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STATE GEOTHERMAL COMMERCIALIZATION PROGRAMS IN SEVEN ROCKY MOUNTAIN STATES

Semiannual Progress Report
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PREFACE

The continuing efforts of the seven Rocky Mountain Basin and Range Commercialization teams in areas of public outreach, creative technical applications, innovative institutional arrangements, and positive encouragement in the use of geothermal energy are contributing to the awareness and development of this valuable alternative energy source. This document describes the accomplishments and findings of these seven commercialization teams during the last six months of 1981.

SUMMARY OF DEPARTMENT OF ENERGY STATE GEOTHERMAL COMMERCIALIZATION PROJECT IN THE ROCKY MOUNTAIN BASIN AND RANGE REGION

1.0 INTRODUCTION

This report chapter contains three sections that describe the activities and findings of the seven state commercialization teams participating in the Rocky Mountain Basin and Range commercialization program. The period covered is July through December 1981. Section 1.0 provides background information, discusses program objectives and the technical approach that is used, and describes the benefits of the program. The summary of findings is found in Section 2.0. Prospect identification, area development plans, site specific development analyses, time-phased project plans, the aggregated prospective geothermal energy use, and institutional analyses are discussed. Section 3.0 covers public outreach activities and summarizes findings and recommendations.

Unless indicated otherwise, the information presented in this summary originates with the State Commercialization Team reports that comprise the rest of the report. Those later chapters describe in similar format the commercialization activities carried out by the respective state teams.

1.1 Background

The Rocky Mountain Basin and Range Regional Hydrothermal Commercialization Project was initiated in 1977 to stimulate geothermal commercialization throughout the region. This program is a cooperative effort involving the U. S. Department of Energy (DOE) and seven states in the Rocky Mountain region. The Department of Energy is cooperating with other groups of states and local governments throughout the country in similar geothermal commercialization programs to ensure that the program elements reflect state and local as well as national goals.

DOE has provided support for state geothermal programs through cooperative agreements with state agencies that were selected by the respective governors' offices. The cooperative agreements support activities in planning, analysis, and marketing of geothermal energy and technical assistance to prospective users and developers. The state commercialization program is closely intertwined with the DOE-sponsored state-coupled geothermal resource assessment programs, which provide inventories and reservoir data about the geothermal resource areas in each state. Coordination of these two closely-related programs of resource assessment and commercialization helps assure that these efforts are all directed toward the single goal of stimulating the uses of geothermal energy. Now that the state commercialization programs are well-established, state and local governments have the expertise available to continue programs that provide both technical information and assistance to prospective developers and users.

The Idaho Operations Office of the Department of Energy (DOE-ID) has cooperative agreements with seven Rocky Mountain Basin and Range states (Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming) to conduct state geothermal commercialization programs. These seven states provide a portion of the funding and thus share the cost of this program with the Department of Energy.

The states are assisted in their efforts by additional contractors who provide technical support: The University of Utah Research Institute, Earth Science Laboratory (UURI/ESL) provides resource assessment assistance; the New Mexico Energy Institute (NMEI) provides preliminary economic analyses; and EG&G Idaho, Inc. (EG&G) provides preliminary engineering assistance, coordination with other DOE programs, and other support services.

EG&G Idaho, Inc., now coordinates the state team efforts. A new emphasis has been placed on these efforts. Rather than directing their efforts toward achieving long-range plans, the State Teams have been solicited as to which efforts would be the most productive. As a result, a variation is seen in the accomplishments of the various teams. In states where geothermal energy use is not large, the emphasis remains on long-range planning. In other states where geothermal resources are more pronounced and more available for immediate use, the emphasis of the teams has shifted toward outreach in order to allow interested parties access to data and information that is of more immediate use.

In order to assist in this latter effort, technical information and technical assistance, which previously had been handled more or less independently by the regional technical assistance center, EG&G Idaho, has been coordinating more closely with the state teams. Requesters of information and assistance are referred back to the state teams for initial assistance. Only when the state teams find their resources limited are requests forwarded to EG&G Idaho. This results in closer coordination between the state teams and the technical assistance center. As a result, the state teams have become more involved generally in direct outreach activities, thus reducing requests to EG&G Idaho. Conversely, the number of requests to the technical assistance center has been reduced markedly from its rapid growth; however, the nature of the requests has required more extensive involvement by EG&G Idaho engineering staff. This arrangement seems to more effectively involve both the state team and technical assistance center expertise in stimulating interest in geothermal energy use.

1.2 Objectives

Several major objectives are identified to achieve the goal of increased geothermal commercialization through the activities of the state commercialization program. They include:

- Match geothermal sites with potential markets to identify and rank "targets of opportunity" where state commercialization efforts will be concentrated.

- Identify and describe the actions needed by both private and public participants for geothermal commercialization.

- Stimulate interest and cooperative action among the participants in geothermal commercialization.

- Stimulate development of geothermal resources in the private sector by providing technical information, including permit requirements and financial, economic, engineering, and resource information.

- Help stimulate economic development through identification of geothermal energy potential for industrial and utility use and coordination with state economic development agencies.

- Identify the constraints to geothermal commercialization, and recommend ways to alleviate them where appropriate.

1.3 Technical Approach

The technical approach of the State commercialization projects has been to use existing information and data from available sources whenever possible. Interviews and discussions with a variety of state and local participants contribute data, direction, and ideas. Both quantitative and qualitative analyses are performed as necessary. Within these parameters and the objectives indicated in Section 1.2, a number of specific tasks were defined and performed. Although the specific tasks vary in scope and detail, all the states incorporated ten tasks into their contracts with DOE. The nature of each task is listed below; progress on each will be found in the respective State Sections.

1.3.1 Outreach

Outreach programs are conducted by each state to promote the use of geothermal energy by industry, utilities, private citizens, business, agriculture, government, and communities. A technical assistance program provides prospective geothermal users and developers with information about all aspects of development, including laws and regulatory processes, preliminary economic and engineering feasibility, and the geothermal resource.

1.3.2 Prospect Identification

Data about geothermal resources and sites are documented in order to identify the potential geothermal energy resources. These data include a classification of the resources as either electrical power generation or direct thermal application, and whether the resource is proven, potential, or inferred, on the basis of definitions for those terms that were established in previous studies (Meyer and Davidson, 1978).

1.3.3 Energy and Economic Analyses

Energy consumption and economic data are collected and analyzed to provide a basis for calculating current and future energy demand. This in turn is used to estimate the market demand for geothermal energy. Energy consumption is described or estimated by type of use and by commercial, residential, and industrial sectors. Industrial users are described by four-digit standard industrial classification (SIC) codes.

1.3.4 Area Development Plans

An Area Development Plan (ADP) provides an assessment of the possible geothermal supply and demand over time. It covers a broad area, either a county or several counties in most cases, and includes the known resource sites and the identified prospective energy users within that area. It is a source of energy and economic data for the New Mexico Energy Institute analyses as well. The ADPs generate the targets for the Site-Specific Development Analyses.

1.3.5 Site-Specific Development Analyses

Using targets identified by ADPs or other selection processes, Site-Specific Development (SSDAs) are written as tools for marketing geothermal energy. They identify specific applications of the energy for business, industry, government, and residential sectors. Analyses are prepared for major geothermal resource prospects and uses or users. They include examination of a variety of issues, including the technological, economic, environmental, institutional, developmental, and use considerations. Communication with the prospective users and developers is established and maintained to assure realism and implementation.

1.3.6 Time-Phased Commercialization Project Plans

If additional detailed planning is required beyond the SSDA document, detailed project management plans showing specific activities and deadlines are prepared. These plans are completed for a limited number of sites that are in advanced stages of development or commercialization. They reveal actions by both private and government sectors needed to achieve commercial operation, and they stimulate cooperative interactions to accomplish the project milestones. Step-by-step procedures are described and shown on a time-line chart. Direct communication between the geothermal developer and the governmental entities is required and produced during the process.

1.3.7 Institutional Analyses and Handbooks

The local, state, and federal regulatory systems and practices for geothermal activity are documented and analyzed to understand the effects on the rate of utilization.

1.3.8 State and Regional Aggregations of Development Plans

The geothermal prospects included in all three types of plans are aggregated to obtain estimates of the amount of geothermal energy that can be developed and used between now and the year 2020.

1.3.9 Identification of Constraints and Recommended Actions

Technological, environmental, economic, and institutional constraints that might delay or preclude the development of geothermal energy are examined. Possible solutions are evaluated, leading to recommendations for actions, to be taken by local, state, and federal governments and by the private sector.

1.3.10 Marketing

As this program progresses, the emphasis changes from a planning activity to outreach, and finally to marketing geothermal energy within the states.

1.4 Benefits

The benefits to be gained from geothermal projects are numerous. The ultimate goal is the replacement of energy from fossil fuels with energy from untapped domestic resources. Conserving natural gas and other fossil fuels can either directly or indirectly affect that goal. The value of the conventional energy saved, less the total project costs to put geothermal energy on line, gives a conservative estimate of benefits. However, when funds are spent within this country rather than being exported, they have a multiplier effect that should be considered. Taxes paid by the developer or user are an additional benefit to the government.

For national planning, programming, and budgeting purposes, the information produced by State Commercialization Projects is essential. The projects provide realistic assessments of how much geothermal energy can and is likely to be produced within a specific time frame and by what consuming sectors. From this information, public and private expenditures congruent with the amount of energy can be appropriately allocated to stimulate geothermal production and use.

Indirect benefits include local values such as lower fuel bills for users and economic development stimulated by the lower cost of energy. Furthermore, the assurance that a supply of energy will be available at a comparatively stable price can help both the private and public sectors to plan for their futures.

During this report period, the actions of these State Geothermal Commercialization Teams and various public and private resources have heightened the awareness of officials and residents, and have stimulated many projects that may have a significant effect on the energy uses within the region.

2.0 SUMMARY OF ACCOMPLISHMENTS

Identification and stimulation of geothermal commercialization projects requires the synthesis of three elements. The geothermal resource must be of a suitable quality and magnitude. A user must be available who is either already located at the resource site or willing to locate at or near it. The site itself, including institutional, economic, demographic, environmental, and other facets, must be suitable for the proposed use. The tasks accomplished by the states were directed toward first revealing the opportunities to effect such three-way matches and then actively participating in implementation.

2.1 Resource Identification

The identification and categorization of geothermal resource prospects is a continuing process in each state. The most current information regarding the number of prospects in the seven states is summarized in Table 1-1. This indicates that there are presently a total of 19 geothermal sites in the region that have electrical power generation potential. Two of these sites have been classified as proven, five as potential, and twelve as inferred. These numbers will continue to change as exploration and reservoir confirmation continues. On the basis of exploration results, some areas are added and others are reclassified into another category. In some states, little interest has been expressed in electrical power generation,

TABLE 1-1. NUMBER OF GEOTHERMAL RESOURCE SITES

	High-Temperature Electric Prospects				Low-Temperature Direct Thermal Prospects				
State	Proven	Potential	Inferred	Total	Proven	Potential	Inferred	Total	Grand Total
Colorado[a]	0	0	1	1	4	7	46	57	58
Montana[b]	0	0	0	0	3	22	46	71	71
New Mexico	1	4	10	15	10	11	10	31	46
North Dakota[b,c]	0	0	0	0	0	71	0	71	71
South Dakota[d]	0	0	0	0	56	12	NA	58	58
Utah	1	1	2	3	6	9	35[b]	50	53
Wyoming	0	0	0	0	2	29	6	37	37
Totals	2	5	12	19	81	161	143	373	351

a. This includes only those sites that have been inventoried by the Colorado Geological Survey.

b. Heat report data used.

c. The Madison, Dakota, Fox Hills, Hell Creek, and other less extensive aquifers are currently being surveyed for geothermal potential, and the list is continuously being revised.

d. The Madison Formation in the western part of South Dakota offers geothermal potential; this refers to those sites where towns are located.

but federal lease applications have been submitted. As Table 1-2 shows, as of October 1977, some 1402 federal geothermal lease applications had been submitted. By 1979, only 1,058 federal leases had been issued. The lease interest may indicate a large inferred potential for high-temperature resources. In any case, detailed investigations of leasing activity have indicated that the major part of that activity is directed toward the identification of sites for power generation. Too few leases have been issued and too few sites have been explored to conjecture how many sites will ultimately prove to be suitable for electrical power.

There are many locations where geothermal resources are a valuable source of energy for space and water heating and for commercial, agricultural, and industrial uses. Table 1-1 shows that as many as 369 sites are suitable for these uses, not counting the large but undefined Dakota and Madison aquifers that underlie much of the Northern Plains.

Additional details about the geothermal resource prospect development are discussed in the individual state summary reports.

2.2 Highlights of State Accomplishments

In the sections that follow, each of the state teams has presented its activities and accomplishments for this reporting period. To accentuate

TABLE 1-2. GEOTHERMAL LEASING ON PUBLIC LANDS IN THE ROCKY MOUNTAIN BASIN AND RANGE REGION

	Acres Leased			Number of Leases Issued			
	State	Federal	Total	State	Federal	Total	Number of Federal Lease Applications[a]
Colorado	3,200	22,999	26,199	4	17	21	48
Montana[b]	-0-	10,687	10,687	-0-	6	6	97
New Mexico	21,184	225,710		53	140		508[b]
North Dakota	-0-	-0-	-0-	-0-	-0-	-0-	-0-
South Dakota	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Utah	243,184	459,138[b]		248	275[b]		657[b]
Wyoming	1,150	7,448	8,598	1	4	5	92
Totals	281,928	951,692	284,404	346	565	196	1,910

a. Noncompetitive and competitive Federal leases, as of October 1977 (Beeland, 1978), plus update report of Colorado.

b. Last report data used.

SOURCES: Uses and State Geothermal Commercialization Teams.

these accomplishments, some of the more important achievements are highlighted below. Please refer to the appropriate state section for more detail on these achievements.

2.2.1 Colorado

- The City of Alamosa drilled a well with funding from the User Coupled Drilling Program. The planned uses for the well are space heating and barley malting.

- At Glenwood Springs, two commercial developers, Wright Water Engineers and the Redstone Corporation, drilled their planned wells.

- An analysis of the Colorado geothermal institutional framework was published.

2.2.2 Montana

- About 67 thermal springs and 30 thermal wells have been recorded and analyzed by the Montana Bureau of Mines and Geology.

- A four-part series about geothermal development appeared in the Butte Montana Standard newspaper in November. Other newspapers also ran articles about geothermal development.

- Personal contact with geothermal developers through telephone calls, visits, or letters is proving to be the best information dissemination method.

2.2.3 New Mexico

- Construction began July 1 on a hot water heating system for 30 campus buildings at New Mexico State University at Las Cruces. $829,000 was appropriated during the 1981 legislative session to finance the construction.

- Technical assistance and information were shared with 23 companies that have potential geothermal commercialization activities in Dona Ana County.

- The greatest interest in geothermal development is being shown in Dona Ana County in the southern part of the State.

2.2.4 North Dakota

- Program personnel located funding for several geothermal studies and helped 10 developers apply for public and private financial assistance.

- The State Industrial Commission received the authority to regulate the exploration, development and utilization of geothermal resources in the State.

- Program emphasis switched during the reporting period from planing activities to more advanced technical assistance to communities and private developers interested in geothermal district heat and cooling systems and in larger-scale commercial and community projects.

- A feasibility study substantiated the economic and technical feasibility of a district heating system for the city of Dickinson.

- A shallow test well proved adequate flow and temperature for heat pump use in an existing school at Oakes.

2.2.5 South Dakota

- Two communities are seeking funding for geothermal heating projects. Philip is seeking funding for further development of district heating, using the discharge from the Haakon County School. Lemmon is seeking funding for space heating in a 14-block downtown area.

- The geothermal heating system at St. Joseph's Indian School in Chamberlin began operating October 29.

2.2.6 Utah

- A new rotary separator turbine was successfully tested at Roosevelt Hot Springs.

- The first electrical power generated from geothermal resources in Utah was fed from the Roosevelt Hot Springs installation to an electrical utility.

- Preliminary design work was finished for the space heating project in the Utah State Prison.

2.2.7 Wyoming

- The final site-specific development analysis for Cody was finished during the reporting period.

- Thermopolis was selected for DOE-sponsored community assistance for their district heating system project.

- A commercial greenhouse for vegetable production began using 126°F water for heating.

- "Opportunities for Use of Geothermal Energy in Wyoming Industries," a packet of materials, was issued in November.

- A U.S. Senate subcommittee held a hearing in Casper concerning geothermal leasing in areas adjacent to Yellowstone National Park.

3.0 OBSERVATIONS AND CONCLUSIONS

3.1 Outreach Mechanisms

- The technical assistance program has contributed significantly to the growth of geothermal energy use, and to project success.

