLANT: 7.99	LIFE: 20
GENERATING PLANT: 37.2	LIFE: 30
CAPITALIZED EXPLORATION: 3.5	LIFE: 30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.056
UTILITY: 1.248

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.185
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.372
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

18-11

SITE: SULPHUR H.S., NV

DESCRIPTION AND DATA

SITE: Sulphur H.S., NV

SUMMARY

TEMPERATURE °C

Surface: 93

Subsurface: 190

TOTAL DISSOLVED SOLIDS (PPM):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 96⁽⁷⁾

TYPE OF OVERLAYING ROCK:

Hard

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS):

500

DESCRIPTION OF KGRA

Total KGRA Acres:

Total Federal Acres:

Federal Acres Leased:

Total State and Private Acres:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

LAND USE AND POPULATION:

Mountainous area, no close population centers other than Indian Reserves. Adjacent to National Forest.⁽⁶⁾

COMMENTS AND CRITICAL ISSUES:

Transportation and utilities not available near site.⁽⁶⁾

SITE: SULPHUR H.S., NV

SITE: Sulphur H.S., NV

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 40° 35' 12" N

REGION 4

LONGITUDE: 115° 17' 06" W

COUNTY: Elko

ADJACENT COUNTIES: Box Elder, Tooele, White Pine, Eureka, Lander, Humboldt; Owyhee and Twin Falls, Idaho

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Plains with high mountains	Adjacent to Humboldt National Forest. Desert shrubland, grazed.			

18-14

SITE: Sulphur H.S., NV

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 93°C
Subsurface: 190°C

Geochemical

SiO₂: 183°C
Na-k-Ca: 181°C

TOTAL DISSOLVED SOLIDS (TDS):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 96⁽⁷⁾

TYPE OF OVER LAYING ROCK: Alluvium/granite/metamorphics. (Hard)

ESTIMATED DEPTH TO TOP OF RESERVOIR: 500 M (1640 ft)

SEISMIC ACTIVITY:

SITE: Sulphur H.S., NV

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Ruby Valley		5,743			
LAND LEASED IN KGRA					
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)			2,419		
\$/ACRE	LESSEE				
101.28	Union Oil Co.				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 1			640		
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		988			

18-16

SITE: Sulfur H.S., NV
GEOTHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT

18-17

SITE: Sulfur H.S., NV

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)

18-18

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 20.3 - 40.6 cm (8-16 inches)

Average Temperature

Minimum: -12.2 to -6.7°C (10-20°F)

Maximum: 26.7 to 32.2°C (80-90°F)

Relative Humidity

(Seasonal Peaks)

Summer: 30-40%

Winter: 60-70%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	Approximately 3 Km (2 miles) from Franklin Lake. Groundwater and surface water avail- able. (6)		Great Basin sagebrush, pinyon-juniper. (6)		

SITE: Sulphur H.S., NV

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Ruby Valley Indian Reservation	13 Km (8 miles)	20	241 Km (150 miles) to primary (230- 500Kv) line. ⁽⁶⁾	Interstate 93, 24 Km (15 miles).	Secondary railroad line 40 Km (25 miles), primary line 56 Km (35 miles).
Ruby Valley	24 Km (15 miles)				
Odgers Ranch Indian Reservation	56 Km (35 miles)				

18-20

RECORD 00001

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 2

SECTION A. - GEOTHERMAL FIELD AREA

RECORD IDENTIFICATION

NAME..... E. A. JOHNSON, J. RENNER
 DATE..... 7/01
 ORGANIZATION.. U.S.G.S.

RECORD NO..... 000510
 CROSS INDEX NO.. 000001
 RECORD TYPE..... A

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD AREA.. SULPHUR HOT SPRINGS (HOT SULPHUR SPRINGS) UNITED STATES
 COUNTRY CODE..... US COUNTRY..... ELKO
 STATE/PROVINCE..... NEVADA COUNTRY..... 115-17-05W
 LATITUDE..... 40-35-12N LONGITUDE.....

TOWNSHIP RANGE SECTION 1/4 1/4
 31N 59E 11 NW

RACE & MERIDIAN..... 4E, DIABLO

AVAILABLE MAPS OF AREA: LANDVILLE 1:62,500, ELKO 1:250,000

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION..... 0.5 KM**2
 ELEVATION..... 1044.04 M 6050. FT
 RESOURCE CATEGORY..... B
 SURFACE THERMAL ACTIVITY..... HOT SPRINGS
 ASSOCIATED DEPOSITS..... SINTER
 NO. OF HOT SPRINGS..... 101

GEOTHERMAL CHARACTERISTICS

NATURAL SURFACE DISCHARGE..... 0.33 L/S 5.0000E+02 L/MIN ESTIMATED
 TOTAL CALCULATED DISCHARGE OF DEEP WATERS: 9.17 L/S 550.00 L/MIN
 TOTAL NATURAL HEAT FLUX..... 6.70 L/S 1.5999E+00 CAL/S
 SPRING TEMPERATURES..... 45. C TO 93. C

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 170. C TO 200. C ASSUMED
 BEST ESTIMATE..... 190.0 C TO 10.0 KM**2
 SUBSURFACE AREA..... 2.0 KM**2
 BEST ESTIMATE..... 4.0 KM**2
 BASED ON: GEOLOGY, SURFACE EXPRESSION, TEMP GRADIENT
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1000.00 M 1.000 KM
 BEST ESTIMATE..... 500.00 M 0.500 KM TO 3000.00 M 3.000 KM
 DEPTH TO BOTTOM OF RESERVOIR..... 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM TO 2500.00 M 2.500 KM
 THICKNESS OF RESERVOIR..... 2000.00 M 2.000 KM
 BEST ESTIMATE..... 2500.00 M 2.500 KM TO 25.000 KM**3
 VOLUME OF RESERVOIR..... 4.000 KM**3
 BEST ESTIMATE..... 10.000 KM**3
 COMMENTS: DEPTH TO BOTTOM OF RESERVOIR IS ASSUMED.

RESERVES

TOTAL STORED HEAT..... 1.5600E+13 J 3.6999E+17 CAL TO 1.1720E+19 J 2.7999E+18 CAL
 BEST ESTIMATE..... 9.3949E+13 J 1.0499E+18 CAL ABOVE 15. C

18-21

GEOLGY
 GENERAL ROCK TYPES: QUATERNARY ALLUVIUM; UPPER MESOZOIC GRANITE; PRECAMBRIAN THRU PALEOZOIC METAMORPHIC ROCKS

PRIMARY REFERENCE:

AUTHOR..... D.F. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
 REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) GRANGER, A.F., AND OTHERS, 1957, GEOLOGY & MINERAL RESOURCES OF ELKO COUNTY, NEVADA: NEVADA BUR. MINES BULL. 54
- 2) MARSHER, P.H., & OTHERS, 1974, THE CHEMICAL COMPOSITION AND ESTIMATED MINIMUM THERMAL RESERVOIR TEMPERATURE OF THE PRINCIPAL HOT SPRINGS OF NORTHERN AND CENTRAL NEVADA: U.S.G.S. OPEN-FILE REPORT
- 3) GLUSTED, F.H., AND OTHERS, 1975, PRELIMINARY HYDROGEOLOGIC APPRAISAL OF SELECTED HYDROTHERMAL SYSTEMS IN NORTHERN & CENTRAL NEVADA: U.S.G.S. OPEN-FILE REPORT 75-56