- The distribution of heat pump literature, coupled with personal contacts, continues to cause a definite increase in the use of heat pumps, an area of application that is promising to become a significant geothermal application. State agencies and organizations are starting to encourage their members to actively participate in geothermal energy commercialization.

- Public awareness created by the varied outreach activities of the state teams continues to increase favorably. The use of newsletters appears to be generating the greatest response. Personal contacts with individuals and groups are also contributing significantly to the interest in, and the development of, geothermal energy.

- Informing bankers and community leaders about geothermal energy is making them more willing to support development.

- State research and development programs, state geothermal demonstration programs, and the Appropriate-Technology Small Grants program are continuing to elicit positive responses. Assistance being provided in preparing geothermal legislation will continue to encourage the use of geothermal energy.

3.2 Conclusions

- Contacts with geothermal developers continues to reveal that they are in much need of help, including receiving general information and technical assistance. The state teams are shifting toward more technical assistance activities. This is producing significant results. This effort should be increased, and the services of especially qualified geothermal persons should be made available on a periodic basis, say 30 to 90 days, to the state teams to strengthen their position.

- Significant contributors to the development of geothermal energy continues to be the R&D and the demonstration programs of New Mexico. The funding provided by the state has had a substantial impact on development, technology transfer and outreach. Efforts should be directed to obtaining funding to increase this type of outreach activity.

- Interest is running high, but inadequate legislation, the risk associated with "first holes," funding limitations, the lack of financial incentives, and the need for technical assistance are limiting development. Restriction of Federal funding is tempering the enthusiasm for development. Therefore, removal or mitigation of these items should occur to accelerate geothermal energy development and use.

- The appropriate technology small-grants program has been effectively used as an outreach mechanism to encourage geothermal energy development.

- Community supported projects should benefit not only the community, but others as well, because they will serve as successful working models.

- Efforts need to be directed to change the federal tax laws to allow credits for systems using groundwater heat pumps.

- A simpler method is needed to allow potential geothermal developers to use abandoned mineral exploration wells without the capital-intensive in perpetuity bonding regulations.

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COLORADO GEOTHERMAL COMMERCIALIZATION PROJECT

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July-December, 1981

Prepared by

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Colorado Geological Survey

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COLORADO GEOTHERMAL COMMERCIALIZATION PROJECT SEMIANNUAL

PROGRESS REPORT, JULY-DECEMBER, 1981

1.0 INTRODUCTION

1.1 Purpose of Project

The Colorado Geothermal Commercialization Project exists to promote the development of geothermal energy in Colorado.

1.2 Objectives

To assist and educate potential users of geothermal energy through outreach mechanisms and technical assistance.

1.3 Team Members and Approach

Richard H. Pearl, project coordinator, Kevin P. McCarthy, geologist, and Ms. Becky Nelson, secretary.

1.3.1 Approach

Produce a monthly newsletter and perform market development tasks. Market development activities are to be concentrated in the communities of Steamboat

Springs, Ouray, Alamosa, Buena Vista, Salida and Glenwood Springs. These activities are to include the development of educational and informational materials applicable to a wide range of potential users. Work to be performed include the preparation and mailing of a monthly newsletter. The newsletter is written monthly and mailed to approximately 275 persons throughout the United States.

A pamphlet titled "Groundwater Heat Pumps in Colorado-An Efficient and Cost Effective Way to Heat and Cool Your Home" was written by Garing and Connor (1981) of the firm Coury and Associates. This report was reprinted in December, 1981.

1.4 Project Benefits to the State and DOE

Citizens of the State are becoming aware that the geothermal resources of Colorado can be are a valuable resource and can be put to beneficial use. D.O. E. benefits: Geothermal energy use increasing, energy dependence of the nation decreasing.

2.0 SPECIFIC TASK DESCRIPTIONS AND PROJECT

2.1 Geothermal Prospect Identification

2.1.1 Electrical Generation (over 150°C)

No sites in Colorado have been proven yet for electrical generation. At Mount Princeton, one of the potential sites noted in the July-December, 1980 Semi-Annual Report, (Pearl, 1981) AMAX Exploration, Inc. after completion of exploration efforts has reassigned their leases to Petro-Lewis Corp. As a result this area has been downgraded from electrical potential to direct use potential (Table 2).

TABLE I. Inferred Electrical Power Generation Areas (>150°C)
(All areas classified as inferred)

Site	Highest Measured Surface Temp. (°C)	Estimated Probable Subsurface Temp. (°C)	Estimated Probable Heat Content (BTU's x 1015)	Depth
47 Cebolla Hot Springs	40	NA	0.048	? m

TABLE 2. INFERRED DIRECT THERMAL AREAS (<150°C)

Site	Highest Measured Surface Temp. (°C)	Estimated Probable Subsurface Temp. (°C)	Estimated Probable Heat Content (BTU's x 1015)	Depth
01 Juniper Warm Springs	38	50-75	0.016	? m
02 Craig Water Well	39	40-60	0.033-0.340	?
03 Routt Hot Springs	64	125-175	0.111-0.166	?
04 Steamboat Hot Springs	39	125-130	0.049	?
05 Brand's Ranch Well	42	42-55	0.004-0.016	?
06 Hot Sulphur Springs	44	75-150	0.070	?
07 Haystack Butte Well	28	50	0.006-0.017	?
08 Eldorado Warm Springs	26	26-40	0.015	?
09 Idaho Warm Springs	46	NA	0.171	?
10 Dotsero Hot Springs	32	32-45	0.005	?
12 South Canyon Springs	49	100-130	0.002	?
13 Penny Hot Springs	56	60-90	0.166-0.486	?
14 Col. Chinn Well	42	NA	0.018	?
15 Conundrum Warm Springs	38	40-50	0.004	?

TABLE 2. INFERRED DIRECT THERMAL AREAS (<150°C) (CONTINUED)

Site	Highest Measured Surface Temp. (°C)	Estimated Probable Subsurface Temp. (°C)	Estimated Probable Heat Content (BTU's x 1015)	Depth
16 Cement Creek Springs	25	30-60	0.013-0.066	?
17 Ranger Warm Springs	27	30-60	0.002-0.006	?
18 Rhodes Spring	24	25-35	0.043-0.200	?
19 Hartsel Hot Springs	52	NA	0.047	?
22 Brown's Canyon Springs	25	50-100	0.226-0.486	?
24 Wellsville Warm Springs	33	35-50	0.009-0.015	?
25 Swissvale Warm Spring	28	35-50	?	?
29 Don K Ranch	28	NA	0.035	?
30 Clark Warm Water Well	25	25-50	0.008	?
32 Valley View Warm Springs	37	40-50	0.056	?
33 Shaws Warm Springs	30	30-60	0.015	?
34 Sand Dunes Well	44	NA	0.155	?
35 Splashland Well	40	40-100	0.155	?
36 Dexter Warm Springs	20	20-50	0.034	?
37 McIntyre Warm Springs	14	20-50	?	?
38 Dutch Crowley Well	70	70-80	0.026-0.062	?
39 Stinking Springs	27	40-60	?	?
40 Eoff Well	39	40-60	0.017	?
42 Rainbow Warm Spring	40	40-50	0.047-0.094	?
43 Wagon Wheel Gap Spg.	57	NA	0.063-1.429	?
44 Antelope Warm Spg.	32	35-52	0.011-0.088	?
45 Birdsie Warm Spg.	30	35-52	?	?
48 Orvis Warm Springs	52	NA	0.028-0.131	?
50 Lemon Warm Springs	33	NA	0.015	?
51 Dunton	42	50-70	0.007	?
52 Geyser Spring	28	60-120	0.007	?
53 Paradise Hot Springs	46	NA	0.023	?

TABLE 2. INFERRED DIRECT THERMAL AREAS (<150°C) (CONTINUED)

Site	Highest Measured Surface Temp. (°C)	Estimated Probable Subsurface Temp. (°C)	Estimated Probable Heat Content (BTU's x 1015)	Depth
54 Rico	44	NA	0.174	?
55 Pinkerton Warm Spring	33	75-125	0.010-0.021	?
56 Tripp/Trimble	44	45-70	0.036	?
57 Stratton Warm Spg.		?	?	?
58 Piedra River Spg.		?	?	?

TABLE 3. POTENTIAL DIRECT THERMAL AREAS (<150°C)

Site	Highest Measured Surface Temp. (°C)	Estimated Probable Subsurface Temp. (°C)	Estimated Probable Heat Content (BTU's x 1015)	Depth
23 Poncha Hot Springs	71	115-145	0.141-1.91	?
26 Canon City	40	NA	0.003	305
27 Fremont Well	35	35-50	0.010	to
28 Florence Well	28	34-50	0.008-0.043	1,524
31 Mineral Hot Springs	60	70-90	0.949	?
46 Waunita Hot Springs	80	175-225	0.061	?
49 Ouray	69	70-90	0.226	?

TABLE 4. PROVEN DIRECT THERMAL AREAS (<150°C)

Site	Highest Measured Surface Temp. (°C)	Measured Subsurface Temp (°C)	Estimated Probable Heat Content (BTU's x 1015)	Depth
11 Glenwood Springs	51	60	0.38	30-100
20 Cottonwood Springs	58	150-200	0.389-1.167	? m
21 Chalk Creek				
Mt. Princeton	56	150-200		?
Wright Water Well	72	150-200		?
Hortense Hot Spring	82	150-200		?
Woolmington Well	39	150-200		?
41 Pagosa Springs	58	80-150	0.023	90-200

Classification of the above systems is based on the following critera:

- o Proven. Test and/or production wells have been drilled. Limited use of waters being made for direct uses.

- o Potential. Some type of resource assessment work has been done by the Colorado Resource Assessment Team or private companies have released their exploration data to the general public. Based on this information, an estimate can be made of the size and magnitude of the resource.

- o Inferred: A spring or thermal well has been located, field mesurements of pH, temp., or discharge made, and in most instances geothermometer models analysis run.

2.1.2 Leasing

Table 5 lists current non-competitive leases on Federally owned lands, Table 6 lists current competitive Federal leases [known geothermal resource areas (KGRAs)], and Table 7 lists current leases to Colorado State owned lands.

TABLE 5. FEDERAL NONCOMPETITIVE LEASES IN COLORADO, DECEMBER, 1981

Lessee	Acres	Township and Range	County	Date Issued
Chaffee Geothermal	80.00	49N, 8E	Chaffee	11/75
Petro-Lewis Corp 50% Chaffee Geoth. 50%	1,280.00	49N, 8E	Chaffee	11/75
Petro-Lewis Corp. 50% Chaffee Geoth. 50%	2,113.30	49N, 7&8E	Chaffee	11/75
Geothemal Kinetics	1,795.11	37&38N 12 & 13E	Alamosa	11/75
	1,203.15	29S, 73W	Alamosa	11/75
	320.00	38N, 12E	Alamsoa	8/79
	642.88	37N, 12E	Alamosa	8/79
	827.31	38N&29S 1E & 73W	Alamosa	11/75
	1,335.99	29S, 73W	Alamosa	11/75
Utah Inter. Inc.	2,326.89	40&41N, 1E	Mineral	8/79
	2,335.22	40&41N, 1E	Mineral	8/79
Buttes Resource Co.	781.32	49N, 2W	Gunnison	1/77
	2,226.88	46N, 1&2W	Gunnison	1/77
	1,804.57	46N, 1 1/2W	Gunnison	1/77
	1,040.04	46&47N, 2W	Gunnison	1/77
	1,970.30	46&47N, 2W	Gunnison	1/77
Total	22,082.96			

Source: U.S. Bureau of Land Management

TABLE 6. FEDERAL COMPETITIVE LEASES IN COLORADO, DECEMBER, 1981

Lessee	Acres	Township and Range	County	Date Issued
Occidental Pet. 50%				
Petro-Lewis 50%	915.84	49N, 8E	Chaffee	7/75
Total	915.84			

Source: U.S. Bureau of Land Management

TABLE 7. COLORADO STATE GEOTHERMAL LEASES, DECEMBER, 1981

Lessee	Acres	Township and Range	County	Date Issued
Petro-Lewis Corp.*	1,560.00	49N, 7E	Chaffee	5/74
Petro-Lewis Corp.*	3,226.61	50N, 8E	Chaffee	
C.A. Underwood	2,840.00	41N, 10E	Saguache	
Chaffee Geothermal	360.00	49N, 8E	Chaffee	
Total	3,200.00			

* Dropped 2/82

Source: Colorado State Board of Land Commissioners

2.2 Area Development Plans

2.2.1 State Geothermal Planning Areas

There are no Geothermal Planning Areas in Colorado.

2.2.2 Specific ADPs completed or in preparation:

No specific Area Development Plan reports were to be prepared in 1981. ADP's were to be prepared in close support of the Outreach and Market Development programs.

2.3 Site Specific Development Plans

2.3.1 Candidate Geothermal Sites/Applications

The City of Alamosa drilled their User Coupled Drilling Program funded well. At Glenwood Springs two commercial developers, Wright Water Engineers and the Redstone Corp. drilled their planned geothermal wells

2.3.2 Site Specific Development Plans-Completed or in Preparation

No Site Specific Site Development Plans were required to be prepared during this period.

2.4 Time Phase Project Plans

No plans were prepared during this period.367

2.5 Site Aggregation of Prospective Geothermal Utilization Use

Table 8 lists the current uses of geothermal resources in Colorado

TABLE 8. USES OF GEOTHERMAL ENERGY IN COLORADO

USE	AREA
Recreation Swimming	Juniper Hot Springs Steamboat Hot Springs Hot Sulphur Springs Eldorado Warm Springs Idaho Hot Springs Glenwood Hot Springs Cement Creek Hot Springs Mt. Princeton Hot Springs Poncha Hot Springs Valley View Hot Springs Shaws Warm Springs Splashland Hot Water Well Pagosa Hot Springs Wagon Wheel Gap Hot Springs Waunita Hot Springs Ouray Hot Springs
Baths	Juniper Hot Springs Hot Sulphur Springs Idaho Hot Springs Glenwood Hot Springs Mt. Princeton Hot Springs Valley View Hot Springs Pagosa Hot Springs Cebolla Hot Springs Orvis Hot Springs Ouray Hot Springs Lemon Hot Springs Dunton Hot Springs
Space Heating	Cottonwood Creek Hot Springs Mt. Princeton Hot Springs Hortense Hot Spring Poncha Hot Springs Sand Dunes Hot Water Well Robert Owens Warm Water Well, West side of Alamosa Pagosa Springs Ouray Hot Springs Waunita Hot Springs

TABLE 8. USES OF GEOTHERMAL ENERGY IN COLORADO (CONTINUED)

USE	AREA
Other	
Laundry	Hot Sulphur Springs
Greenhouses	Penny Hot Springs
	Wright Hot Water Wells
Algae growing	Wellsville Warm Springs
Irrigation	Dutch Crowley
Bottled Water	Clark Artesian Well
Fish Farming	Sand Dunes Hot Water Well
	Wellsville Warm Spring
	Warm Water Well South of Alamosa
Pig Farms	Mineral Hot Springs
	Warm Water Wells south of Alamosa
Under Development	Glenwood Hot Springs
Space heating	Alamosa
	Ouray Hot Springs
	Poncha Hot Springs
	Warm Water Wells east of Castle Rock (Park West Corp.)

2.6 Institutional Analysis

An analysis of the Colorado geothermal institutional framework has been prepared and published (Coe and Forman, 1980). This document will not be summarized here. Copies have been distributed to D.O.E. and others.

It has been noted before in other Semi-Annual Progress Reports that several institutional problems were affecting the development of geothermal resources in Colorado. These problems related to the permitting of groundwater heat pumps wells, and a temperature definition. As of yet these problems have not been resolved, although meetings have been held with the staff of the Colorado Oil and Gas Conservation Commission, the agency responsible for permitting geothermal wells, in an attempt to resolve these problems. It is hoped that some positive action will be taken in the near future.

2.7 Public Outreach Program

2.7.1 Outreach Mechanisms

The Colorao Commercialization Team's outreach activities during the last 6 months of 1981 consisted of: Newsletter, an advertisement in Area Development Magazine, meetings with individuals either in their or our offices, answering letters and telephone calls of inquiry.

2.7.2 Summary of Contacts and Results

The following contacts were made during the report period.

July:

Margery Dorfmeister, Buena Vista
Robert Schutte, Buena Vista
Charles A. Harmon, Buena Vista
Marijo Hicks, Salida
Jim Treet, Salida
Terry Huntley, Alamosa
Guy Miles, Alamosa
Fraser Goff, Los Alamos Sci. Lab.
Leroy Payne, Alamosa
D.H. McFadden, Alamosa, Colo. Dept. of Water Res.
Jay Kunze, Idaho Falls, ID
Petroleum Pioneers Group, Denver
Margaret Petty, Mayor of Ouray, Colo.
Walt Gorrod, Ouray
Jeff Wiengard, Rancho Santa Fe, CA
Anthony and Edward Vagnino, Denver
Peter Kwass, Cambridge, MASs.

August:

John Hess, Steamboat Springs
Herb Ventker, Canon City
Western State College, Gunnison, CO, workshop
Western Energy Planners
Four Corners Regional Planning Comm, Albuquerque, N.M.

Sept.:

Alex Sifford, Elliot Allen and Assoc,
Mike Uberauga, City Manager, Steamboat Springs
Steamboat Springs Public Meeting.
Colorado Mountain College, Steamboat Springs,
J. Drislane, Peabody, Maine
Kenneth Kunda, Chicago
Energy and Man's Environment, Colorado Springs
Curbside Flowers, Denver
Ruedi Bear, Tripp Hot Springs
Park Funding Corp, Denver
Spa Motel, Pagosa Springs

Oct.:

David Woodward, Morrison
Stan Harwood, Morrison
Richard Folk, Leadville
Cindy Cray, Bailey
Sam Madich, Colorado Springs
Clarence DeVries, Denver
Craig Riglin, Denver
Kim Long, Boulder
Larry Keating, Colorado Springs
Sidney J. Hollister, Denver
Steve Blohm, Golden
Frank J. Ehko, Englewood
Gene Warren, Arvada
Kristin Rvd, Winter Park
Frank Smolka, Littleton
Bruce A. Boomer, Denver
T. Sulzbach, Wheat Ridge
Richard Ingram, Englewood
Colorado Legislature's Energy Coordinating Council
Tom Haven
Kathryn Goldner, Stoneham, Mass.
Jeff Francetic, Thousand Oaks, CA
Mr. and Mrs. Bradley, Steamboat Springs,
Thomas Leone, Buffalo, N.Y.
Mr. and Mrs. C. Williams, Steamboat Springs,
Ed Kelley, Phippsburg
D. Eudaley, Alamosa,
Sam Johnson, Steamboat Springs
G.O. Elliott, Monte Vista
Wayne Seat, Hartsel

Nov.:

Energy and Man's Environment, Colorado Springs
Geba P. Hannon, Wiggins,
Kim Girdner and David Watson, Salt Lake City, UT
Dedication of Pagoas Springs dist. heating project.

Dec.:

Denver Mining Club

In addition to the above, contact was made almost daily with other State agencies such as the Oil and Gas Conservation Commission, and the Division of Water Resources.

2.7.3 Overall prospectus for Future Geothermal Commercialization

It was reported in the Jan.- July, 1981 Semi-Annual Report that the Colorado Commercialization Team believed that geothermal development in Colorado was on the edge of a break through. However, due to the downturn in the economy and the declining envolvment of the Federal Govt. in the development of low to moderate temperature geothermal energy, it is believed that the future of geothermal energy development in Colorado is not bright. While some small projects may be developed by individuals, it is felt that any large scale commercial development of geothermal energy in Colorado will not occur for many years.

During the past several years the Federal Govt. has played an important role in the development of geothermal resources in Colorado. For example, with D.O.E. User Coupled Drilling funds, last fall the City of Alamosa drilled a deep (> 7,000 ft) geothermal well. If upon completion adequate amounts of thermal waters are found they will be used in a new malting plant. This well would not have been drilled without D.O.E. funds. The city of Pagosa Springs has just brought on line one of the most successful district heating systems in the country. This project was funded by a D.O.E. PON grant. Other projects in Glenwood Springs and Ouray have benefited from D.O.E. funding or technical assistance.

The State of Colorado has an economic development program to encourage industrial development in economically distressed areas. Fortunately, or unfortunately now in light of the federal budget cuts, most of the better thermal areas are located in economically distressed counties. The successful development of geothermal resources in these areas will greatly enhance the economic outlook of the areas. With the lack of Federal funds, either for development or for advice and assistance, it is felt that the development of Colorado's geothermal resources will be seriously impacted.

SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS:

The direct technical assistance has brought the Colorado team into contact with developers, and was thus we are able to provide a wide range of advice and assistance. This type of effort will do more to bring geothermal on line quickly, than anything else attempted. Unfortunately, if the use of geothermal resources is to occur rapidly then direct governmental financial and technical assistance is necessary. This assistance may take many forms. For example, someone should be available locally on the State level to provide general information and limited technical assistance when needed. Financial grant assistance should be available. The two most useful grant programs are the Appropriate Technology Small Grants Program and the User Coupled Drilling Program. Both of these programs are being used extensively in Colorado.

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MONTANA GEOTHERMAL COMMERCIALIZATION PROJECT

SEMI-ANNUAL REPORT

JUNE-DECEMBER 1981

Prepared by

Jeff Birkby
Geothermal Energy Specialist

Department of Natural Resources & Conservation

32 S. Ewing

Helena, Montana 59620

Work Performed under Contract No. DE-FC07-79ID12014

U.S. Department of Energy

Idaho Operations Office

1.0 INTRODUCTION

1.1 Purpose of Project

Montana has enormous geothermal energy potential, both in its rugged western mountains and valleys and beneath the open sedimentary basins in the eastern portion of the state. To assist potential geothermal developers in using this valuable energy source, the Montana Geothermal Program was created in 1979. This program provides geothermal users with information on all phases of geothermal development -- exploration, financing, engineering, and regulation. The Montana Geothermal Program has and will continue to be a valuable information clearinghouse for geothermal energy developers throughout the state.

1.2 Objectives of the Project

The objectives of the Montana Geothermal Program have changed since the program's inception as a result of both changes in program staff and in program needs. The first year of the program was spent preparing broad development scenarios and energy on-line predictions. This initial work developed the program staff's familiarity with geothermal sites in Montana and with the technology involved in using geothermal energy. Area development plans were prepared for several multi-county areas in the state, as well as preliminary site-specific development plans.

The last two years of the program have seen a change in the direction of our efforts. Instead of producing scenarios and development plans, we have concentrated on providing technical assistance to specific geothermal projects.

1.3 TEAM MEMBERS

Jeff Birkby is Program Manager for the project, and as of July 1981 has been the sole team member of the project.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

Approximately 67 thermal springs and 30 thermal wells have been recorded and analyzed by the Montana Bureau of Mines and Geology. These resources are shown on Figure 1 and Table 1.

2.2 Area Development Plans

No ADPs were completed during this work period. No further work on ADPs is anticipated under the current contract. Most of the program's efforts will continue to be devoted to outreach.

2.3 Site Specific Development Plans

No site specific development plans were completed during this time period. Redirection of our efforts to outreach makes it doubtful that any further work will be done on site specific development plans.

2.4 Time Phased Project Plans

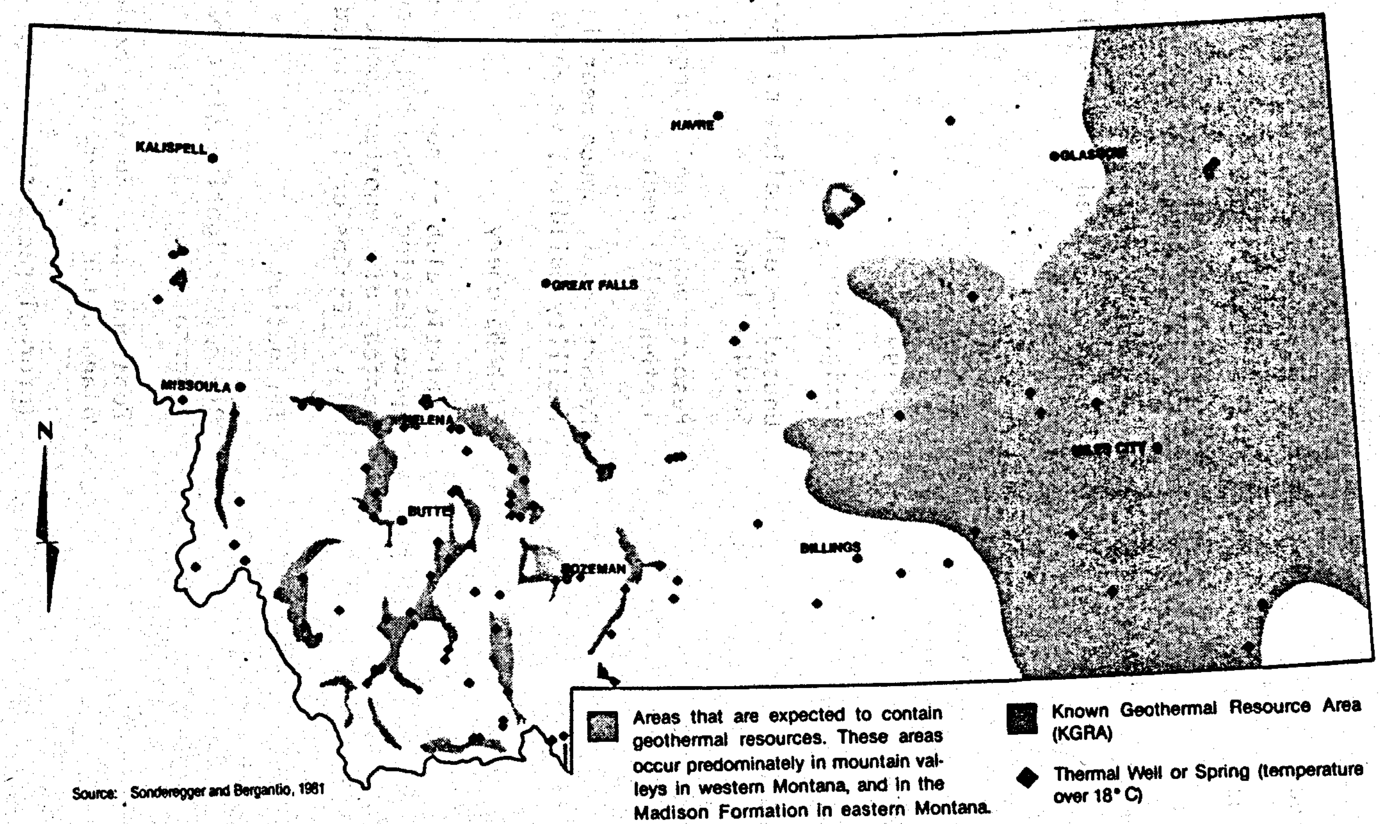
No time phased project plans were done during this work period. No further TPPPs are plannned for this program.

2.5 State Aggregation for Prospective Geothermal Utilization

A summary of current geothermal use in Montana is presented in Table #2.

2.6 Institutional Analysis

No work was done on institutional analyses during this time period.



GEOTHERMAL RESOURCES OF MONTANA

FIGURE 1

TABLE 1. PRESENT AND PLANNED USES OF MONTANA HYDROTHERMAL RESOURCES

Thermal Spring or Well	Uses
Alhambra	Hydronic space hearing of a nursing home -- gravity feed-piping in concrete slab
Anaconda	Unused
Anderson's/McLeod	Pool and spa
Anderson's Pasture	Irrigation
Apex	Irrigation
Avon	Planned solar/geothermal greenhouse (to be completed Fall 1982)
Bear Creek	Unused
Bearmouth	Unused
Beaverhead Rock	Irrigation
Bedford	Irrigation
Blue Joint 1 and 2	Unused -- elk wallow on Forest Service land
Boulder	Resort, pools, and plunges; Hotel Geothermally heated
Bozeman	Resort, pool, space hear in campground facility building, warehouse, shop
Bridger Canyon	Fish hatchery
Broadwater	Athletic club -- pool, eater-to-air space heating. One house on site heated, also another about ¼ mile away. Expansion is planned.
Brooks	Irrigation
Brown's	Planned irrigation (information uncertain)
Camas	Pool and spa. Further exploration planned for summer 1982
Carter Bridge	Informal recreational use

TABLE 1. PRESENT AND PLANNED USES OF MONTANA HYDROTHERMAL RESOURCES (Continued)

Thermal Spring or Well	Uses
Chico	Resort, pool -- planned use with water source heat pump to heat lodge
Deer Lodge Prison	Unused
Durfee Creek	Irrigation and stock watering
Elkhorn	Pool and cabins
Ennis	Small natural flow but large potential; numerous hot water wells; planned space or district heating in town; further drilling in summer 1982
Gallogly	Pool
Garrison	Unused
Granite	Hotel, small pool
Green Springs	Unused
Gregson	Large resort, pools
Greyson	Irrigation(?) -- other agricultural uses.
Halvorson	Unknown
Hunsaker	Agricultural use(?)
Hunter's	Presently unused -- old resort with great potential
Jackson	Pool -- locally used for space heating
LaDuke	Unused -- old resort
Landusky 1, 2 and Plunge	Domestic use and stock watering
Little Warm Springs 1, 2, & 3	Domestic use, stock watering, irrigation
Lodgepole 1, 2, & 3	Irrigation
Lolo	Resort, pools -- space heat in locker rooms

TABLE 1. PRESENT AND PLANNED USES OF MONTANA HYDROTHERMAL RESOURCES (Continued)

Thermal Spring or Well	Uses
Lovell's	Irrigation
McMenomy Ranch	Some agricultural use
New Biltmore	Resort; pool and plunge; home heating
Nimrod	Informal recreation
Norris	Pool
Pipestone	Unused, old resort
Plunkett's	Irrigation
Potosi 1, 2, & 3	Space heating of house (radiant slab heating)
Puller's	Old resort, unused
Quinn's	Pool, whirlpool. space heating of several buildings
Renova	Informal recreation
Silver Star	Resort, pool, water-to-air space heating
Sleeping Child	Resort, pools
Sloan Cow Camp	Bathing, stock watering
Staudenmeyer Ranch	Irrigation
Sun River	Pool
Toston	Irrigation
Trudeau	Informal recreation
Vigilante	Unused
Warm Springs	Newly drilled well -- planned space heat, domestic hot water
Warner	Irrigation
West Fork Swimming Hole	Informal Recreation

TABLE 1. PRESENT AND PLANNED USES OF MONTANA HYDROTHERMAL RESOURCES (Continued)

Thermal Spring or Well	Uses
White Sulphur Springs	Space heated bank; space heated motel; pool; planned water preheat for hospital laundry; planned four-building heating system for public buildings
Campaqua	Pools, baths, spa; planned ethanol facility
Lucas	Unknown
Marysville	Exploration well -- now plugged
Ringling	Informal recreation
Symes	Showers and bath at hotel
Saco	Pool

TABLE 2. SPRINGS, INVENTORY DATA

Spring Name	Estimated Reservoir Temp. C	Observed Temp. C	TDS
Alhambra	96	55.6	660
Anaconda	75	21.7	2310
Anderson's	30	25.0	270
Anderson's Pasture	45	26.0	400
Apex	76	25.0	340
Avon	--	25.5	650
Bear Creek	--	24.0	2000
Bearmouth 1 & 2	35	20.2	480
Beaverhead Rock	--	27.0	--
Bedford	30	23.6	350
Blue Joint 1	45	29.0	145
Blue Joint 2	45	29.0	145
Boulder	136	76.0	423
Bozeman	80	54.6	433
Bridger Canyon	25	20.2	270
Broadwater	118	62.0	596
Brooks	25	19.9	622
Browns	30	23.7	480
Camas	100	45.0	330
Carter's Bridge	40	28.0	600
Chico	58	45.0	255
Deer Lodge Prison	40	26.0	170
Durfee Creek	30	--	2630
Elkhorn	65	48.5	179

TABLE 2. SPRINGS, INVENTORY DATA
(Continued)

Spring Name	Estimated Reservoir Temp. C	Observed Temp. C	TDS
Ennis	129	83.2	1030
Gallogly	56	41.7	153
Garrison	35	25.0	530
Granite	80	51.0	210
Green Springs	--	26.0	280
Gregson	70.0	560	
Greyson	25	17.9	460
Hunsaker	40	24.5	3500
Hunter's	78	59.0	280
Jackson	125	58.0	660
La Duke	73	65.0	2080
Landusky 1 & 2	35	21.0	1480
Landusky Plunge	30	24.0	960
Little Warm Springs 1,2&3	35	22.5	1750
Lodgepole 1,2,3	35	30.0	1100
Lolo	83	44.0	230
Lovells	30	19.4	420
McMenomey Ranch	30	19.0	480
Medicine	82	45.0	260
New Biltmore	71	53.0	1860
Nimrod	30	20.5	645
Norris	107	52.5	640
Pipestone 1 & 2	88	57.0	340

TABLE 2. SPRINGS, INVENTORY DATA (Continued)