SITE: HOT LAKE, OR
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Hot Lake, Oregon

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM/USFS BLM/USFS	Process EIA/EIS Lease Land	CEQ Developer	ASSUMED COMPLETED										
BLM/USFS USGS Developer	Issue STG Drilling Permit Issue Drilling Permit Preliminary Geophysical Exploration	Developer Developer											
Developer	Exploratory Drilling and Reservoir Evaluation												
Developer Developer and Utility Producer (Developer) and Utility Producer	Develop Utility Interest Feasibility Study Financial Negotiations												
Producer and Utility Producer and Utility Producer and Utility Utility	Site Selection Commitment to Development Design (Preliminary, Final)						Δ						
Producer and Utility Utility	Prepare Master Development Plan Prepare Environmental Data Statement	BLM/USFS, USGS BLM/USFS, FPC											
BLM, FPC	Certify Plant and Site, Issue Permits	Producer, Utility											
USGS FPC FPC	Process EIA/EIS (Drilling) Process EIA/EIS (Plant) Process EIA/EIS	CEQ CEQ CEQ											
Producer Utility Utility	(Transmission Line) Development Drilling Plant Construction Install Transmission Line												

SITE: Hot Lake, OR

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Extensive (Federal) leasing--may be sufficient to develop two 50 MWe power plants.
- No development yet. Development will be slowed by lack of developed infrastructure.

Principal Milestones:

• Issue drilling permit, start exploratory drilling	January 1979
• Identify utility	January 1980
• Complete feasibility study	October 1980
• Select site, commit to development	July 1981
• Start development drilling	October 1983
• Start construction	January 1984
• On line	April 1986

SITE: Hot Lake, OR

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the Primary Technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Hot Lake, OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS*	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods--optimized to identification and characterization of geothermal fields in basaltic rock 	X	X	2	79			
<u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location 	X	X	3	79			
	X	X	3	79			

* Status of exploration operations at this site needs further investigation.

SITE: Hot Lake, OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods--to aid in determining field boundaries in this type of rock formation Drilling Techniques--(basaltic rocks) <u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Resource Characterization--with regard to determining type and extent of field Basic Understanding of the Geothermal Process--in the earth for this type of field 		X	2	80			
		X	3	80			
		X	2	80			
	X	X	3	80			
	X		4	80			
	X		4	80			

SITE: Hot Lake, OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--basaltic rock, temperature <180°C		X	4	83			
• High Temperature, Deep-well, Down-hole Pumps	X		2	84			
• Brine Injection Pumps	(ID)		2	84			
• Brine Deaerators	?	?	2	84			
• Injection Technology--basaltic rocks	X		2	84			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	X		2	83			
• Instrumentation and Control--with regard to injection process	X		2	83			
• Resource Characterization--with regard to behavior of field when produced	X	X	1	83			
• Reservoir Engineering--with regard to best way to produce field	X	X	1	83			
• Basic Understanding and Injection Process-- for this type of field	X	X	2	84			
<u>Environmental</u>							
• Injection Impact Prediction Technology	X		1	83			
(ID) Insufficient Data							
* Further investigation required to obtain requirements for this site.							

SITE: Hot Lake, OR

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
● Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperatures between 170°C-180°C	X		2	82			
● Working Fluid Selection Technique--(or Fluid Development Program)	X		2	82			
● Advanced Heat Exchanger Design--geothermal brines to secondary fluid (190°C-200°C)	X	X	2	82			
● Secondary Fluid Condensers*	?	?	2	82			
● Waste-Heat Handling*	?	?	2	82			
<u>Supporting Technology--Binary Concepts</u>							
● Brine Chemistry*		X	3	81			
● Waste Brine Purification*		X	3	81			
<u>Environmental</u>							
● Secondary Fluid Control/Disposal	X		4	81			
<p>* Further investigation required to obtain requirements for this site.</p>							

SITE: Hot Lake, OR

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 180

DEPTH, M: 1000

ROCK TYPE: Hard

SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1986	1987	1988	1989+		
CAPACITY FACTOR ASSUMED	.50	.60	.65	.70		
COST OF ELECTRICITY (MILLS/KWH)	64.1	53.4	49.3	45.8		

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	11.49	LIFE:	10
INJECTION WELLS:	2.43	LIFE:	20
PRODUCER PLANT:	8.74	LIFE:	20
GENERATING PLANT:	37.8	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.262
UTILITY: 1.273

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	0.262
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	0.378
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

*1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

19-11

SITE: HOT LAKE, OR
DESCRIPTION AND DATA

SITE: Hot Lake, OR

SUMMARY

TEMPERATURE °C

Surface: 96

Subsurface: 180

TOTAL DISSOLVED SOLIDS (PPM):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 106⁽⁷⁾

TYPE OF OVERLAYING ROCK:

Hard

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 1,000

DESCRIPTION OF KGRA

Total KGRA Acres:

Total Federal Acres:

Federal Acres Leased:

Total State and Private Acres:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

LAND USE AND POPULATION:

Unpopulated grassland and woodland in low mountains.

COMMENTS AND CRITICAL ISSUES:

No population centers, transportation, or utilities in the area.⁽⁶⁾ Same KGRA as Mickey, H.S.

SITE: HOT LAKE, OR

SITE: Hot Lake, OR

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 42° 20' 08" N

REGION 3

LONGITUDE: 118° 35' 58" W

COUNTY: Harney

ADJACENT COUNTIES: Lake, Deschutes, Crook, Grant, Malheur, Humboldt, NV

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Plains with low mountains.(6)	Subhumid grassland and open wood- land, with some grazing.(6)			

SITE: Hot Lake, OR

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 96°C
Subsurface: 180°C

Geochemical

SiO₂: 165°C
Na-k-Ca: 176°C

TOTAL DISSOLVED SOLIDS (TDS):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 106⁽⁷⁾

TYPE OF OVER LAYING ROCK: Alluvium, andesite, basalt. (Hard)

ESTIMATED DEPTH TO TOP OF RESERVOIR: 1000 M (3281 ft)

SEISMIC ACTIVITY:

SITE: Hot Lake, OR

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Alvord		176,835			
LAND LEASED IN KGRA			13,921		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
17.90	Chevron Oil Co.				
10.56	Republic Geothermal				
7.17	Al-Aquitaine Exploration				
6.03	Mapco				
TENTATIVE LEASE SALE DATES					
1977					
1978					
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS:					
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE):					
SUBSURFACE AREA OF RESERVOIR		1,483			

SITE: Hot Lake, OR
GEOTHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT

SITE: Hot Lake, OR

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)

SITE: Hot Lake, OR

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds
Precipitation (Annual): 0 - 20.3 cm (0 - 8 inches)⁽⁶⁾
Average Temperature
Minimum: -6.7 to -1.1°C (20-30°F)
Maximum: 15.6 to 21.1°C (60-70°F)