Spring Name	Estimated Reservoir Temp. C	Observed Temp. C	TDS
Plunkets	20	165	260
Potosi 1	60	49.5	330
Potosi 2 & 3	60	37.0	360
Puller's	90	44.4	1160
Quinn's Hot Springs	99	43.4	192
Renova	90	50.0	655
Silver Star	131	71.5	610
Sleeping Child	125	52.0	390
Sloan Cow Camp	85	29.5	260
Staudenmeyer Ranch	45	28.0	390
Sun River	35	30.4	890
Targhee Sulphur	18	18.0	370
Toston	20	15.2	330
Trudau	45	22.7	540
Vigilante	30	23.5	400
Warm Springs State Hospital	79	77.0	1251
Warner	23	18.0	125
West Fork Swimming Hole	30	26.0	180
White Sulphur Spings	125	46.0	1520
Wolf Creek	77	68.0	360

TABLE 2. WELLS INVENTORY DATA (Continued)

Well Name	Producing Depth (M)	Estimated Reservoir Temp. C	Observed Temp. C	Lab TDS
Angela Hot Springs	2496-2530	85	82.0	6240
Bakers Hole (WY026)	19	45	16.0	330
Bruce	50.5-122	45	18.0	1370
Campaqua	74	100	50.0	410
Colstrip	2580	100	97.0	1470
Florence	125	70	15.0	291
Fox Inc.	183-335	22	19.0	429
Halvorson Hot Springs	946	50	45.0	4760
Hanover	232	22	20.0	410
Hanser	313	22	18.0	1380
Hunsaker	33	45	15.0	240
Koehler	91	90	44.8	340
Leistner	128	90	29.8	330
Lucas	210-1284	45	42.2	3150
Marysville	1747	122	96.5	618
McLeod	686	50	48.0	2100
Montaqua	293-1227	50	39.0	3260
Quinn's Hot Springs	44	--	25.0	--
Ringling	647-707	50	48.0	1360
Rocky Ranch	1204	45	42.0	3116
Saco (Sleeping Buffalo)	975	45	42.0	3116
Scott Feed Lot #1	913	46	43.0	1400
Scott Feed Lot #2	921	46	44.0	1240
Steller Creek	1119	50	50.0	290

TABLE 2. WELLS INVENTORY DATA (Continued)

Well Name	Producing Depth (M)	Estimated Reservoir Temp. C	Observed Temp C	Lab TDS
Symes	76	88	39.0	290
Two Dot	274	22	20.0	392
Uranium Test	150 (?)	50	15.5	1226
Wendt	61	50	24.0	175

2.7 PUBLIC OUTREACH PROGRAMS

2.7.1 Outreach Mechanisms

Outreach mechanisms have changed little in the past year. Personal contact with geothermal developers, either through phone calls, letters or on-site visits, had the most impact on development. General outreach mechanisms were also used. Several newspaper articles on geothermal development appeared in Montana newspapers, including a four-part series in the Butte Standard in November. A summary of contacts and results follows.

2.7.2 Summary of Major Contacts (June-December 1981)

Contact	Assistance Given
Walt Garrison, Attorney Virginia City	Assisted in negotiating water rights for hot springs well
Gary Moiken Silver Star Hot Springs	Regulatory, geological and engineering information
Connie Flamm Roy High School	General geothermal information for high school science class
Frank Smoyer Helena	Information on aquaculture using a geothermal source
Dr. Dennis Blacketter Mechanical Engineer Montana State University	Feasibility study on heating unviersity with geothermal energy
William Dressler Hastings Law Journal	Geothermal regulation in Montana
Michael Grove 1st National Bank White Sulphur Springs	Arranged geothermal financing meeting with City Council
Thor Jackola Jackola Engineering	Information on goethermally heated ethanol plants
Bill Cunningham The Wilderness Society	Information on geothermal leasing near Yellowstone

Contact	Assistance Given
George Ochenski Southern Cross	Geothermal greenhouse construction
Jeff Renz Patten and Renz law firm	Letter of support re tax credits for groundwater heat pumps
Ed Sheitlin Virginia City	Soil warming and groundwater heat pumps
Art Gilliam Real Estate West, Livingston	Assistance in marketing Hunter's Hot Springs
Tom Bateridge Tribal Hydrologist Flathead Reservation	Geothermal Exploration techniques financing options
Vernon Johnson Fairview	Oil well conversion to geothermal
Ed Mills State Nursery, Helena	Greenhouse heating options (direct-use and groundwater)
Charles Page Bozeman Hot Springs	Pricing geothermal resources
Ira Fonshill Fonshill & Co., Boise	Montana site data base
Allan Miller Multitech, Inc., Butte	Critique for grant proposal for space heating Warm Springs Hospital
Bill Valach Montana Power Company	Groundwater heat pump information
Darrel Pearson LPC Heat Pumps, Inc.	Critique of draft heat pump brochure
Eliott Allen & Associates Salem, Oregon	Arrangement for financial workshop
Ron Wilcox, editor *Solar Law Reporter*	Montana geothermal regulations
Vivian Brideham Goldcrest Realty	Information on marketing for Norris Hot Springs
Frank Gruber Helena	Rankine Cycle turbines
West Energy Planners Aurora, Colorado	Baker feasibility study for geothermal district heat
Enertech Solar Designs, Inc. Blaine, Minnesota	Groundwater heat pumps brochure

Contact	Assistance Given
Coury & Associates Lakewood, Colorado	District heating in Ennis and and White Sulphur Springs

2.7.3 Overall Prospectus for Future Geothermal Development

The prediction for geothermal development in the state remains the same: interest in development is still strong in the state, but a lack of financing, engineering know-how and relatively low fossil fuel energy prices in some areas may prevent geothermal from advancing rapidly in the state. Recent federal budget cuts in such programs as the cost-shared drilling program, the appropriate technology grants program, and the technical assistance program will further hinder the rate of development.

Our own program will continue to provide geothermal information at least through 1982. Emphasis will continue to be on assisting specific geothermal developers with specific projects. In addition, we plan to produce several geothermal publications and audiovisual materials that will increase the awareness of the general public as to the potential for geothermal energy in the state. The loss of the EG&G technical assistance program and the reduction in our office staff to one full-time employee cannot help but affect our outreach efforts. We will continue, however, to promote the development of geothermal in the state as much as we possible can.

NEW MEXICO GEOTHERMAL COMMERCIALIZATION PLANNING

SEMI-ANNUAL PROGRESS REPORT

July 1981 - December 1981

NEW MEXICO ENERGY AND MINERALS DEPARTMENT

SANTA FE, NEW MEXICO 87501

Work performed under Contract No. DE-FC07-79ID12017

Mod No. A001

U.S. Department of Energy

Idaho Operations Office

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1.0 INTRODUCTION

1.1 Purpose of the Project

This project was developed as a mission-oriented program aimed at accelerating the commercial utilization of geothermal resources. The project provides the Department of Energy, the State of New Mexico, and the private sector with a technical and economic guide for commercialization direction and actual implementation of development proposals. These objectives are accomplished through the marketing strategies of public outreach, brokerage functions, and mimi-engineering evaluations of specific resources and the appropriate direct-heat applications.

1.2 Objectives

In this market planning effort of the New Mexico geothermal energy commercialization program, critical evaluation is made of the potential geothermal energy use, the availability of geothermal energy, and prospective user neeeds and applications.

In order to explore and assess all marketing possibilities for geothermal commercialization, the New Mexico Team, in conjunction with the New Mexico State University Energy Institute has identified major energy consumers, with specific emphasis on potential on-site geothermal users and the appropriate site-specific direct-heat applications. This project has provided a basis for promotional marketing activities aimed at specific resource sites and potential adopters of geothermal energy. Potential or current end-users of geothermal energy have been supported with technical assistance on an as requested basis. This effort has provided the New Mexico State Team with good experience and greater insight into the marketing needs and demands by the end-users.

1.3 State Geothermal Commercialization Team Members

George Scudella, Principal Investigator and Project Manager; Resources Bureau, Energy and Minerals Department, Santa Fe, New Mexico.

Roy Cuniff, State Geothermal Program Coordinator; Chief Engineer, NMSU Campus Project, Physical Science Laboratory, NMSU, Las Cruces, New Mexico.

Dr. Larry Iceman, NMSUEI Coordinator; Director, New Mexico State University Energy Institute, Las Cruces, New Mexico.

Dennis Fedor, EMD Coordinator; Energy Consultant, New Mexico Energy and Minerals Department, Geothermal Commercialization Office, NMSU, Las Cruces, New Mexico.

Kay Hatton, Mining and Minerals Division Coordinator; Geologist, Mining and Minerals Division, Energy and Minerals Department, Santa Fe, New Mexico.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

An estiamte of the geothermal energy potentially available from New Mexico prospect areas and sites has been compiled in Tables 1 through 3. In this compilation, areas and sites of geothermal prospects in the State of New Mexico have been identified by various criteria for both electric and direct thermal uses.

The prospective sites and areas are categorized in Table 1 as: (1) proven, (2) potential, or (3) inferred.

Proven sites: (1) sites which are in an advanced stage of development or commercialization by a private company or by government for specific applications or demonstrations, or (2) sites on which favorable quantitative data on the measured subsurface temperatures, volume, and water flows are available.

Potential sites: (1) sites on which there is exploration or development activity, or (2) sites on which some favorable quantitative subsurface data have been estimated or measured.

Inferred sites: (1) sites identified by subsurface manifestations such as wells or springs, (2) chemical thermometry, or (3) proximity to potential or proven sites.

TABLE 1

NEW MEXICO IDENTIFIED GEOTHERMAL PROSPECTS

ELECTRIC ≥ 150°C

PROVEN	POTENTIAL	INFERRED
Baca Location	Animas Area	Closson
	Kilbourne Hole	Columbus Area
	Radium Springs	Guadalupe Area
	San Diego Mountain	Jemez Reservoir
		Lordsburg
		Lower Frisco Hot Springs
		Prewitt Area
		Socorro
		Southern Tularosa Basin
		White Sands Missile Range

DIRECT THERMAL (20°C ≤ T ≤ 150°C)

PROVEN	POTENTIAL	INFERRED
Animas Area	Albuquerque	Crown Point
East Mesa Geothermal Field*	Black Mountain-West Mesa	East San Augustin Plain
Faywood Hot Springs	Cliff Area	Fort Wingate
Gila Hot Springs	Derry Hot Springs	Garton Well
Jemez Springs	Mesquite-Berino	Jicarilla Indian Reservation
Montezuma Hot Springs	Mimbres Hot Springs	Little Blue Mesa
Ojo Caliente	San Diego Mountain	Mamby Hot Springs
Ponce De Leon Springs	San Ysidro Area	Mancisco Mesa
Truth or Consequences	Socorro	Southern Tularosa Basin
Radium Springs	Turkey Creek Hot Springs	Tohatchi
	Upper Frisco Hot Springs	

*The area originally named Las Alturas has been reclassified as the East Mesa Geothermal Field since recent research has proven the field to be far more extensive than it was originally anticipated.

Source: Swanberg, 1980; PSL/NMSUEI Data File, 1980; revised, 1981.

TABLE 2

STATE OF NEW MEXICO

PROVEN, POTENTIAL AND INFERRED DIRECT THERMAL APPLICATIONS

SITE	LATITUDE/ LONGITUDE	TEMPERATURE (°C) SURFACE	SUBSURFACE	ESTIMATED VOL. (km^3)	ESTIMATED POWER (quad, 10^{15} Btu) PROVEN	POTENTIAL	INFERRED
Albuquerque	35° 05' 106° 45'	27	30	3.0	-	-	0.0449
Animas	32° 08' 108° 50'	102	144	3.3	-	0.0359	0.4102
East Mesa Geothermal Field*	32° 16' 106° 42'	55	120	75.0	-	-	0.5635
Faywood Hot Springs	32° 33' 108° 00'	54	78-97	1.0	-	-	-
Gila Hot Springs	33° 12' 108° 12'	66	125	-	-	-	-
Jemez Springs	35° 47' 106° 04'	73	103	3.3	-	0.0206	0.6150
Ojo Caliente	36° 18' 106° 58'	45	122-161	3.3	-	-	-
Radium Springs	32° 30' 107° 58'	30-85	130-198	3.3	-	-	0.0368
San Diego Mountain	32° 37' 106° 59'	52	125	-	-	-	-
San Ysidro	35° 30' 106° 40'	50	80	1.0	-	-	0.0206
Socorro	34° 02' 106° 56'	33	35	3.0	-	-	0.0135
T or C	33° 09' 107° 15'	36-46	100	1.0	-	0.0269	0.4563
TOTAL					0	0.0834	2.1608

*The area originally named Las Alturas has been reclassified as the East Mesa Geothermal Field since recent research has proven the field to be far more extensive than it was originally anticipated.

Source: PSL/NMSUEI Data File, 1980; revised, 1981.

TABLE 3

STATE OF NEW MEXICO

PROVEN AND POTENTIAL ELECTRIC APPLICATIONS

SITE	LATITUDE/ LONGITUDE	TEMPERATURE (°C) SURFACE	SUBSURFACE	ESTIMATED VOL.(km^3)	ESTIMATED POWER PROVEN	POTENTIAL	(Mwe for 3(TOTAL
Animas (Lightning Dock)	32° 08' 108° 50'	102	170	3.30	-	5	20
Baca Location	35° 54' 106° 32'	-	260-315	125.00	<50	350	1942
Kilbourne Hole	31° 57' 106° 58'	45-83	155	3.50	-	5	25
Radium Springs	32° 30' 106° 58'	30-85	93-130	3.30	-	5	30
San Diego Mountain	32° 37' 106° 59'	-	125	1.00	-	5	20
TOTAL					<50	370	2037

Source: PSL/NMSUEI Data File, 1980

2.2 Area Development Plans

2.2.1 State Geothermal Planning Areas

The New Mexico State Team has defined one geographical area for which the development and utilization of geothermal energy prospects are likely between now and the year 2020. The first-priority target areas for development planning are centered on the Rio Grande Rift throughout its entire length within the state (Figure 1).

2.2.2 Specific Area Development Plan: Dona Ana County

Dona Ana County has emerged as the first area of intense study and planning activity for direct thermal use by private and government entities. The strong local interest and community leadership shown for geothermal energy, plus the economic growth pattern of El Paso, Texas, adjacent to the county, provided the basis of selection for the area development plan. A number of research investigations of the geothermal potential in the county have been conducted. There are two KGRAs in the county: Radium Springs and Kilbourne Hole. The Kilbourne Hole KGRA, located near to the U.S. - Mexico border, and the Radium Springs KGRA, north of Las Cruces, have potential electrical generation capacity. The Las Cruces East Mesa Geothermal Field and the Radium Springs area have considerable potential for direct heat applications.

The Dona Ana Area Development Plan involves: (1) the investigation of the area attributes such as geography, population, economy, and attitudes of

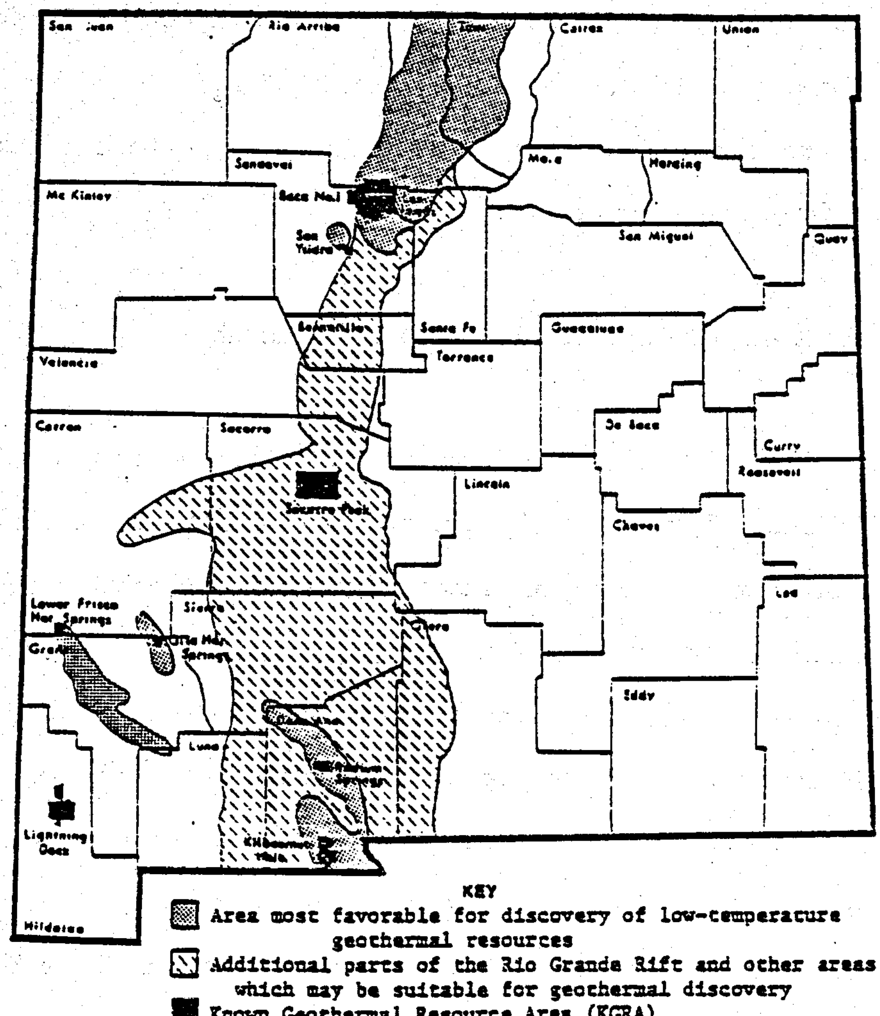

Figure 1 GEOTHERMAL RESOURCES OF NEW MEXICO

Source: NMEI-NMSU, NOAA, DOE, 1980, 1:500,000 MAP: Geothermal Resources of New Mexico.

the residents; (2) the energy demands of the area for both current and projected needs by Standard Industrial Codes and fuel types; and (3) the current and future geothermal energy development activities. A possible schedule of activities has been estimated during the planning process, although the actual rate of development is largely dependent on the actions of the private sector, which are influenced by many factors other than resource availability.