Relative Humidity
(Seasonal Peaks)
Summer: 30-40%
Winter: 70-80%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
	Groundwater and surface water available. ⁽⁶⁾		Alpine meadows and sagebrush steppe. ⁽⁶⁾		21 Km (13 miles) from Malheur National Wildlife Refuge. ⁽⁶⁾

SITE: Hot Lake, OR

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Arock	89 Km (55 miles)	25	> 8 Km (5 miles) to primary trans- mission lines (230 - 500 Kv). (6)	40 Km (25 miles) to Interstate 95.	80 Km (50 miles) to secondary railroad line. (6)
Princeton	72 Km (45 miles)	10 ⁽⁶⁾			

RECORD 00196

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION A.- GEOTHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000632
 CROSS INDEX NO.. CF02411
 RECORD TYPE..... A

NAME..... F. SMITH, J. REINER
 DATE..... 75/09
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. HOT LAKE
 WARING FIGURE..... 6
 COUNTRY CODE..... US
 STATE/PROVINCE..... OREGON
 LATITUDE..... 42-20-08N

WARING NUMBER..... 69,70
 COUNTRY NAME..... UNITED STATES
 COUNTY..... HARNEY
 LONGITUDE..... 118-35-58W

TOWNSHIP RANGE SECTION 1/4 1/4
 37S 33E 15

BASE & MERIDIAN..... WILLAMETTE
 AVAILABLE MAPS OF AREA: ADEL 1:250,000

GENERAL DESCRIPTION

SIZE OF SURFACE EXPRESSION.... 0.1 KM**2
 ELEVATION..... 1234.44 M 4050. FT
 RESOURCE CATEGORY..... B
 SURFACE THERMAL ACTIVITY..... HOT SPRING(S),
 NO. OF HOT SPRINGS..... 2

GEOTHERMAL CHARACTERISTICS

NATURAL SURFACE DISCHARGE..... 0.25 L/S 1.5000E+01 L/MIN ESTIMATED
 SPRING TEMPERATURES..... 36. C

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 160. C TO 225. C ASSUMED
 BEST ESTIMATE..... 180.0 C
 SUBSURFACE AREA..... 0.1 KM**2 TO 26.0 KM**2
 BEST ESTIMATE..... 6.0 KM**2
 BASED ON: GEOLOGIC INFERENCE
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 2000.00 M 2.000 KM
 BEST ESTIMATE..... 1000.00 M 1.000 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1000.00 M 1.000 KM TO 2500.00 M 2.500 KM
 BEST ESTIMATE..... 2000.00 M 2.000 KM
 VOLUME OF RESERVOIR..... 0.100 KM**3 TO 65.000 KM**3
 BEST ESTIMATE..... 12.000 KM**3
 COMMENTS: DEPTHS TO TOP & BOTTOM OF RESERVOIR ARE ASSUMED.

RESERVES

TOTAL STORED HEAT..... 4.1441E+16 J 9.8999E+15 CAL TO 2.6936E+19 J 6.4349E+18 CAL
 BEST ESTIMATE..... 5.0228E+16 J 1.1999E+18 CAL ABOVE 15. C

GEOLOGY

19-21

GENERAL ROCK TYPES: ALLUVIUM, ANDESITE, BASALT

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
 REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) MARINER, R.H., AND OTHERS, 1974, THE CHEMICAL COMPOSITION AND ESTIMATED MINIMUM THERMAL RESERVOIR TEMPERATURES OF SELECTED HOT SPRINGS IN OREGON: U.S.G.S. OPEN-FILE REPORT
- 2) WALKER, G.W., COMPILER, 1973, PRELIMINARY GEOLOGIC AND TECTONIC MAPS OF OREGON EAST OF THE 121ST MERIDIAN: U.S.G.S. MISC. FIELD STUDIES MAP MF-495
- 3) WALKER, G.W., AND KEPENNING, C.A., 1965, RECONNAISSANCE GEOLOGIC MAP OF THE ADEL QUAD., LAKE, HARNEY, & MALHEUR COUNTIES, ORE.: U.S.G.S. MISC. GEOL. INV. MAP 1-446
- 4) WARING, G.A., 1965, THERMAL SPRINGS OF THE UNITED STATES AND OTHER COUNTRIES OF THE WORLD--A SUMMARY: U.S.G.S. PROF. PAPER 492, 383P.

RECORD 00188

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION 8

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000683
 CROSS INDEX NO.. C102411 HARP3P4
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFALL

NAME..... SANFORD, LINDA J.
 DATE..... 76/03
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. HOT LAKE
 NAME OF SAMPLE SOURCE.. UNNAMED HOT SPRING (NEAR HOT LAKE)
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... OREGON COUNTY..... HARNEY
 LATITUDE..... 42-19.7 N LONGITUDE..... 118-36.5 W

TOWNSHIP RANGE SECTION 1/4 1/4
 37S 33E 14

MAP REFERENCE: ADEL, ORE. (2 DEG.)

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1972
 COLLECTOR(S)..... BARNES GROUP
 WATER SAMPLING TEMP.... 52. C
 WATER FLOW RATE..... 3.33 L/S 200. L/MIN
 DEPOSITS OR ALTERATION: NO DEPOSITS.
 WATER TREATMENT DATA: PRESSURE FILTERED THROUGH A .45 MICROMETRE - MEMBRANE FILTER, METAL ANALYSES ACIDIFIED WITH
 NITRIC ACID, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: ALKALINITY REPORTED AS BICARBONATE.

WATER ANALYSIS

W

ANALYSIS DATE..... 1972-74
 ANALYST(S)..... BARNES GROUP
 PH 1)..... 7.30
 SPECIFIC CONDUCTANCE..... 2020. UMHO/CM
 ALKALINITY..... 374. MG/L

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RE	CS	NA+K			
.51	450	28	.18	.1				
MG	CA	SR	BA	CA+MG				
.3	14	.60						
MN+3	BR(TOT)	FE+3	FF(TOT)	CU				
	.04		LI .02	.01				
ZN	MG	E	HR02	AL	FB	AS	SB	U
	.0008	15		.020				
F	CL	LR	I					

19-23

7.2	250					
NO ₃	NO ₃	ED ₄	SiO ₂	SO ₄	CO ₃	HCO ₃
.17		1.20	160	434	4	

COMMENTS: ANDESITE, BASALT, AND RHYOLITE ARE ROCK TYPES OF THE SPRING.

CONDENSATE ANALYSIS

PH 1)..... 7.30
 SPECIFIC CONDUCTANCE..... 2020 UMHO/CM2

ISOTOPIC DATA

DEL D(18) OF WATER..... -14.36 0/00
 DEL D OF WATER..... -125.4 0/00

REFERENCES: MARINER, R. H., PRESSER, RAPP, WILLEY, THE MINOR & TRACE ELEMENTS, GAS, & ISOTOPE COMPOSITIONS OF PRINCIPAL HOT SPRINGS OF NEVADA AND OREGON. MARINER, R. H., RAPP, WILLEY, PRESSER, THE CHEMICAL & ESTIMATED MINIMUM THERMAL RESERVOIR TEMPERATURES OF SELECTED HOT SPRINGS IN OREGON.