Dona Ana County has the second largest geothermal heat potential in the state, next to the Baca Location in Sandoval County. The county has numerous hot wells located outside of the two KGRAs and the East Mesa Geothermal Field. The geothermal potential considering all sites is estimated to be 0.9899 quad for direct thermal use.

Dona Ana County is one of the fastest growing areas in New Mexico. The total county population is about 100,000. Expanding industrial and governmental sectors are contributing to a robust economy in the county.

Large-scale greenhouse operations, some of which are already located in Dona Ana County, are very suitable to conversion with the use of heat from geothermal water depending on the resource and the location. Thus, large-scale greenhouse operators have been targeted as prime potential geothermal users in the development plan.

2.3 Site Specific Development Plans

2.3.1 Candidate Geothermal Sites

The specific resource sites and energy applications (i.e., residential, commercial, industrial, and agricultural), which are candidates for the site specific development plans (SSDP) are briefly described as follows:

1. Albuquerque

Current Application: Heat pump space heating of nine-story Sandia Savings office building.

Anticipated Applications: Large user space heating: West Mesa Airport, West Mesa High School, University of Albuquerque campus pre-heat boiler system, district heating of future subdivisions on the West Mesa.

Resource Data: Surface Temperature 27°C
Subsurface Temperature 30°C

Estimated Energy Potential: 0.04 quad

Estimated Reservoir Size: 3.0 km^3

2. Animas Lightning Dock

Current Applications: Space heating for one house. Two geothermally-Heated greenhouses with a total of 70,000 square feet. Geothermal irrigation and soil warming system for fruit orchard.

Anticipated Applications: Additional 500,000 square feet of geothermally-heated greenhouses. Site of DOE 1979 Appropriate Technology Program grant in Region 6 of $20,000 to Tom McCants.

Resource Data: Surface Temperature 102°C

Subsurface Temperature 155°C

Estimated Energy Potential: 0.45 quad

Estimated Reservoir Size: 3.3 km^3

3. East Mesa Geothermal Field (Formerly Las Alturas)

Current Applications: Space heating of President's House/University Center and the Campus hot water and space heating project at New Mexico State University.

Anticipated Applications: Space heating: Sandyland and other commercial greenhouses, land development subdivision district heating.

Resource Data: Surface Temperature 55°C

Subsurface Temperature 120°C

Estimated Energy Potential: 0.56 quad

Estimated Reservoir Size: 75.0 km^3

4. <u>Jemez Springs</u>

Current Applications: Bathhouse.

Projected Application: Greenhouse space heating, space heating of the village municipal buildings, and village district heating.

Resource Data:	Surface Temperature	73°C
	Subsurface Temperature	103°C

Estimated Energy Potential: 0.64 quad

Estimated Reservoir Size: 3.3 km^3

5. <u>Radium Springs</u>

Current Application: No current application.

Anticipated Applications: Space heating for greenhouse complexes. Industrial process heat for ethanol production facilities.

Resource Data:	Surface Temperature	30 - 85°C
	Subsurface Temperature	130 - 198°C

Estimated Energy Potential: 0.0368 quad

Estimated Reservoir Size: 3.3 km^3

6. Truth or Consequences

Current Applications: Several resort spas, bathhouses, and pools. Spaceheating of the Yucca Lodge. Preheated boiler feedwater, hot-water supplies, and therapeutic pool heating at Carrie Tingley Hospital. Space heating of city senior citizens center.

Anticipated Application: Yucca Gardens condominium building complex and commercial buildings.

Resource Data:	Surface Temperature	36 - 46°C
	Subsurface Temperature	100°C

Estimated Energy Potential: 0.48 quad

Estimated Reservoir Size: 1.0 km^3

2.4 Time Phased Project Plan

2.4.1 Active Demonstration and Commercialization Projects

There have been ten recent geothermal demonstration and commercialization projects in New Mexico. Seven of these projects are demonstration and commercialization projects that were initiated by the New Mexico Energy and

Minerals Department and cost-shared with federal and private funding sources. Five of these projects resulted in active direct thermal demonstration systems.

1. New Mexico State University (NMSU) Campus Project. The system delivers about 10 million Btu/hr for hot water heating in 30 campus buildings, including 5 multi-structure dormitories, space heating of the natatorium and football stadium, and heating of the indoor and outdoor pools. The project had a total installed cost of about $1.5 million and the annual savings on expenditures for natural gas will be approximately $300,000 in 1982. The operating system uses two 260 m (860-ft) production wells capable of producing a total of 2,270 liters/min (600 gal/min) of water at a temperature of 61 to 63°C (142 to 146°F). The hot water is tranported via a double insulated cement asbestos pipe to a heat exchanger prior to being reinjected 788 m (2,600 ft) away. Fresh water from the campus water supply is heated at the heat exchanger and transported by the same type of pipeline 1,820 m (6,600 ft) to a central distribution point, arriving at a temperature of 58°C (137°F). The not fresh water is then distributed to buildings withing a radius of about 1,210 m (4,000 ft). The project was initiated in February 1980, construction began July 1, 1981, and the system will become operational in early 1982. This project advanced through the spectrum from basic research to commercialization in approximately six years, with the financial support of the State of New Mexico Energy Research and Development Program and the U. S. Department of Energy. When completed, this system will be one of the nation's largest direct-use applications of geothermal energy.

2. University President's House/University Center, NMSU, Las Cruces. This single building space-heating project, which preceded the NMSU Campus Project as a prototype, is supplied by a well drilled into the East Mesa Geothermal Field which underlies the building. The space-heating system uses 48°C (118°F) water from a depth of 137 meters (450 ft) at a flow rate of 68.1 liters/min (18 gal/min). The project started June 28, 1979, the construction was completed in September 1980, and the building was occupied in December 1980. Monitoring and reporting activities were scheduled to continue until June 1982.

3. Solar-assisted geothermal greenhouse, Faywood Hot Springs. The resource is the Faywood Hot Springs 48.3 km (30 miles) southeast of Bayard, New Mexico, which flows at 132.5 liters/min (35 gal/min) at a temperature of 54.°C (129°F). The geothermal greenhouse uses runoff water from the hot spring. The greenhouse was constructed and is operated by handicapped labor from the Southwest Services for Handicapped Children and Adults, which also owns the greenhouse. Native plants for waste tailings reclamation projects by Kennecott Copper Corporation are being grown. Initiation of this project was on June 18, 1979, and monitoring and reporting ended December 31, 1981.

4. City of Truth or Consequences Senior Citizens Center. This retrofit space-heating project tapped the artesian thermal water basin underlying the city. The well water temperature in the area averages 43°C (109°F). An attempt to produce geothermal water was unsuccessful when a 76 m (250 ft) dry well was drilled on city property. An existing well was then connected to the Senior Citizens Center to supply up to

100,000 Btu/hr during peak demand periods. The design, installation, and monitoring of the space heating system was completed by February 1981. The project commenced on June 28, 1979, and monitoring and reporting ended December 31, 1981.

5. <u>Solar-assisted geothermal greenhouse, Ranchos de Taos</u>. The resource is the Ponce de Leon Hot Springs near Ranchos de Taos. The springs discharge 1,305,977 liters/day (240 gal/min) at a temperature of 35°C (95°F) and an elevation of about 2,256 m (7,445 ft). The project utilizes a geothermal heat recovery system to provide thermal energy for greenhouse space heating for growing cash crops and other commercial processes. This project used technology transferred from power plant waste heat recovery systems and was conducted by Solar America, Inc., of Albuquerque. The project began May 22, 1979, and was dedicated at a ribbon-cutting ceremony on October 28, 1980. Monitoring and reporting are now complete.

6. <u>Carrie Tingley Hospital, Truth or Consequences</u>. This project consists of a geothermally preheated hot water system designed, installed, and operated by the BDM Corporation. The project utilized an existing well system that provided natural hot water for two therapeutic pools. The project commenced on September 18, 1980. The system was monitored until June 31, 1981. The system is equipped to handle 169,000 liters/day (31 gal/min) of continuously pumped well water at a temperature of 43°C (109°F), which contains a useful heat content of 12,000 Btu/min. Due to the relocation of hospital operations to Albuquerque, the geothermal system and physical plant are inactive and will remain so until the property is sold and operations restarted.

7. L'eggs Products, Inc., Mesilla Park. This project evaluated the potential resource and required engineering needed to bring geothermal energy on line for industrial process heat at the hosiery manufacturing plant. A 545 m (1,800 ft) test well was drilled on the plant site on May 12, 1980. No usable resource was found but a bottom-hole temperature of 32°C (90°F) was encountered, with a noticeable increase in temperature gradient near the bottom of the hole. A series of economic and engineering studies determined that the development of a deep resource to provide process steam would not be economically feasible and no further commercialization activities are planned.

With the exception of some historical hot spring resort spas, most private business enterprises utilizing geothermal energy in New Mexico started in the 1960s. The most significant developments are listed below:

1. Baca Location geothermal power plant demonstration program, Jemez Mts. The resources for this project are within the Valles Caldera and include both liquid and vapor-dominated reservoirs. The major liquid-dominated reservoir is over-pressured and contains a calculated 1.8 x 10^{12} kg of fluid in place. The average reservoir fluid temperature is in excess of 260°C (500°F). The main production and injection zone is the lower Bandelier Tuff; upper Bandelier Tuff forms the caprock. Since the first geothermal well was completed in 1963, Union Geothermal of New Mexico has completed more than 20 producing wells. Drilling activity was suspended in late 1981. During 1982, the U.S. Department of Energy, the Public Service Company of New Mexico, and Union Geothermal of New Mexico are likely to terminate the project.

2. The Animas Valley geothermal greenhouses. The two commercial greenhouses, operated by Tom McCants and Dale Burgett, are together because they have the same underlying resources, identical charactaristics, energy-use applications, and geothermal energy-requirements. The resource is the "Animas hotspot", a very shallow anomalous aquifer, where abundant water of 102°C (217°F) is obtained at depths of less than 29 m (96 ft). The thermal anomaly has no surface manifestations, is geophysically conspicuous in a one square-mile section, and is apparently a fault-controlled feature adjoining a sediment-filled basin. The two greenhouse operations overlying the thermal anomaly use 36,000 Btu/min and 17,000 Btu/min with no thermal drawdown. The geothermal energy is used in the production of various high-price floral plants, particularly roses.

3. Geothermal heat pump system at the Sandia Savings Bldg, Albuquerque. Two aquifers, at 27 and 81 m (90 and 270 ft) of depth, supply cool and warm waters, respectively, according to the seasonal demand. Two wells are involved in this operation. The shallow well supplies cool water with a temperature range from 17 to 21°C (60 to 70°F). The deeper well supplies warm water at about 27°C (81°F). The water is withdrawn from either the cool or warm well, depending on the season, and injected into the other well. A heat exchanger and three 100-horsepower compressors are used to boost or lower the water temperatures for winter heating or summer cooling. Heating requires 2,518,000 Btu/hr and cooling requires 3,467,182 Btu/hr.

2.5 State Aggregation of Prospective Geothermal Utilization.

Estimates have been of the total geothermal energy on-line for the planning area as a function of time to the year 2020 and are summarized in Table 4.

2.6 Institutional Analysis

2.6.1 Overview of State Legislation

Legislation regarding regulatory conflicts, geothermal leasing, and district heating authority was not considered during the 1981 legislative session. However, it is possible that some difficulties in the relationship between appropriative rights and correlative rights for geothermal resources may potentially be resolved through administrative action. District heating legislation and amendments to state geothermal leasing policies have not been examined in recent legislative sessions. A review of state statutes and extensive discussions and correspondence with Steve Reynolds and D.E. Gray of the State Enegineer's office identified the following findings:

* In declared groundwater basins, conflicts between appropriative rights and correlative rights for geothermal resources may potentially be resolved administratively. In the State Engineer's view, the resolution may be achieved through conditions placed on geothermal fluid appropriations vis-a-vis other geothermal appropriations.

* The State Engineer's jurisdiction does not extend outside of declared groundwater basins. The appropriate rights/correlative rights conflict, therefore, cannot be resolved in these areas by means of con-

TABLE 4

POSSIBLE ECONOMICAL GEOTHERMAL ENERGY ON-LINE (10^{12} Btu)

COUNTY	YEAR 1985	YEAR 1990	YEAR 2000	YEAR 2020
Dona Ana	2.47	8.09	23.00	48.70
Bernalillo, Torrance, and Valencia	-	-	0.77	0.81
Los Alamos, Rio Arriba, Sandoval, Santa Fe, and Taos	1.87	5.37	13.13	26.10
Sierra and Socorro	0.72	1.79	2.47	3.22
Catron, Grant, Hidalgo, and Luna	-	0.89	4.43	6.99
Chaves, Eddy, Lea, Lincoln, and Otero	-	-	-	-
McKinley, San Juan, and Cibola	0.65	4.38	11.40	23.20
All northeastern counties	-	-	-	-

ditions on geothermal appropriations. Legislation to resolve the conflict in these areas may be warranted.

* According to certain statutory provisions (§72-12-25 NMSA [1978]), "non-potable" water at depths of 2,500 feet or more is exempt from declared basins. Although the State Engineer questions the force of this provision, it may remove most hinderances to development of deep resources. Geothermal development is clouded by this provision in the statute, which deserves legislative review.

Only one legislative item was enacted in the 1980 session and is of great importance in promoting geothermal energy in New Mexico. An appropriation called Chapter 134 of Laws 1980, Section 2, was enacted to provide $600,000 of State funds for the purpose of funding geothermal drilling and demonstration projects, with the stipulation that awards be made only on the basis of equal matching funds from private or federal sources.

During the 1981 legislative session, $829,000 was appropriated to finance the construction of the campus geothermal heating project at New Mexico State University. This project is the largest demonstration of the use of geothermal energy in New Mexico.

2.7 Public Outreach Program

The goal of the Public Outreach Program was to increase awareness and acceptance of geothermal energy and to promote the use of geothermal resources by industry, commerce, agriculture, and government. This program was designed to expedite the direct applications of geothermal energy by: (1) identifying geothermal application concepts and potential resource end-users, (2) identifying potential funding sources by serving as a broker between end-users, government, and private resource developers; and (3) providing engineering and technical assistance to potential end-users.