RECORD 00190

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION B

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000782
 CROSS INDEX RU.. NARP3P4
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J
 DATE..... 76/03
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. HOT LAKE
 COUNTRY CODE..... US
 STATE/PROVINCE..... OREGON
 LATITUDE..... 42-19.7 N

COUNTRY NAME..... UNITED STATES
 COUNTY..... HARNEY
 LONGITUDE..... 118-36.5 W

TOWNSHIP RANGE SECTION 1/4 1/4
 37S 33E 14

MAP REFERENCE: ADL, ORE. (2 DEG.)

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1972
 COLLECTOR(S)..... BARNES GROUP
 POINT OF COLLECTION..... NEAR ORIFICE OF SPRING
 WATER SAMPLING TEMP.... 36. C
 WATER FLOW RATE..... 3500. C

DEPOSITS OR ALTERATION: SILICA APRON AROUND SPRING; TRACES OF GAS PRESENT.

WATER TREATMENT DATA: PRESSURE FILTERED THROUGH A .45 MICROMETRE - MEMBRANE FILTER, METAL ANALYSES ACIDIFIED WITH
 NITRIC ACID, DILUTED

OTHER CHEMICAL CHARACTERISTICS: ALKALINITY REPORTED AS BICARBONATE.

WATER ANALYSIS

W

ANALYSIS DATE..... 1972-74
 ANALYST(S)..... BARNES GROUP
 PH 1)..... 7.28
 SPECIFIC CONDUCTANCE..... 2410. UMHO/CM
 ALKALINITY..... 420. MG/L

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

L1	NA	K	RB	CS	NA+K			
.05	500	31	.23	.1				
RG	CA	SR	BA	CA+MG				
.3	16	.42						
BR+3	BR(TOT)	FL+3	FE(TOT)	CU				
	.03		LT .02	.03				
ZN	RG	B	HB02	AL	PB	AS	SB	U
	.0004	16.6				.01		
F	CL	BR	I					

9.0	200	2	.2			
NO ₃	NO ₂	PO ₄	SiO ₂	SO ₄	CO ₃	HCO ₃
		.88	190	350	LT 1	420

COMMENTS: ALLOUVIUM, ANDESITE, AND BASALT ARE ROCK TYPES OF THE SPRING.

CONDENSATE ANALYSIS

PH 1)..... 7.28
 SPECIFIC CONDUCTANCE..... 2410 UMHO/CM

ISOTOPIC DATA

DEL O(18) OF WATER..... -11.57 0/00
 DEL D OF WATER..... -115.8 0/00

REFERENCES: MARINER, R. H., PRESSER, RAPP, WILLEY, THE MINOR & TRACE ELEMENTS, GAS, & ISOTOPE COMPOSITIONS OF PRINCIPAL HOT SPRINGS OF NEVADA AND OREGON. MARINER, R. H., RAPP, WILLEY, PRESSER, THE CHEMICAL & ESTIMATED MINIMUM THERMAL RESERVOIR TEMPERATURES OF SELECTED HOT SPRINGS IN OREGON.

SITE: GREAT BOILING H.S., NV
ANALYSIS OF POSTULATED DEVELOPMENT

SITE: Great Boiling (Gerlach) H.S., Nevada (Federal/Private Land)

SITE DEVELOPMENT SCHEDULE (FOR FIRST 50 MWe PLANT)

OPERATING ENTITIES	ACTIVITY	RECIPIENTS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
BLM BLM	Process EIA/EIS Lease Land	CEQ Developer	} ASSUMED COMPLETED										
BLM USGS Developer	Issue STG Drilling Permit Issue Drilling Permit Preliminary Geophysical Exploration	Developer Developer	—	— —									
Developer	Exploratory Drilling and Reservoir Evaluation			—	—	—							
Developer Developer and Utility	Develop Utility Interest Feasibility Study			—	—								
Producer (Developer) and Utility	Financial Negotiations					—							
Producer	Site Selection					—							
Producer and Utility	Commitment to Development					—							
Producer and Utility	Design (Preliminary, Final)						—	—					
Producer and Utility	Prepare Master Development Plan	BLM, USGS					—						
Utility	Prepare Environmental Data Statement	BLM, FPC, State DEQ					—						
BLM, FPC	Certify Plant and Site, Issue Permits	Producer, Utility					—	—					
USGS	Process EIA/EIS (Drilling)	CEQ					—	—	—				
FPC	Process EIA/EIS (Plant)	CEQ					—	—	—				
FPC	Process EIA/EIS (Transmission Line)	CEQ					—	—	—				
Producer Utility Utility	Development Drilling Plant Construction Install Transmission Line								—	—	—		

SITE: Great Boiling H.S., NV

PRINCIPAL ASSUMPTIONS AND MILESTONES FOR SITE DEVELOPMENT

Principal Assumptions:

- Sufficient (Federal and private) land is leased for a 50 MWe plant.
- No development has occurred. There should be no opposition to development.

Principal Milestones:

• Issue drilling permit, start exploratory drilling	July 1978
• Identify utility	July 1979
• Complete feasibility study	April 1980
• Select site, commit to development	January 1981
• Start development drilling	April 1983
• Start construction	July 1983
• On line	October 1985

SITE: Great Boiling Springs, NV

TECHNOLOGY R&D NEEDS ANALYSIS

Identification of the Technology R&D needs and timing for the development of the needs at this site have evolved through an examination of the technology oriented reservoir-specific data and the schedule for development contained here-in. This listing of technology needs is structured by Development Phase to match the R&D Technology Needs Checklist (WP-12055). The needs identified for this site:

EXPLORATION OPERATIONS

- Primary Technology
- Supporting Technology

EXPLORATION DRILLING

- Primary Technology
- Supporting Technology

EXTRACTION

- Primary Technology
- Supporting Technology

CONVERSION

- Primary Technology--Binary Concepts
- Supporting Technology--Binary Concepts

The Primary Technology needs are related to those activities in the Development Phase that provide the equipment, methods, techniques, etc. that are used to achieve the goal of the activity. The Supporting Technology needs are related to those activities that enable the Primary Technologies to be developed, and that allow processing, analysis and interpretation of data gathered using the Primary Technology. A brief description of the activities that occur in each phase follows:

- Exploration Operations--Drilling of shallow-small bore wells to measure temperature gradients, use of seismic, electrical, gravity, etc. methods to select sites for drilling deep holes.
- Exploration Drilling--Drilling of deep wells of potential production size in order to obtain data (temperature, salinity, flow rate, etc.) that will characterize the field.
- Extraction--Drilling of production wells, installation of brine/steam gathering network, drilling of reinjection wells, activities related to the producer of geothermal brines.
- Conversion--Design and erection of power plant and ancillary structures and equipment at the power plant site, activities related to the user (utility) of geothermal brines.

SITE: Great Boiling Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION OPERATIONS*	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u> <ul style="list-style-type: none"> Improved Geophysical Exploration Methods--optimized to identification and characterization of geothermal fields in medium-hard rock (Granadiorite/Altiurium) 	X	X	2	79			
<u>Supporting Technology</u> <ul style="list-style-type: none"> Data Gathering and Processing Data Analysis and Interpretation Basic Understanding of the Geothermal Process--at depth for rock formations similar to this location 		X	2	79			
	X	X	3	79			
	X	X	3	79			
* Status of exploration operations at this site needs further investigation.							

SITE: Great Boiling Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXPLORATION DRILLING	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Improved Geophysical Exploration Methods-- to aid in determining field boundaries in this type of rock formation		X	2	80			
• Drilling Techniques--(Medium-hard rock)		X	3	80			
<u>Supporting Technology</u>							
• Data Gathering and Processing		X	2	80			
• Data Analysis and Interpretation	X	X	3	80			
• Resource Characterization--with regard to determining type and extent of field	X		4	80			
• Basic Understanding of the Geothermal Process--in the earth for this type of field	X		4	80			

SITE: Great Boiling Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

EXTRACTION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology</u>							
• Drilling Techniques--Medium-hard rock, temperature <170°C		X	4	83			
• High Temperature, Deep-well Down-hole Pumps	X		2	84			
• Brine Injection Pumps	(ID)		2	84			
• Brine Deaerators	?	?	2	84			
• Injection Technology--site located on a major fault	X		3	83			
<u>Supporting Technology</u>							
• Brine Chemistry--with regard to hole plugging during injection	(ID)		2	84			
• Instrumentation and Control--with regard to injection process	X		4	83			
• Resource Characterization--with regard to behavior of field when produced	X	X	1	83			
• Reservoir Engineering--with regard to best way to produce field	X	X	1	83			
• Basic Understanding of Injection Process--for field in proximity to major fault	X	X	3	83			
<u>Environmental</u>							
• Injection Impact Prediction Technology*--with regard to triggering seismic events	X		1	83			
(ID) Insufficient Data							
* Further investigation required to obtain requirements for this site.							

SITE: Great Boiling Springs, NV

TECHNOLOGY R&D NEEDS AND TIMING FOR POSTULATED DEVELOPMENT

CONVERSION	PRIMARY THRUST OF NEED		DATE TECHNOLOGY NEEDED		SCHEDULED COMMERCIAL AVAILABILITY DATE		IMPLICATIONS
	TECHNICAL	ECONOMIC	QTR	YEAR	QTR	YEAR	
<u>Primary Technology--Binary Concepts</u>							
• Advanced Commercial Scale Organic Turbine Technology--for operation at inlet temperature between 170°C-180°C	X		2	82			
• Working Fluid Selection Technique--(or fluid Development Program)	X		2	82			
• Advanced Heat Exchanger Design--geothermal brines to secondary fluid (170°C-180°C)	X	X	2	82			
• Secondary Fluid Condensers--to operate where cooling water is scarce	X	X	2	82			
• Waste-heat Handling--water scarce area	X	X	2	82			
<u>Supporting Technology--Binary Concepts</u>							
• Brine Chemistry*		X	3	82			
• Waste Brine Purification*--for this type field		X	3	82			
<u>Environmental</u>							
• Secondary Fluid Control/Disposal	X		4	81			
<p>* Further investigation required to obtain requirements for this site.</p>							

SITE: Great Boiling H.S., NV

SITE ECONOMICS (ASSUMING NO COST REDUCTIONS DUE TO R&D)

TYPE: Hot Water

TEMPERATURE, °C: 170

DEPTH, M: 500

ROCK TYPE: Medium SYSTEM SIZE, MW: 50

TYPE: Binary

YEAR	1986	1987	1988	1989+		
CAPACITY FACTOR ASSUMED	.5	.6	.65	.7		
COST OF ELECTRICITY (MILLS/KWH)	55.3	46.1	42.5	39.5		

ENGINEERING DATA AND ASSUMPTIONS

CAPITAL COSTS* AND LIVES (YEARS):

PRODUCING WELLS:	5.24	LIFE:	10
INJECTION WELLS:	1.07	LIFE:	20
PRODUCER PLANT:	9.49	LIFE:	20
GENERATING PLANT:	38.5	LIFE:	30
CAPITALIZED EXPLORATION:	3.5	LIFE:	30

O&M COSTS (1976 \$ x 10⁶ PER YEAR):

PRODUCER: 1.164
UTILITY: 1.298

FINANCIAL DATA AND ASSUMPTIONS

PRODUCER DEBT/EQUITY RATIO:	30/70
UTILITY DEBT/EQUITY RATIO:	50/50
PRODUCER COST OF CAPITAL (PERCENT PER YEAR):	20
UTILITY COST OF CAPITAL (PERCENT PER YEAR):	12
PRODUCER COST OF DEBT (PERCENT PER YEAR):	8
UTILITY COST OF DEBT (PERCENT PER YEAR):	8
PRODUCER INCOME TAX RATE (PERCENT):	50
UTILITY INCOME TAX RATE (PERCENT):	50
OTHER PRODUCER TAXES (1976 \$ 10 ⁶ /YEAR):	.193
OTHER UTILITY TAXES (1976 \$ 10 ⁶ /YEAR):	.385
PRODUCER ROYALTY (PERCENT):	10
UTILITY ROYALTY (PERCENT):	-
PRODUCER DEPLETION ALLOWANCE (PERCENT):	-

* 1976 \$ x 10⁶ INCLUDING ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION

20-11

SITE: GREAT BOILING H.S., NV

DESCRIPTION AND DATA

SITE: Great Boiling (Gerlach) Springs, NV

SUMMARY

TEMPERATURE °C

Surface: 86

Subsurface: 170

TOTAL DISSOLVED SOLIDS (PPM):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 201⁽⁷⁾

TYPE OF OVERLAYING ROCK: Medium

ESTIMATED DEPTH TO TOP OF RESERVOIR (METERS): 500

DESCRIPTION OF KGRA

Total KGRA Acres: 34,297⁽⁹⁾

Total Federal Acres:

Federal Acres Leased: 8,493

Total State and Private Acres:

State and Private Acres Leased:

GEOHERMAL DEVELOPMENT STATUS:

As of August 1975, no drilling had occurred.⁽⁴⁾

LOCAL AND STATE ATTITUDE TOWARD GEOHERMAL DEVELOPMENTS:

Use permit required on zoned lands. Mild constraints and brief delays expected.^(1A) Administration attitude is favorable and no public opposition is apparent.⁽⁴⁾ Ad-

LAND USE AND POPULATION:

Sparsely populated foothills/mountainous. Grazing, farming, mineral production, recreation. Land zoned for open use.⁽⁴⁾

COMMENTS AND CRITICAL ISSUES:

EAR is complete.⁽⁴⁾ Reservoir is located on a major regional fault intersection.⁽⁴⁾ A water shortage exists. Tentative lease sale on BLM lands, 10-18-77.