2.7.1 Outreach Mechanisms

The New Mexico Outreach Program is oriented prmiarily toward assisting potential end-users. Outreach mechanisms utilized include:

* New Mexico Commercialization Office Technical Assistance Program
* New Mexico Energy Research and Development Program
* New Mexico Geothermal Demonstration Program
* New Mexico State University Energy Institute Low Temperature Resource Assessment (through DOE and NMERDI funding) and Geothermal Regional Operations Programs
* DOE Region VI Appropriate Energy Technology Small-Grants Program
* DOE 100-Hour Engineering Assistance, Direct Heating, and Reservoir Engineering Assistance Programs
* New Mexico Energy Extension Service Outreach Program

New Mexico Commercialization Office Technical Assistance Program. Technical assistance and information was distributed to 23 companies with potential geothermal commercialization activities in Dona Ana County. The companies were either interested in resource assessment and potential development or end-user applications. These companies include:

Resource Assessment and Potential Development

Chaffee Geothermal, Ltd., Jay Dick - cost shared resource assessment

Hidaldo County Industrial Development Committee - resource assessment for Animas Valley

Hunt Energy Corporation, Geothermal Division, Roger Bowers - resource assessment

McCulloch Geothermal - land leasing assistance

Trans-Pacific Geothermal, Inc., Tsvi Meidav, cost-shared resource assessment

End-User Applications

Charles O'Donnell - heating apartments in Telshor area of Las Cruces

Chino Valley Greenhouses - possible relocation to Dona Ana County

City of Las Cruces - geothermally-heated new outdoor swimming pool

City of Las Cruces (Animal Humane Society) - geothermal heating of new animal shelter

Eddie Binns Construction - residential housing in Las Cruces

Firestone Greenhouse - geothermal greenhouse heating

Gadsden School District - geothermal heating of new school complex

Good Samaritan Retirement Village, Joe Pomplin - heating of apartments

Greenleaf Nurseries, Ray Kitayama - possible relocation in Dona Ana County

Memorial General Hospital - geothermally-assisted space and water heating

National Rose Growers Association - geothermal greenhouse heating

Pajaro Balley Greenhouses - geothermal greenhouse heating

Prepared Foods, Inc. - possible geothermal user (new to Dona Ana County)

Radium Springs greenhouses, Tom Beall - geothermal greenhouse heating and possible relocation to Dona Ana County

Sandyland Nurseries, Frank Cobb - well drilling under the New Mexico Geothermal Demonstration Program

Shawn Ramos & Associates - geothermal greenhouse heating

Solar Mesa Greenhouse - geothermal greenhouse heating

Albuquerque Federal - residential subdivision east of Las Cruces

New Mexico Research and Development Program. Six geothermal demonstration and/or commercialization projects have been funded under the New Mexico Energy Research and Development Institute (NMERDI) Research and Development Program.

Utilization of Geothermal Energy for Agribusiness Development in Southwestern New Mexico - an assessment of resource and economic potential in the Animas Valley for agribusiness end-users.

New Mexico Geothermal Commercialization Coordination - base support for activities of the State Commercialization team.

Geothermal Test Well Drilling Program for the Village of Jemez Springs, New Mexico - testing and establishment of a production well and preliminary engineering design to space heat the Town Hall and Fire Department building.

Comprehensive Planning for the Development of Geothermal Energy in Las Cruces and Dona Ana County, New Mexico - accelerating the development and commercialization of geothermal energy in Dona Ana County by including local governments in planning and coordination through the formal adoption of city and county geothermal commercialization policies.

New Mexico State University Campus Geothermal Demonstration Project - detailed engineering construction cost estimate and economic evaluation of low temperature geothermal energy application for the NMSY campus.

Monitoring Environmental and Related Performance Parameters for a Rankine-Cycle Turbine Electric Generator Utilizing Geothermal Energy at the Gila Hot Springs, New Mexico - an evaluation of the environmental effects, if any, from the operation of a 10-kwe Rankine-cycle generator in a rural location.

New Mexico Geothermal Demonstration Program. In 1979, six projects were funded for goethermal space-heating demonstrations under the original $200,000 program. Four of these demonstration systems remain in operation and two have become inactive.

Active Demonstration Projects
City of Truth or Consequences Senior Citizen Center
Faywood Hot Springs geothermal greenhouse
NMSU President's House and University Center, Las Cruces
Ranchos de Taos geothermal greenhouse

Inactive Demonstration Projects
Carrie Tingley Hospital, Truth or Consequences
L'eggs Products, Inc., Mesilla Park

Under the additional $600,000 program, one award was made to Sandyland Nurseries for a $175,000 drilling program in April 1981. This award was later relinquished in anticipation of geothermal energy becoming available from private resource developers. New project applications are being developed for funding consideration under this program.

New Mexico State University Energy Institute Low Temperature Geothermal Resource Assessment and Geothermal Regional Operations Programs. Through funding by the New Mexico Energy Research and Development Institute and the U.S. Department of Energy, Division of Geothermal Energy, two major comprehensive programs, one for statewide low temperature resource assessment activities and one for economic analysis of potential resource applications provided state-of-the-art data for distribution to potential end-users.

DOE Region VI Appropriate Energy Technology Small-Grants Program. One geothermal project was funded to Doc Campbell at the Gila Hot Springs to assist in the testing of a 10-kwe Rankine-cycle electric generator system to provide electricity from low temperature geothermal resources in a remote area.

DOE 100-Hour Engineering Assistance Program. EG&G technical assistance was obtained for two end-users:

The Navajo Nation and the Gallup-McKinley School System, Ken Newman of K.L. Engineering - to assess the geothermal potential in the Twin Lakes/Tohatchi areas for possible space heating of a new school.

Ojo Caliente Mineral Springs Company, Coupland, Moran & Associates - to assess the potential for space heating in a resort complex.

DOE Direct Heating Program. EG&G technical assistance was obtained for an additional two end-users:

City of Las Cruces, Eliot Allen & Associates - to assess the district heating potential in Las Cruces.

City of Truth or Consequenses, Eliot Allen & Associates - to assess the district heating potential in T or C.

DOE Reservoir Engineering Assistance Program. EG&G technical assistance was obtained for four end-users:

City of Las Cruces - gradient well drilling for West Mesa developments.

Doc Campbell - pump testing a well at the Gila Hot Springs.

Karl Kortemeier - geothermal heating of a T or C condominium complex.

Randy Ashbaugh - future geothermal usage in T or C.

New Mexico Energy Extension Service Information Programs. Energy Extension Service (EES) state and regional offices assisted in the dissemination of geothermal information and referral of potential end-users to the New Mexico State Commercialization Team.

2.7.2 Summary of Contacts and Results

All of the contacts made in past years are summarized and briefly described in Appendix A-5, "The Complete List of New Mexico Consultants, Resource Developers, Private Users and Suppliers."

2.7.3 Overall Prospectus for Future Geothermal Activity

The New Mexico Geothermal Demonstration Program has successfully raised the profile of direct use geothermal energy as an alternative energy resource. New Mexico now finds itself in a position of not only having five active demonstrations stimulated by state-funding but also having an active interest in geothermal energy technology shown by a broad spectrum of our community.

The greatest interest in geothermal development is being shown in Dona Ana County in the southern part of the state. The county is the home of New Mexico State University, which will activate its geothermal system on the campus in February 1982. The University successfully completed two production wells and obtained state and DOE financial assistance for the construction of the campus domestic hot water and space heating systems. The State Commercialization Team has been working with community leaders in Dona Ana County to identify and attract potential users of geothermal energy in a variety of applications.

All in all, New Mexico's geothermal future continues to be bright and geothermal energy commercialization activities continue to expand. The State of New Mexico continues to take a very active role in geothermal research, development, demonstration, outreach, and commercialization. The impact of these efforts is becoming increasingly visible as the interest in geothermal energy development grows throughout New Mexico.

3.0 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

1. Outreach efforts have raised the geothermal profile and substantially increased end-user potential.

2. The State of New Mexico's geothermal programs have had a substantial positive impact on geothermal development, technology transfer, and outreach. These activities will continue to be supported by the State as the federal commitment to the commercialization of geothermal energy technology declines.

3. New Mexico's Geothermal Demonstration Program has provided a big boost to geothermal development. The initial $200,000 appropriation has been developed into six projects valued at more than $500,000. The new $600,000 appropriation is expected to stimulate additional projects in the near future. The New Mexico State University campus project will provide the first commercial-scale demonstration of geothermal energy use in New Mexico.

4. The first major privately-financed geothermal project, which is likely to occur during the next calendar year, will trigger a very rapid growth in the utilization of geothermal energy resources in New Mexico.

5. Technological and financial efforts must be made to reduce geothermal development risks by improving technologies associated with exploration, well drilling, and reservoir identification. Prime emphasis must be placed on reducing the disproportionate risk associated with first holes.

APPENDICES

A-1 TOTAL ACREAGE OF GEOTHERMAL LEASES

A-2 FEDERAL ACTIVE COMPETITIVE LEASES

A-3 FEDERAL ACTIVE NON-COMPETITIVE LEASES

A-4 STATE LEASES

A-5 RECENT EXPLORATION ACTIVITY IN NEW MEXICO

A-6 THE COMPLETE NEW MEXICO LIST OF CONSULTANTS, RESOURCE DEVELOPERS, PRIVATE USERS AND SUPPLIERS

APPENDIX A-1

TOTAL ACREAGES OF GEOTHERMAL LEASES - NEW MEXICO

Federal Leases	
Total Acreages of Competitive Leases in KGRA's: (51 Leases)	87,540
Total Acreages of Non-Competitive Leases: (72 Leases)	138,170
State Leases	
Total Acreages of State Leases: (53 Leases)	21,184
TOTAL OF ALL ACREAGES LEASED	246,894

APPENDIX A-2
FEDERAL ACTIVE COMPETITIVE GEOTHERMAL LEASES - NEW MEXICO

COUNTY & LESSEE	SIZE, ACRES	NO.OF LEASES	KGRA/LOCATION	DATE ISSUED	COST/ ACRE
DONA ANA					
Aminoil USA, Inc.	1,235.45	1	Radium Spgs, KGRA T21S, R1W	02/01/78	$ 8.29
Anadarko Production	18,476.45	9	Kilbourne Hole, KGRA T27 & R1W	07/01/75	10.06 30.50 10.63
Chevron USA	2,193.48	3	Radium Spgs, KGRA T21S, R1W	12/01/77 12/01/78	30.50 10.63
N.K. Hunt	360.00	2	Radium Spgs, KGRA	12/01/78	56.00
HIDALGO					
Amax Exploration	6,580.43	3	Lightning Dock, KGRA T25S, R19 & 20W	Various	3.13 8.11 13.07
Aminoil USA, Inc.	1,271.64	1	Lightning Dock, KGRA T25S, R19W	01/01/77	1.99
J.E. Blankenship	1,235.72	3	Lightning Dock, KGRA T25S, R19W	01/01/77	1.99
Earth Power Corp.	5,060.12	2	Lightning Dock, KGRA T24 & 25S, R19 & 20W	10/01/76 12/01/78	
Phillips Petroleum Company	2,898.37	2	Lightning Dock, KGRA T25S, R19W	10/01/76	3.38 5.23
RIO ARRIBA					
Amax Exploration	6,183.45	4	Baca Location No.1 KGRA, T21N, R3 & 4E	08/01/77 12/01/77	5.67 5.23
SANDOVAL					
Amax Exploration	3,870.84	2	Baca Location No.1 KGRA, T18N, R3 & 4E	08/01/77	5.67

Sources: Bureau of Land Management/Kay Hatton, 1980.

APPENDIX A-3

FEDERAL ACTIVE NON-COMPETITIVE GEOTHERMAL LEASES - NEW MEXICO

COUNTY & LESSEE	SIZE, ACRES	NO.OF LEASES	LOCATION	DATE ISSUED
DONA ANA				
Mary Antweil	1,365.44	1	T19S, R2W	03/19/79
Chevron USA, Inc.	2,522.17	2	T20 & 21S, R1E & 1W	06/29/79
J.F. Grimm	9,568.61	5	T25 & 26S, R1E	06/11/73
C.L. Hunt	13,730.68	6	T27S, R1 & 2W & T20 & 21S, R1W	05/29/75 06/26/79 01/25/80
Nancy B. Hunt	1,280.00	1	T28S, R2W	05/29/79
Nelson B. Hunt	15,536.00	7	T26S, R1 & 2W	05/29/79
N.K. Hunt	8,306.94	4	T29S, R1 & 2W	05/29/79
M.W. Sands	2,440.00	1	T20S, R1W	04/27/79
Ramona Sands	4,307.79	3	T20 & 21S, R1W	04/27/79
H.W. Schoellkopf, Jr.	9,636.92	3	T17 & 28S, R2W	05/29/75
Southland Royalty Co.	14,263.29	7	T19, 20 & 21S, R1E	06/15/79
HIDALGO				
Chevron USA, Inc.	5,814.13	4	T26S, R20W	09/11/79 11/01/79
Earth Power Corp.	533.68	1	T26S, R19W	12/28/76
Sun Oil Company	1,280.00	2	T25S, R20W	10/24/79
Thermal Resources Inc.	1,320.00	2	T25S, R19W	07/07/77
U.S. Geothermal Corp.	2,954.57	2	T25 & 26S, R19 & 20W	03/29/77
SANDOVAL				
Occidental Geothermal Inc.	2,817.95	4	T15N, R1 & 2E	07/07/77 06/21/79
Sunoco Energy Dev.Co.	1,542.32	2	T15N, R3 & 4W	08/19/77

APPENDIX A-3

FEDERAL ACTIVE NON-COMPETITIVE GEOTHERMAL LEASES - NEW MEXICO

(Cont'd)

COUNTY & LESSEE	SIZE, ACRES	NO.OF LEASES	LOCATION	DATE ISSUED
SIERRA				
Fluid Energy Corp.	12,182.93	5		
Chevron USA, Inc.	639.36	1		08/14/79
Energetic Corp.	640.00	1		07/19/79
GRANT				
Aminoil USA, Inc.	5,015.94	18		08/08/79
HIDALGO				
Amax Exploration, Inc.	5,634.00	19		07/10/79 07/19/79
Aminoil USA, Inc.	960.00	2		08/03/79
SOCORRO				
J.W. Covello	640.00	1		03/12/75
Gulf Oil Corp.	960.00	2		03/12/75

APPENDIX A-4

GEOTHERMAL LEASING IN NEW MEXICO ON STATE LANDS

Fiscal Year	No. of Leases	Acres
71-72	-	
72-73	27	671
73-74	24	15,487
74-75	212	90,242
75-76	213	90,882
76-77	185	78,579
77-78	147	63,374
78-79	137	56,991
79-80	54	21,828
80-81	53	21,184

Source: State Land Office, Minerals Division

RECENT EXPLORATION ACTIVITY IN NEW MEXICO

Area	Companies	Comments
Rincon	A.J. Antwell	Has working arrangement with active geothermal companies and has interests in three areas: Animas, Rincon, and Ojo Caliente - La Madora.
San Diego Mountain	Hunt Energy Corp.	Three 2,000-ft heat-flow wells permitted.
Radium Springs	Aminoil/GRI	Geological and geophysical program starts spring of 1982.
	H.N. Bailey	One 500-ft low-temperature production well, five 500-ft heat-flow wells, and one 500-ft temperature observation well permitted. Results encouraging; 164°F water at 100 gpm at depths less than 27 feet. Direct use possibilities being evaluated. Possible energy park under consideration.
	Chevron U.S.A.	Now evaluating data from extensive drilling and geophysical work.
	Hunt Energy Corp.	Drilled two deep exploration wells which are being studied and evaluated. Plans third deep exploration well for this area.
	Southland Royalty	Federal leases pending.
Las Cruces	Chaffee Geothermal	Under cooperative agreement, with EMD will drill forty to fifty 300-ft temperature-gradient holes on East Mesa area (from East side of Las Cruces to Texas most promising site in search of 200 to 300°F fluids. Goal: industrial processing for Las Cruces.
	New Mexico State University	One 505-ft production well, two 1,000-ft production wells, two 100-ft observation wells, and one 860-ft observation well drilled.
	Southland Royalty	Federal leases pending.
Mesquite-Berino-Anthony	Southland Royalty	Federal leases pending.
Kilbourne Hole	Hunt Energy Corp.	Six 2,000-ft heat-flow wells permitted.
Faywood -	Aminoil/GRI	Geological and geophysical program starts spring of 1982.
Ojo Caliente - La Madera	A.J. Antwell	Leases pending BLM approval
Valles Caldera	Amax	Geochemical and thermal-gradient evaluations finished.
	Aminoil/GRI	Drilled seventeen 500-ft and three 2,000-ft thermal gradient holes. Deep test to be drilled next year.
	Sunoco	Deep exploration well permitted to 9,000 feet.
	Union Geothermal	Four production wells permitted to depths of 6,000 to 10,000 feet.
Socorro	Aminoil U.S.A.	Dropped some leases on Federal land.
	Atlantic Richfield	Dropping all geothermal leases in New Mexico.
	Chevron Resources	Now evaluating data from extensive drilling and geophysical work.
	J.W. Covello	
	Gulf Oil	No exploration work in New Mexico is planned at this time.
	Supron	Completed chemistry, fault, and shallow ground-water studies on holdings southwest of Socorro. Company is considering magnetotelluric and deep resistivity surveys.
	Thermal Power	Drilled three shallow temp-gradient holes on 13,000 acres of Federal leases. Additional geophysical work is planned.
Augustine	O'Brien Resources	Preliminary evaluations.
Elephant Butte	Southland Royalty	Between February 1979 and May 1981, applied for leases on 61,031 acres of Federal land in areas near Elephant Butte Reservoir, Radium Springs, Las Cruces, Mesquite, Berino, and Anthony.
Truth or Consequences	Amax	Federal leases pending.
	City of T.or C.	One 500-ft production well permitted.
Hillsboro	MCR Geothermal	Federal leases pending. Company plans to continue evaluating its leases in the T or C and Magdalena areas.
Mimbres	New Mexico State Universtiy	Three 300-ft heat-flow wells drilled for area southwest of Faywood Hot Springs.
Tres Hermanos Mountains	O'Brien Resources	Federal leases pending. Has more than 40,000 acres of current and pending leases on private and Federal lands. Acreage also includes State lands which company has nominated for leasing. Now doing preliminary evaluations on its prospects to determine their geothermal potential.
Northeast of Deming	O'Brien Resources	
Lordsburg	Amax Exploration	Eighteen 2,000-ft heat-flow wells permitted. Final temperature logs completed for the four intermediate depth holes drilled last year. Magnetotelluric survey made over thermal anomaly. Geochemical data being evaluated in light of M.J. Logsdon thesis on aqueous geochemistry of the area.
	Aminoil	Geological and geophysical program starts spring, 1982.
	A.J. Antwell	
	Chevron Resources	Now evaluating data from extensive drilling and geophysical work.
	Earth Power	Has joint venture agreement with Amax and plan to drill deep exploration test well in 1981 with Amax.
	Reading & Bates Petroleum Co.	Has applied for leases to 14,581 acres of Federal land.