20-13

SITE: Great Boiling (Gerlach) Springs, NV

SITE LOCATION AND PHYSICAL DESCRIPTION

LATITUDE: 20° 39' 43" N

REGION 4

LONGITUDE: 119° 21' 44" W

COUNTY: Washoe

ADJACENT COUNTIES: Humbolt, Pershing, Churchill, Lyon, Storey, Ormsby; OR-Lake; CA-Modoc, Lassen, Sierra, Nevada, Placer

LAND OWNERSHIP:

TOPOGRAPHY	PRESENT LAND USE	FUTURE LAND USE PLANS	AESTHETICS	HISTORICAL/ ARCHAEOLOGICAL SIGNIFICANCE
Foothill/mountainous, Basin and Range desert with broad valleys, playas, and dry washes. (4)	Rural, primarily grazing, farming, mineral production and recreation. Land zoned for open use. ⁽⁴⁾		Interesting color and texture contrasts, rough and rugged beauty. ⁽⁴⁾	Sites abound in the region but none found in immediate vicinity of the prospect. ⁽⁴⁾

SITE: Great Boiling (Gerlach) Springs, NV

RESERVOIR CHARACTERISTICS AND GEOLOGICAL/GEOPHYSICAL DESCRIPTION

RESERVOIR TEMPERATURE

Surface: 86°C
Subsurface: 170°C

Geochemical

SiO₂: 167°C
Na-k-Ca: 205°C

TOTAL DISSOLVED SOLIDS (TDS):

ESTIMATED ELECTRIC ENERGY POTENTIAL (MWe 30 YEARS): 201⁽⁷⁾

TYPE OF OVER LAYING ROCK: Granodiorite, alluvium and lacustrine deposits. (medium hardness)

ESTIMATED DEPTH TO TOP OF RESERVOIR: 500 M (1640 ft)

SEISMIC ACTIVITY: Located on a major regional fault intersection.⁽⁴⁾

SITE: Great Boiling (Gerlach) Springs, NV

LAND OWNERSHIP AND LEASING

		TOTAL AREA (ACRES)	FEDERAL (ACRES)	STATE (ACRES)	PRIVATE (ACRES)
KGRA: Gerlach, Gerlach Addition and Gerlach Northeast		34,297 ⁽⁹⁾	~17,148 ^(1A)	~17,148 ^(1A) (State & Private)	
LAND LEASED IN KGRA			8,493		
HIGHEST-PRICED LEASES (BY DOLLARS/ACRE)					
\$/ACRE	LESSEE				
28.48	Sunoco Energy Dev.				
17.88	Sunoco Energy Dev.				
9.89	Sunoco Energy Dev.				
5.13	Sunoco Energy Dev.		2,163		
TENTATIVE LEASE SALE DATES			1,850		
1977	10/18 BLM ⁽¹⁴⁾		2,560		
1978			1,920		
1979					
1980					
NUMBER OF SALES OFFERED BUT NO BIDS: 7			14,072		
NUMBER OF BIDS REJECTED (RESULTING IN NO LEASE): 0					
SUBSURFACE AREA OF RESERVOIR		2,471			

SITE: Great Coiling (Gerlach) Springs, NV

GEOHERMAL DEVELOPMENT STATUS

PRESENT DEVELOPMENT STATUS	PROJECTED OR PLANNED DEVELOPMENT
<p>As of August 1975, no drilling was reported at Gerlach. (4)</p>	

ADMINISTRATIVE REQUIREMENTS

ADMINISTRATIVE REQUIREMENTS	ADMINISTRATIVE AND PUBLIC ATTITUDES	STATUS OF ADMINISTRATIVE PROCEDURES (i.e., EIA/EIS WRITTEN)
<p>A use permit is required for geothermal activity on lands zoned in the county. Mild constraints and brief delays may be expected.(1A)</p>	<p>No public opposition to geothermal development. Washoe County officials are looking forward to development.(4)</p>	<p>Environmental Analysis Record of area has been generated.(4)</p>

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds

Precipitation (Annual): 20.3-40.6 cm (8-16 inches)

Average Temperature

Minimum: -6.7 to -1.1°C (20-30°F)

Maximum: 21.1 to 26.7°C (70-80°F)

Relative Humidity

(Seasonal Peaks)

Summer: 20-30%

Winter: 60-70%

20-19

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
Air quality has not been measured but particulate matter from dust storms is a problem. Noxious gases from vehicles and aircraft have been found in small amounts.(4)	Alluvial basin contains groundwater of good quality; quality decreases toward dry lakes. Streams are intermittent but there are several large reservoirs located on private land in the general region.(4) Generally however, a water shortage exists in the area.(1A)	Ambient noise levels are low.(4)	Saltbush/grease-wood, sagebrush, shadscale, winterfat.(4)	58 species of mammals, 115 species of birds, 5 of amphibians, 20 of reptiles and 9 of fish recorded in area. Dominant species are mule deer, pronghorn antelope, sage grouse and cutthroat trout. Aquatic invertebrates and plants are found in the hot springs.(4)	Prarie Falcon, Desert Dace and Lahontan Cutthroat Trout.(4)

SITE: Great Boiling (Gerlach) Springs, NV

POPULATION, TRANSPORTATION, AND UTILITIES

GENERAL DESCRIPTION OF POPULATION AT THE RESERVOIR:

Area is extremely isolated and sparsely populated.

CLOSEST POPULATION CENTERS			APPROXIMATE DISTANCE BETWEEN SITE AND TRANSMISSION LINES	ROADS SERVICING AREA AND DISTANCE FROM SITE	OTHER UTILITIES OR RIGHTS-OF-WAY AND DISTANCE FROM SITE
NAME	DISTANCE FROM RESOURCE	POPULATION			
Gerlach	0 Km	130	Primary (230-500kv) lines within 8 Km (5 miles) of site.	State Route 34 5 Km (3 miles) from site.(6)	Primary railroad line within 8 Km (5 miles) of site. (6)

RECORD 00069

GEOTHERMAL RESOURCES FILE (GEOTHERM) REVISION E

SECTION E.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000581
 CROSS INDEX NO.. CPG1901 MAKPIP4
 RECORD TYPE.....
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J
 DATE..... 76/03
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOTHERMAL FIELD-AREA.. GREAT BOILING SPRINGS (GERLACH HOT SPRINGS)
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... WASHOE
 LATITUDE..... 40-39.7 N LONGITUDE..... 119-21.8 W

TOWNSHIP RANGE SECTION 1/4 1/4
 32N 15 NW

MAP REFERENCE: GERLACH, NEV. (15 MIN.); LOVELOCK, NEV - CAL (2 DEG)

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1972-73
 COLLECTOR(S)..... MARINER'S GROUP
 POINT OF COLLECTION..... NEAR ORIFICE OF SPRING
 WATER SAMPLING TEMP.... 86. C
 DEPOSITS OR ALTERATION: TRACES OF CALC3 AND SILICA APRON DEPOSITED
 WATER TREATMENT DATA: PRESSURE FILTERED THROUGH A .1 MICROMETRE MEMBRANE FILTER, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: BOILING, HIGH CHLORIDE. ALKALINITY REPORTED AS CARBONATE AND BICARBONATE.

WATER ANALYSIS

W

ANALYSIS DATE..... 1972-73
 ANALYST(S)..... BARNES GROUP
 PH 1)..... 7.15
 SPECIFIC CONDUCTANCE..... 7610. UMHO/CM
 ALKALINITY..... 84. MG/L

ISOTOPIC DATA

DEL D(18) OF WATER..... -10.83 0/00
 DEL D OF WATER..... -100.5 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RB	CS	NA+K			
1.6	1400	130	.94	.3				
HC	CA	SR	BA	CA+MG				
1.2	66	2.6						
MN+3	BR(101)	FE+3	FE(101)	CU				
	.05		.02	.08				
ZN	HC	B	HSE2	AL	PB	AS	SE	U
	LT .0001	9.9		.011		.05		

F	CL	FR	1			
4.5	2200	6	.4			
NO ₂	NO ₃	IO ₄	SiO ₂	SO ₄	CO ₂	HCO ₃
1.03		.31	165	400		

COMMENTS: GRANODIORITE, ALUVIUM, AND LAKE SEDIMENTS ARE ROCK TYPES.

REFERENCES: MARINER, R. H., RAPP, PRESSER, THE CHEMICAL COMPOSITION & ESTIMATED MINIMUM THERMAL RESERVOIR TEMPERATURES OF PRINCIPAL HOT SPRINGS OF NORTHERN & CENTRAL NEVADA. MARINER, PRESSER, RAPP, WILLEY, THE MINOR AND TRACE ELEMENTS, GAS, AND ISOTOPE COMPOSITIONS OF THE PRINCIPAL HOT SPRINGS OF NEVADA AND OREGON.

RECORD 00070

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION B

SECTION A.- GEOHERMAL FIELD-AREA

RECORD IDENTIFICATION

RECORD NO..... 0000580
 CROSS INDEX NO.. CFC1901
 RECORD TYPE..... A

NAME..... E. A. JOHNSON, J. REMNER
 DATE..... 75/01
 ORGANIZATION.. U.S.G.S.

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. GREAT BUILDING SPRINGS (GERLACH HOT SPRINGS)
 MAPING FIGURE..... R WADING NUMBER..... 38
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... WASHOE
 LATITUDE..... 40-39-43N LONGITUDE..... 119-21-44W

TOWNSHIP RANGE SECTION 1/4 1/4
 32N 23E 15 NW

BASE L MERIDIAN..... MT. DIABLO
 AVAILABLE MAPS OF AREA: GERLACH 1:62,500, LOVELOCK 1:250,000

GENERAL DESCRIPTION

ELEVATION..... 1207.01 M 3960. FT
 RESOURCE CATEGORY..... B
 SURFACE THERMAL ACTIVITY..... HOT SPRINGS
 ASSOCIATED DEPOSITS..... SINTER
 NO. OF HOT SPRINGS..... 2 MAJOR GROUPS & 4 OTHERS

GEOHERMAL CHARACTERISTICS

NATURAL SURFACE DISCHARGE..... 16.67 L/S 1.0000E+03 L/MIN ESTIMATED
 TOTAL CALCULATED DISCHARGE OF DEEP WATERS: 36.00 L/S 2040.00 L/MIN
 TOTAL NATURAL HEAT FLUX..... 2.9302E+07 J/S 7.0000E+06 CAL/S
 SPRING TEMPERATURES..... 20. C TO 90. C

WELL INFORMATION

BOTTOM-BOLE TEMPERATURE..... 110.0 C TO 150.00 M

RESERVOIR PROPERTIES

RESERVOIR TEMPERATURES..... 0. C TO 0. C
 BEST ESTIMATE..... 170.0 C
 SURFACE AREA..... 2.5 KM**2 TO 30.0 KM**2
 BEST ESTIMATE..... 10.0 KM**2
 BASED ON: GEOLOGY, TEMP GRADIENT
 DEPTH TO TOP OF RESERVOIR..... 500.00 M 0.500 KM TO 1500.00 M 1.500 KM
 BEST ESTIMATE..... 500.00 M 0.500 KM
 DEPTH TO BOTTOM OF RESERVOIR.. 3000.00 M 3.000 KM TO 3000.00 M 3.000 KM
 BEST ESTIMATE..... 3000.00 M 3.000 KM
 THICKNESS OF RESERVOIR..... 1500.00 M 1.500 KM TO 2500.00 M 2.500 KM
 BEST ESTIMATE..... 2500.00 M 2.500 KM
 VOLUME OF RESERVOIR..... 3.750 KM**3 TO 75.000 KM**3
 BEST ESTIMATE..... 25.000 KM**3
 COMMENTS: DEPTH TO BOTTOM OF RESERVOIR IS ASSUMED.

RESERVED

20-23

TOTAL STORED HEAT.....	1.4651E+18 J	3.4999E+17 CAL	TO 2.9302E+19 J	6.9999E+18 CAL
BEST ESTIMATE.....	9.6274E+18 J	2.2999E+18 CAL	ABOVE 15.	C

GEOLOGY

GENERAL ROCK TYPES: CRETACEOUS OR TERTIARY GRANODIORITE, QUATERNARY ALLUVIUM & LAKE SEDIMENTS

PRIMARY REFERENCE:

AUTHOR..... D.E. WHITE & D.L. WILLIAMS, EDITORS
 DATE..... 1975
 TITLE..... ASSESSMENT OF GEOTHERMAL RESOURCES OF THE UNITED STATES - 1975
 REFERENCE... U.S.G.S. CIRCULAR 726

RELATED REFERENCES:

- 1) BOHMAN, H.F., 1969, GEOLOGY AND MINERAL DEPOSITS OF WASHOE AND STOREY COUNTIES, NEVADA: NEVADA BUR. MINES BULL. 70
- 2) HARKNER, R.H., & OTHERS, 1974, THE CHEMICAL COMPOSITION AND ESTIMATED MINIMUM THERMAL RESERVOIR TEMPERATURE OF THE PRINCIPAL HOT SPRINGS OF NORTHERN AND CENTRAL NEVADA: U.S.G.S. OPEN-FILE REPORT
- 3) GLIMSTED, F.H., AND OTHERS, 1975, PRELIMINARY HYDROGEOLOGIC APPRAISAL OF SELECTED HYDROTHERMAL SYSTEMS IN NORTHERN & CENTRAL NEVADA: U.S.G.S. OPEN-FILE REPORT 75-56
- 4) WARRING, G.A., 1965, THERMAL SPRINGS OF THE UNITED STATES AND OTHER COUNTRIES OF THE WORLD-A SUMMARY: U.S.G.S. PROF. PAPER 492

RECORD 00071

GEOHERMAL RESOURCES FILE (GEOHERM) REVISION 6

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0000798
 CROSS INDEX NO.. MAR00P2
 RECORD TYPE..... B
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/03
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOHERMAL FIELD-AREA.. GREAT BOILING SPRINGS (GERLACH HOT SPRINGS)
 NAME OF SAMPLE SOURCE.. UNNAMED HOT SPRING NEAR GREAT BOILING SPRING
 COUNTRY CODE..... US COUNTRY NAME..... UNITED STATES
 STATE/PROVINCE..... NEVADA COUNTY..... WASHOE
 LATITUDE..... 40-39.9 N LONGITUDE..... 119-22. W

TOWNSHIP	RANGE	SECTION	1/4	1/4
32N	23E	10	SW	NW

SAMPLE INFORMATION

SOURCE TYPE..... SPRING
 COLLECTION DATE..... 1975/08/20
 COLLECTOR(S)..... MARINER AND EVANS
 POINT OF COLLECTION..... NEAR ORIFICE OF SPRING
 WATER SAMPLING TEMP.... 89.5 C
 WATER FLOW RATE..... 1.67 L/S 100. L/MIN
 WATER TREATMENT DATA: PRESSURE FILTERED THROUGH A .1 MICROMETRE MEMBRANE FILTER, METAL ANALYSES ACIDIFIED WITH NITRIC ACID, DILUTED
 OTHER CHEMICAL CHARACTERISTICS: SPRING RISES IN EXCAVATION ON NORTH SIDE OF GRADED ROAD FROM GERLACH TO SOLDIER MEADOWS, ESTIMATED FLOW RATE 100 L/MIN. ALKALINITY REPORTED AS BICARBONATE.