Source: New Mexico's Energy Resources '81.

APPENDIX A-6

THE COMPLETE NEW MEXICO LIST OF GEOTHERMAL ENERGY CONSULTANTS, RESOURCE DEVELOPERS, PRIVATE USERS AND SUPPLIERS

November, 1981

Prepared by:

Dennis Fedor

NEW MEXICO GEOTHERMAL COMMERCIALIZATION INTEREST

CONSULTANTS/CONSULTING FIRMS

NAME	PHONE	REMARKS/EXPERTISE
Abernathy, George Director, Agricultural Engineering Department, NMSU P.O. Box 3268 Las Cruces, New Mexico 88003	(505) 646-2021	°Consultant on geothermal greenhouses
American Ground-water Hydrologists Contact: Dr. William Turner 2300 Candelaria Road, NW Albuquerque, New Mexico 87107	(505) 345-9505	°Geothermal exploration & geothermal resource suitability surveys
G.A. Baca and Associates, Ltd. 330 Garfield Street Suite 207 Santa Fe, New Mexico 87501	(505) 983-2594	°Complete system design
BDM Corporation Contact: Mr. Arthur J. Mansure 1801 Randolph S.E. Albuquerque, New Mexico 87106	(505) 848-5302	°Project design engineering & management °Designed system for Carrie Tingley Hospital °Engineers & scientific planning services
Bridgers & Paxton Consulting Engineers, Inc. Contact: Mr. Frank H. Bridges 213 Truman Street, N.E. Albuquerque, New Mexico 87108	(505) 265-8577	°Heat pump specialists °Designed systems for Alb. Sandia Savings Bldg and Salt Lake City LDS Bldg
Campbell, Mr. Doc Route 11 Gila Hot Springs Silver City, New Mexico 88061	(505) 534-9340	°A private user with 40 yrs experience materials & systems use of hot spgs water at Gila Hot Springs
Chaturvedi, Dr. Lokesh P.O. Box 3CE NMSU Las Cruces, New Mexico 88003	(505) 646-3233	°Geothermal hydrologist
Chemical Engineer Associates Contact: Mr. Harold M. Belkin 221 West Griggs Las Cruces, New Mexico 88001	(505) 526-3221	

CONSULTANTS/CONSULTING FIRMS (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
CH2M Hill Engineers °Mr. Bob Dart P.O. Box 22508 Denver, Colorado 80222	(303) 771-0900	°Engineers, planners, economists & scientists
°Mr. John Austin Box 8748 Boise, Idaho 83707	(208) 345-5310	°Consultant on Boise Idaho District
°3620 Wyoming	(505) 292-1262	
Coonce, C.A. & Associates Contact: Mr. Pat Coonce 12324 Pineridge, N.E. Albuquerque, New Mexico 87112	(505) 296-1089	°Water system engineers
Coupland & Moran Associates Contact: Mr. Dan Romero Electrical Engineer 200 Altez, S.E. Albuquerque, New Mexico 87123	(505) 296-5573	°Electrical & mechanical engineering
Cunnif, Mr. Roy State Geothermal Prog.Coordinator Physical Science Laboratory Box 3-PSL NMSU Las Cruces, New Mexico 88003	(505) 522-9349	°PI on NMSU campus space-heating project °Technical advisor for all state demonstration projects
DuMars, Dr. Charles College of Law - UNM 1117 Stanford, N.E. Albuquerque, New Mexico 87131	(505) 877-7444	°Law practice in water and mineral resources
E.G.& G., Inc. 9733 Coors Blvd., N.W. Albuquerque, New Mexico	(505) 898-8000	
Energetics Corporation Contact: Mr. L. Dale Clark, Pres. 833 East Arapaho Road Suite 202 Richardson, Texas 75081	(214) 783-4731	
Energy Resources Exploration, Inc. Contact: Mr. Bob Grant 9720 Candelaria, N.E. Albuquerque, New Mexico 87112	(505) 296-6226	°Geologist

CONSULTANTS/CONSULTING FIRMS (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
Gebhard, Mr. Thomas Consulting Engineer 5819 Westmont Drive Austin, Texas 78731	(512) 453-5577	°Planning & feasibility studies °Institutional issues
Geo-Products Corporation Contact: Mr. Kenneth Boren, Pres. Oakland, California 94612	(415) 893-8365	°A resource developer using hybrid concepts with biomass
Geo-Thermal Services, Inc. Contact: Mr. Barry Williams, Project Supervisor 10072 Willow Creek Road San Diego, California 92131	(714) 566-4520	°Heatflow & gradient hole drilling °High temperature geophysical logging °Geothermal consulting
Goodrich - Bartlett & Associates Contact: Mr. James L. Goodrich 1105 Gardner Las Cruces, New Mexico 88001	(505) 522-7633	°Long-range feasibility study °Advanced Planning-Feasibility-Coordination Consultant
Gruy Federal, Inc. Contact: Mr. Alan Lohse, Exec. VP Mr. Paul O'Connor, Tech. Mktg. Rep 2001 Jefferson Davis Highway Suite 701 Arlington, Virginia 22202	(702) 892-2700	°Project management of drilling & testing of wells
Richard L. Lohse Geothermal Field Engineer New Mexico Energy Institute P.O. Box 3EI Las Cruces, New Mexico 88003	(505) 646-1745	°Geophysicist specializing in geothermal exploration and reservoir assessment
Los Alamos Technical Assoc.,Inc. Contact: Mr. Phil Reinig P.O. Box 410 1650 Trinity Drive Los Alamos, New Mexico 87544	(505) 662-9080	
Mancini, Dr. Thomas Mechanical Engineering Department P.O. Box 3450 NMSU Las Cruces, New Mexico 88003	(505) 646-2223	°Principal investigator for the T or C Senior Citizens' Center
R & D Associates 6400 Uptown Blvd., N.E. Suite 398-W Albuquerque, New Mexico 87110	(505) 881-0991	

CONSULTANTS/CONSULTING FIRMS (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
Republic Geothermal, Inc. Contact: Mr. Gerald Juttrer, Exploration Manager P.O. Box 3388 Santa Fe Springs, California 90670	(213) 945-3661	
Shain Engineers, Joe 1519 Pacheco Santa Fe, New Mexico 87501	(505) 983-1297	
Solar America, Inc. 2620 San Mateo, N.E. Albuquerque, New Mexico 87110	(505) 883-0959	°Project design, engineering & management for geothermal greenhouses
Summers, W.K. & Associates, Inc. P.O. Box 684 905 Cuba, S.E. Socorro, New Mexico 87801	(505) 835-2095	°Conducted study on Gila geothermal energy potential °Hydrology & geology
Swanberg, Dr. Chandler A. Physics Department P.O. Box 3D New Mexico State University Las Cruces, New Mexico 88003	(505) 646-1920	
Technology Application Center (TAC) Contact: Mr. Jeryy Yowell 2500 Central Avenue, S.E. Albuquerque, New Mexico 87131	(505) 277-3622	°Conducted state energy consumption study for New Mexico
WESTEC Services, Inc. Contact: Mr. Peter Sherwood, Regional Manager 505 Marquette Avenue, N.W. Suite 1500 Albuquerque, New Mexico 87102	(505) 243-2835	°Contractor for Baca Geothermal Demonstration Project Data Management °Program management for El Centro, CA. District heating & cooling demonstration °Feasibility studies for geothermal grain drying, tungsten ore processing, ethanol & ammonia prod.
Western Energy Planners, Ltd. Contact: Mr. Jerry Tuttle 11000 Candelaria, N.E. Suite 112 W Albuquerque, New Mexico 87112	(505) 296-4070	°Energy systems including economic & engineering systems

RESOURCE DEVELOPERS (EXPLORATION AND LEASE-HOLDERS)

NAME	PHONE	REMARKS/EXPERTISE
AMAX Contact: Mr. Dean Pillsington Mr. Harry Olson 7100 West 44th Avenue Wheat Ridge, Colorado 80033	(303) 420-8100	°Rio Grande Rift °Animas Valley °Valles Calera
American Drilling & Grouting Co. Clinton, Mississippi		°Dona Ana County
Aminoil U.S.A., Inc. Contact: Mr. Claude Jenkins P.O. Box 11279 Santa Rosa, California 95406	(207) 527-5332	°Dona Ana County °Animas Valley
Bailey, Harry N. 25256 Terreno Drive Mission Viejo, California 92576	(505) 526-1403	°Drilled wells on land he owns at Radium Spgs. Wants resource user.
Chaffee Geothermal, Ltd. Contact: Mr. Jay Dick 1776 South Jackson, Suite 1000 Denver, Colorado 80210	(303) 692-9496	°Las Cruces/East Mesa anomaly
Calvert Exploration Company 1000 City Center Building Oklahoma City, Oklahoma 73102	(405) 239-6251	
Chevron Resources Company Contact: Mr. Eric Layman P.O. Box 3722 595 Market Street San Francisco, California 94119	(415) 894-2889	°Radium Springs °Socorro °Lordsburg-Animas
Earth Power Corporation P.O. Box 1566 Tulsa, Oklahoma 74101	(918) 587-9704	°Lightning Dock KGRA
Exxon Company USA Contact: Mr. James H. Hafenbrack Geological Advisor P.O. Box 120 Denver, Colorado 80201	(303) 789-7792	°Hidalgo County °Animas Valley
Fluid Energy Corporation Contact: Mr. Hal Bemis Denver, Colorado 80210	(303) 756-5266	°T or C °Las Cruces

RESOURCE DEVELOPERS (EXPLORATION AND LEASE-HOLDERS) (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
Geo-Products Corporation Contact: Mr. Kenneth Boren, Pres. 1330 Broadway Oakland, California 94612	(415) 893-8365	°Medium to low temperature resource developer °Hybrid geothermal-wood residue electrical generation - ethanol production
Gulf Mineral Resources Company Contact: Mr. Glen Campbell 1720 South Bellaire Denver, Colorado 80222	(303) 758-1700	°Socorro
Hunt Energy Corporation Geothermal Division Contact: Mr. Roger Bowers 2500 1st Nat'l Bank Building 1401 Elm Street Dallas, Texas 75202	(214) 748-1300	°Radium Springs °Kilbourne Hole
McCullock Geothermal Corporation Contact: Mr. H.R. Chantler 10880 Wilshire Blvd. Los Angeles, California 90024	(213) 879-5252	°Dona Ana County °Socorro
Occidental Geothermal, Inc. Contact: Dr. Robert Crewdson 5000 Stockdale Highway Bakersfield, California 93309	(805) 395-8000	°Sandoval County
Phillips Petroleum Company Contact: Mr. Richard Lenzer P.O. Box 239 Salt Lake City, Utah 84110	(801) 364-2083	°Lightning Dock, KGRA
Southland Royalty Company Contact: Jere Denton 1000 Ft. Worth Club Tower Fort Worth, Texas 76102	(817) 390-9200	°Radium Springs °Las Cruces
Sunoco Energy Development Company Contact: Mr. John Knox 12700 Park Central P.O. Box 9 - Suite 1500 Dallas, Texas 75251	(214) 233-2600	°Jemez Mountians
Texaco, Inc., Coal & Energy Resources Contact: Mr. Russ Criswell P.O. Box 2100 Denver, Colorado 80201	(303) 861-4220	

RESOURCE DEVELOPERS (EXPLORATION AND LEASE-HOLDERS) (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
Thermal Power Company Contact: Mr. Louis de Leon 601 California Street San Francisco, California 94108	(415) 981-5700	°Socorro Peak KGRA
Trans-Pacific Geothermal, Inc. Contact: Dr. Tsvi Meidav 1419 Broadway Oakland, California 94612	(415) 763-7812	°Las Cruces °Radium Springs
Union Geothermal of New Mexico Contact: Mr. Richard O. Engebretsen P.O. Box 15225 Rio Rancho, New Mexico 87174	(505) 897-1776	°Develper of the Baca Geothermal Electric Power Generating Project

NEW MEXICO GEOTHERMAL COMMERCIALIZATION INTEREST

PRIVATE AND COMMERCIAL USERS (CURRENT OR POTENTIAL)

NAME	PHONE	REMARKS/EXPERTISE
AMDEC Corp. (formerly under Western Development Corp.) Las Cruces, New Mexico 88001		°Large home developer seeking potential district heating system for subdivision. High Rolls Estates (atop the East Mesa
American Linen Co. 550 N. Church Las Cruces, New Mexico 88001	(505)526-6641	°Need industrial process heat
Aquaculture Products Contact: Mr. Michael Annison, Pres 1754 Lafayette Street Denver, Colorado 80218	(303) 832-2144	°Seeking suitable locality & resource for shrimp production
Ashbaugh, Inc., Randy Building Contractor T or C, New Mexico 87901	(505) 894-7215	°Potential residential space-heating
Bailey, Harry N. 25256 Terreno Drive Mission Viejo, California 92576	(505) 526-1404	°Drilled wells on land he owns at Radium Springs. Wants resource user.
Baker, Mr. Don H. 701 Mesa Place, N.W. Socorro, New Mexico 87801	(505) 835-3979	
Burgett Floral Company Contact: Mr. Dale Burgett Star Route P.O. Box 265A Animas, New Mexico 88020	(505) 548-2353	°Operates 100,000 sq.ft. geothermally heated greenhouse
Campbell, Mr. Doc Route 11 - Box 80 Gila Hot Springs Silver City, New Mexico 88061	(505) 534-9340	°Developer of Gila Hot Springs district heating system and low temperature electrical generation °Seeking venture capital
Chaffee Geothermal, Ltd. Contact: Mr. Jay Dick 1776 S. Jackson, Suite 1000 Denver, Colorado 80210	(303) 692-9496	°Las Cruces/East Mesa anomaly
Chino Greenhouses, Inc. Contact: Mr. Brian Fritz 1235 Urania Avenue Leucadia, California 92024	(714) 436-0194	°Seeking good resource and land for business

PRIVATE AND COMMERCIAL USERS (CURRENT OR POTENTIAL) (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
Clemens, Mr. Clifford R. 221-25 Manor Road Queens Village, New York 11427		°Resident atop the East Mesa anomaly
Geothermal Resources Internat'l Contact: Mr. Domenic Falcone 4676 Admiralty Way, Suite 503 Marina Del Rey, California 90291	(213) 821-8802	°In partnership with Mirador Corp. for a prospective fuel alcohol project
Good Samaritan Village Contact: Mr. Joe Pomplin, Adm. 3025 Terrace Drive Las Cruces, New Mexico 88001	(505) 522-1362	°Retirement center space-heating potential
Hildebrand Greenhouses Contact: Mr. Dick Hildebrand 2008 Edgehill Road Vista, California 92083	(714) 726-6351	°Seeking good resource and land for business
Jordan, Mr. Thomas 145-21 South Road Jamaica, New York 11435		°East Mesa anomaly
Kilde, Dale Lang Corp. P.O. Box 2125 Gallup, New Mexico 87301		°Constructon and development of industrial facilities
L'eggs Products, Inc. Contact: Mr. Stan Smith, Mgr. P.O. Box 788 Mesilla Park, New Mexico 88047	(505) 524-8541	°Industrial process heat requirement
McCants, Mr. Tom Star Route Box 265 Animas, New Mexico 88020	(505) 548-2260	°1979 AET award recipient for greenhouse & space-heating systems
Mirador Corporation Contact: Mr. Mike or Mr. John Bright P.O. Box 1475 305 Black Street Silver City, New Mexico 88061	(505) 388-1701	°Seeking capital venture for fuel alcohol production concept in Animas Valley
Ojo Caliente Mineral Springs Company Contact: Mr. George Mauro P.O. Box 468 Ojo Caliente, New Mexico 88054		°Seeking capital venture and technical assistance for retrofit space-heating