WATER ANALYSIS W

ANALYSIS DATE..... 1975
 ANALYSIS(S)..... BARNES GROUP
 PH 1)..... 7.62
 SPECIFIC CONDUCTANCE..... 6350. UMHO/CM
 ALKALINITY..... 68. MG/L

ISOTOPIC DATA

DEL D(18) OF WATER..... -11.65 0/00
 DEL D OF WATER..... -106.5 0/00

SOLUTE ANALYSIS (WATER)

UNITS USED..... MG/L

LI	NA	K	RE	CS	NA+K
1.5	1400	86	.62	.2	
MG	CA	SR	BA	CA+MG	
1.0	58				
MM+3	BR(101)	FE+2	FE(101)	CU	
	.01		LT .62		

ZK	EC	E 7.1	HD02	AL .011	PB	AS	SE	U
F 4.8	CL 2050	BR	1					
O2	N2	CO2	SO2	H2S LT .5	H2	CH4		
NH4 1.13	NO3	PO4	SIO2 145	SO4 350	CO3	HCO3		

COMMENTS: OXYGEN SHIFT RELATIVE TO METEORIC WATER LINE +2.91
 REFERENCES: MARINER, R. H., PRESSER, EVANS, CHEMICAL DATA FOR EIGHT SPRINGS IN NORTHWESTERN NEVADA

RECORD 00072

GEOCHEMICAL RESOURCES FILE (GEOCHEM) REVISION 6

SECTION B.- CHEMICAL ANALYSIS

RECORD IDENTIFICATION

RECORD NO..... 0007184
 CROSS INDEX NO..
 RECORD TYPE..... F
 SAMPLE TYPE..... SURFACE

NAME..... SANFORD, LINDA J.
 DATE..... 76/06
 ORGANIZATION.. USGS

GEOGRAPHIC LOCALITY

GEOCHEMICAL FIELD-AREA.. GREAT BOILING SPRINGS (GERLACH HOT SPRINGS)

COUNTRY CODE..... US

COUNTRY NAME..... UNITED STATES

STATE/PROVINCE..... NEVADA

COUNTY..... WASHOE

SAMPLE INFORMATION

SOURCE TYPE..... POOL
 COLLECTION DATE..... 1954/07/31
 COLLECTOR(S)..... D. F. HEWETT
 POINT OF COLLECTION..... MAIN POOL

WATER ANALYSIS

W

ANALYSIS DATE..... 1954/09/10
 ANALYST(S)..... R. BRENNAN
 PH 1)..... 7.2 COLOR 4
 SPECIFIC CONDUCTANCE..... 7270. UMHD/CM
 ALKALINITY..... 185. PPM AS CaCO_3
 TOTAL DISSOLVED SOLIDS... 4370. PPM

AT 25. C

SOLUTE ANALYSIS (WATER)

UNITS USED..... PPM

LI	NA	K	KB	CS	NA+K			
1.9	1460	124						
MG	CA	SR	BA	CA+MG				
.7	73							
ZN	MG	U	HCO2	AL	PB	AS	SB	U
		.1						
F	CL	BR	I					
4.6	2180							
NO3	NO3	PO4	SIO2	SO4	CO3	HCO3		
	.4		172	380	0	91		

COMMENTS: B = 0.51% OF EQ. FOR ANALYSIS OF SALINE CRUSTS, SEE REFERENCES, YOUNG.
 REFERENCES: FROM PERSONAL FILE OF DON WHITE, USGS, MENLO PARK.

YOUNG, GEO. J., PROF. PAPER 62, P. 19 BUREAU OF SOILS: U.S. DEPT. OF AGRICULTURE, 1914

APPENDIX A

REFERENCES

- 1,1A. Jet Propulsion Laboratory, Report on the Status of Geothermal Energy Resources in California, 5040-25, Pasadena, CA, California Institute of Technology, March 31, 1976. Ref. 1 is main text, 1A is appendix.
2. U.S. Department of the Interior, Fish and Wildlife Service, Geothermal Project 1976, Handbook, NP-21172, GPO 1976-740-06271, June 1976.
- 3 (1-III). Jet Propulsion Laboratory, Program Definition for the Development of Geothermal Energy, Vol. 1 Background and Program Definition Summary, Vol. 2 Program Definition Development Rationale and Subprogram Descriptions, Vol 3 Appendix, Pasadena, CA, California Institute of Technology, August 29, 1975.
4. TRW and Jet Propulsion Laboratory, A Study of Geothermal Prospects in the Western United States, Report No. 28453-6001-RU-00, Redondo, CA, August 20, 1975.
5. U.S. Department of Commerce, The National Oceanic and Atmospheric Administration, Climates of the States, Vol II - Western States including Alaska and Hawaii, Water Information Center, Inc., Port Washington, NY, 1974.
6. U.S. Department of the Interior, Geological Survey, The National Atlas of the United States of America, Washington, DC, 1970.
7. U.S. Department of the Interior, Geological Survey, Assessment of Geothermal Resources in the United States - 1975, USGS Circular 726, D. E. White, D. L. Williams, editors, 1975.
8. U.S. Department of the Interior, Geological Survey, "Geothermal Resources File (Geotherm) Revision 8," Reston, VA, January 1977.
9. U.S. Department of the Interior, Geological Survey, "Known Geothermal Resources Areas (KGRA's) as Classified by the Indicated Area Geologists Western and Central Regions (As of January 31, 1976)," Reston, VA, January 31, 1976.
10. Gilmore, Donald B., Environmental Protection Agency, letter to Morris Altschuler, GEMI, RD-661 on time schedule for geothermally produced electricity, Las Vegas, NV, November 22, 1976.
11. Geothermal Resources Council, "Bulletin," Volume 5, Number 3, Davis, CA, July 1976.

12. Bureau of Land Management, Personal Communication, Washington, DC, January 1977.
13. Bechtel Corporation, Conceptual Design of Commercial 50 MWe (Net) Geothermal Power Plants at Heber and Niland, CA (Draft), prepared for ERDA, Contract E(04-3)-1124, San Francisco, CA, July 1976.
14. "The Geyser," International Geothermal Energy Newsletter, Vol. 3, Issue 19, Beverly Hills, CA, January 29, 1977.
15. Geothermal Resources Council, "Bulletin," Vol. 5, Number 4, Davis, CA, September/October 1976.
16. "The Geyser," International Geothermal Energy Newsletter, Vol. 3, Issue 18, Beverly Hills, CA, January 10, 1977.
17. Orrin Gilbert, Bureau of Land Management, Personal Communication, Washington, DC, February 1, 1977.
18. Jack Salisbury, ERDA-DGE, Personal Communication, Washington, DC, October 15, 1976.
19. Dave Williams, ERDA-DGE, Personal Communication, February 11, 1977.