PRIVATE AND COMMERCIAL USERS (CURRENT OR POTENTIAL) (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
Pajaro Valley Greenhouses, Inc. Contact: Mr. Arne Thirup P.O. Box 69 Watsonville, California 95077		
Prepared Foods, Inc. Contact: Mr. Russ Johns, Pres. El Paso, Texas		°Needs process heat for beef °Has relocated in Dona Ana County
Roses, Incorporated Contact: Mr. James C. Krone, Ex.V.P. 1152 Haslett Road Haslett, Missouri 48840	(517) 339-9544	°National clearinghouse for rose growers °Researching geothermal energy option for its memo
St.Ann's Hospital Contact: Ms.Dee Rush, Adm. 800 East Ninth Truth or Consequences, New Mexico 87901		°Prospect for retrofit space-heating
Sandyland Nurseries Contact: Mr. Frank Cobb, Pres. P.O. Box 546 Mesilla Park, New Mexico 88047	(505) 684-5441	°Proposed major expansion to include drilling for production well
Headquarters: Sandyland Nurseries 3890 Bia Real Carpenteria, California 93013	(805) 684-5441	
Schaefer Wholesale Florists, Inc. Contact: Mr. Karl J. Schaefer R.D. 3 York, Pennsylvania 17402	(717) 741-3841	°Seeking suitable resource and land for business
Silver Mesa Greenhouses Contact: Mr. Jim Hutton P.O. Box 16301 Denver, Colorado 80216	(303) 573-9251	°Seeking good resource and land position for business preferably in Dona Ana County
Southwestern Services to Handicapped Children and Adults, Inc. Contact: Mrs. Jewell Burk 309 West College Avenue Silver City, New Mexico 88061	(505) 388-1976	°Faywood Hot Springs greenhouse state demonstration project

PRIVATE AND COMMERCIAL USERS (CURRENT OR POTENTIAL) (Cont'd)

NAME	PHONE	REMARKS/EXPERTISE
Tellyer Development Company, The Contact: H.B. Pardner Tellyer P.O. Box 1318 Las Cruces, New Mexico 88001	(505) 522-1964	°Subdivision development atop Los Alturas anomaly
Traylor, Mr. C.L. 1555 Candlelight Drive Las Cruces, New Mexico 88001	(505) 522-4552	°Resident atop the Los Alturas anomaly
Yucca Lodge Contact: Mr. Karl Kortimeier 316 Austin Truth or Consequences, New Mexico 87901 or Yucca Lodge Contact: Mr. Karl Kortimeier S.R. 319 Placitas, New Mexico 87043	(505) 894-3556	°Seeking capital and technical assistance for the construction of geothermally heated condominiums
Young, Tom Racquets & Health Club Contact: Mr. Tom Young 305 East Foster Road Las Cruces, New Mexico 88001	(505) 526-4477	°Space-heating and hot water needs

SUPPLIERS (CURRENT AND PROSPECTIVE)

Heat Exchangers:

NAME	PHONE	REMARKS
APV Company, Inc. P.O. Box 11189 Palo Alto, California 94306	(415) 326-6875	
Agric Machinery Corporation 23 Main Street & Green Village Rd. Madison, New Jersey 07940	(201) 377-7997	
Alpha-Laval Thermal American Heat Division P.O. Box 860 Sommerville, New Jersey 08076	(201) 685-1800	
Bell & Gossett - ITT 3200 North Austin Avenue Morton Grove, Illinois 60053		°Heat exchangers for the Carrie Tingley Hospital Demo Project
Cherry - Burrell 2400 Sixth Street, S.W. Cedar Rapids, Iowa 52406	(319) 399-3200	
Graham Manufacturing Company, Inc. Department G 170 Great Neck Road Great Neck, New York 11021	(800) 645-3757	
Industrial Systems Corporation 1025 Lake Road Medina, Ohio 44256	(216) 725-8500	
Patterson Kelly Company Divisions of HARSCO Corporation 115 Burson Street East Stroudsburg, Pennsylvania 18301	(717) 421-7500	
Process Equipmeny Supply Salt Lake City, Utah	(801) 278-9944	
Skyline Sales Company Salt Lake City, Utah	(801) 486-7114	
Trater Inc. Texas Division P.O. Box 2289 Wichita Falls, Texas 76307	(817) 723-7125	°Heat exchanger for NMSU Campus Project

SUPPLIERS (CURRENT AND PROSPECTIVE) (Cont'd)

Instrumentation:

NAME	PHONE	REMARKS
Energy Control, Inc. Contact: Mr. A. Bruce Cantrell Box 6907 Albuquerque, New Mexico 87197		°Distributor for Higgins Energy Association
Higgins Energy Associates P.O. Box 7317 Newark, Delaware 19711	(301) 885-2172	°BTU meter for the Carrie Tingley Hospital Demo Proj.
Tegal Scientific Inc. P.O. Box 5905 Concord, California Local Rep: Mr. Joe Weckerly 4200 Broadmore, N.E. Albuquerque, New Mexico	(505) 265-3381	

Low Temperature Electrical Generation:

NAME	PHONE	REMARKS
Barber-Nichols Engineering Company Contact: Mr. Ken Nichols, Pres. Denver, Colorado	(303) 421-8111	
Kinetics, Inc. Contact: Mr. Wally Brown Sarasota, Florida	(813) 366-3050	°Rankine-cycle engines
Wuilleumier & Associates Contact: Mr. Tim Wuilleumier, Pres. 7714 Laurel Suite 2 Cincinatti, Ohio 45243	(513) 271-7001	

Pipe & Fittings:

NAME	PHONE	REMARKS
Albuquerque Heating & Plumbing Company Contact: Mr. Gene Stalen Albuquerque, New Mexico		
Energy Materials, Inc. Contact: Mr. Dave Sibila, Mgr. 3300 South Tamarac Suite E105 Denver, Colorado 80231	(303) 750-4853	°High temperature plastic piping materials
Isco, Inc. Commerce Plaza - Suite 8 2719 South Lemel Circle Salt Lake City, Utah 84115	(801) 487-9831	°Bondstrand Pipe

SUPPLIERS (CURRENT AND PROSPECTIVE (Cont'd)

Pipe & Fittings:

NAME	PHONE	REMARKS
Mansville Sales Corporation, John P.O. Box 14624 Albuquerque, New Mexico 87111	(505) 294-1158	°Fittings - John Bell, Kernco, Inc. Albuquerque, New Mexico
Perma Pipe (BHT Engineering Company, Inc.) 1218 Wyoming El Paso, Texas 79902	(915) 533-1231	

Pumps:

NAME	PHONE	REMARKS
Alpha Southwest, Inc. 205 Rossmoor Road, S.W. Albuquerque, New Mexico 87102		
Berkeley Pumps Rodgers & Company, Inc. 1615 Isleta Blvd. S.W. Albuquerque, New Mexico 87105		
Centerlift, Inc. 5421 Argosy Avenue Huntington Beach, California 92649	(213) 598-9711 or (714) 893-8511	
Cole Drilling Company 801 Delhi Street El Paso, Texas 79927	(915) 859-9889	
Farmers Pump Supplies 512 North Copia El Paso, Texas 79927	(915) 562-3785	
Gould Water Systems Lucas Drilling Company 10058 Northloop El Paso, Texas 79927		
James, Cooke & Hobson, Inc. 2817 East Yandell El Paso, Texas 79925		
TP Pump & Pipe Company 1842 Two, N.W. Albuquerque, New Meixo 87102		
TRW Reda Pumps Contact: Mr. Hugh Sosbee P.O. Box 131 Farmington, New Mexico 87401	(505) 325-4648	

SUPPLIERS (CURRENT AND PROSPECTIVE) (Cont'd)

Turbines & Power Systems:

NAME	PHONE	REMARKS
Barber-Nichols Engineering Company Contact: Mr. Ken Nichols, Pres. Denver, Colorado	(303) 421-8111	
Hitachi America, Ltd. Contact: Mr. Glenn Fedirko 100 California Street San Francisco, California 94111		°Pumps, turbines and power systems

SUPPLIERS FOR NMSU CAMPUS GEOTHERMAL PROJECT

Las Cruces:

NAME	PHONE	REMARKS
Haydens Hardware 1210 Foster Road Las Cruces, New Mexico 88001	(505) 522-7220	
Ace Rental 1210 North Valley Drive Las Cruces, New Mexico 88001	(505) 524-9614	
Given Paints 221 North Water Las Cruces, New Mexico 88001	(505) 524-1241	
Woodward Lumber Company 909 West Amador Las Cruces, New Mexico 88001	(505) 526-6622	
Mesilla Valley Rental Center 1635 South Valley Drive Las Cruces, New Mexico 88001	(505) 524-1372	
Rick's Welding P.O. Box 1107 Las Cruces, New Mexico 88001	(505) 526-5412	
Valley Welders Supply Co. 1700 South Valley Drive Las Cruces, New Mexico 88001	(505) 524-3554	
N.O. Nelson 614 West Amador Avenue Las Cruces, New Mexico 88001	(505) 523-7401	
Zia Masonry 201 Union Avenue Las Cruces, New Mexico 88001	(505) 524-0705	
Smith & Aquirre Construction Company East Lohman Avenue Las Cruces, New Mexico 88001	(505) 522-6974	
Southwest Crafts, LTD 990 North Quesenberry Las Cruces, New Mexico 88001	(505) 524-2886	

SUPPLIERS FOR NMSU CAMPUS GEOTHERMAL PROJECT

El Paso:

NAME	PHONE	REMARKS
Kennan Supply, Inc. 1041 Eastside El Paso, Texas 79915	(915) 779-7473	
Vinton Pipe & Supply P.O. Box 9858 El Paso, Texas 79989	(915) 886-3914	
El Paso Pipe & Supply 6914 Industrial El Paso, Texas 79989	(915) 779-4932	
Nu-Tex Pipe & Supply P.O. Box 17967 El Paso, Texas 79917	(915) 859-9151	
Boyd Engineering Supply P.O. Box 3605 El Paso, Texas 79923	(915) 533-7575	
Clowe & Cowan of El Paso, Inc. 11221 Rojas El Paso, Texas 79915	(915) 593-8833	
W.W. Grainger, Inc. P.O. Box 27107 El Paso, Texas 79935	(915) 598-1180	
Wisco Supply, Inc. 802 South Virginia El Paso, Texas 79915	(915) 544-8294	
Willard A. Selle Insulation Company 7344 Stiles Drive El Paso, Texas 79915	(915) 772-8525	
El Paso Engineering & Testing 2315 Myrtle El Paso, Texas 79901	(915) 532-3631	
Baker Plastics P.O. Box 3896 El Paso, Texas 79923	(915) 562-2226	
Bosco Fastening Service Center 960 Tony Lama El Paso, Texas 79925	(915) 592-1223	
Triangle Electric Supply Company 3815 Duranzo El Paso, Texas 79915	(915) 533-5981	

NORTH DAKOTA GEOTHERMAL COMMERCIALIZATION PROJECT

FINAL PROGRESS REPORT

JULY 1 - DECEMBER 31, 1981

Prepared by

Bruce A. Gaugler, Program Coordinator

North Dakota Energy Office
Geothermal Program
Federal Aid Coordinator Office

Work Performed Under Contract No. DE-FC07-79ID12011

U.S. Department of Energy

Idaho Operations Office

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1.0 INTRODUCTION

1.1 Purpose of Project

Unlike much of the western United States, North Dakota is not noted for obvious displays of geothermal energy, such as volcanoes, hot springs, and geysers. Most of North Dakota's geothermal energy potential is available in the form of low to moderate low temperature groundwater resources from many aquifer systems throughout the state. Although hot geothermal fluids are available in many areas, excessive depth and poor quality often limit their usefulness for residential and small commercial applications.

The North Dakota State Commercialization Program was established in September 1979 as a cooperative effort between the United States Department of Energy and the State of North Dakota to stimulate the commercialization of geothermal energy in the state. Program personnel have remained essentially the same during the program's duration. Bruce A. Gaugler has served as Program Coordinator since the program was initiated. Jolene Wetch was employed as program secretary until July 1981 when the State Commercialization Program was incorporated into the North Dakota State Energy Office. Jill Johnson Sholts was retained as a technical writing consultant until July 1980; from July 1980 until March 1982, Jill D. Ritz was employed in that capacity.

1.2 Objectives

Several major objectives have been identified as a means to accomplish the goal of geothermal commercialization in North Dakota. These are:

- Identify prospective geothermal users and developers in the state.
- Match geothermal sites with potential markets.
- Stimulate interest and cooperative action among participants in geothermal commercialization.
- Identify the constraints to geothermal commercialization and recommend ways to alleviate them.
- Provide information to prospective users and developers, including permit requirements and financial, economic, engineering, and resource information.
- Conduct a state-wide outreach program to educate the public and to stimulate interest.

The state commercialization team's initial efforts at commercializing geothermal energy in North Dakota began at the grassroots level. In 1981 the emphasis of our program switched from planning activities to more advanced technical assistance to communities and private developers interested in geothermal district heating and cooling systems and larger-scale commercial and community projects. This report briefly summarizes the achievements and projects initiated by the state commercialization team since 1979.

1.3 Technical Approach and Team Members

To evaluate the possibilities for geothermal commercialization, the state commercialization team investigates substate regions and specific sites in the state. The necessary data for incorporation into the reports are obtained from the assessment of available geothermal resources; current and projected residential growth and industrial development; institutional, technical, and environmental considerations; current and projected energy demand; and economic activity. This information provides the basis for the following specific tasks:

- Prospect identification
- Area development plans
- Site-specific development analyses
- Commercialization plans
- Institutional assessments
- Energy and economic assessments
- Outreach and marketing programs

The North Dakota Energy Office, Geothermal Program, is conducting the North Dakota Geothermal Commercialization Project. Team members are: Bruce A. Gaugler, Program Coordinator, and Jill D. Ritz, Technical Writer.

1.4 Project Benefits to North Dakota and DOE

The North Dakota Geothermal Commercialization Project provides the state with a planning and assistance program to impart information and advice to state agencies, local governments, industries, small businesses and individuals. Increasing the level of understanding regarding the nature and advantages of geothermal energy will encourage its use and lessen reliance on fossil fuel energy sources.

North Dakota's project provides DOE with an assessment of environmental, economic, institutional, and resource conditions that affect the timing and extent of geothermal commercialization in North Dakota. This information is essential for long-range national energy development planning and will indicate the contribution that North Dakota's geothermal resources can make to the national energy demand.

At this time we would like to acknowledge the efforts of several individuals and organizations whose willingness and enthusiasm for geothermal

energy prospects in North Dakota have made this task an easier one:

- Don Mathsen and other members of the University of North Dakota Engineering Experiment Station staff provided invaluable technical advice on groundwater heat pumps and system design.

- Ken Harris of the North Dakota Geological Survey, who also headed up the North Dakota Resource Assessment Team, was our major source of geothermal resource information.

- Ray Butler, United States Geological Survey, Water Resources Division, has been involved in mapping the quality, depth, and temperature of several major aquifer systems in the state and often provided us with up-to-the-minute data on those formations.

- Francis Schwindt and Rick Nelson of the North Dakota State Health Department have worked closely with us on developing guidelines for geothermal fluid disposal regulations.

- The North Dakota State Water Commission provided maps and county groundwater studies, plus advice on permit regulations for water use.

- Also our thanks to other state and local agencies and personnel, too numerous to mention, but without whom our reports and plans would be without substantiation.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Indentification

The North Dakota Resource Assessment Team was established in March 1979 as a cooperative effort between the United States Department of Energy and the North Dakota Geological Survey to evaluate the hydrothermal resources of North Dakota.

Phase I of the agreement consisted of evaluating potential hydrothermal aquifers based on the North Dakota Geological Survey's records of oil and gas wells drilled in the state. A computer library system (WELLFILE) of the oil and gas well data was assembled, and these data were then used to evaluate the hydrothermal potential of the Mississippian Madison Formation and to generate a geothermal gradient map of North Dakota. The results of Phase I activities indicate that the Madison Formation and other Paleozoic aquifers are low to medium temperature geothermal resources, but their great depth and poor water quality will probably preclude their development as significant hydrothermal aquifers in North Dakota.

During Phase II, the Resource Assessment Team concentrated on geothermal gradient and heat-flow studies, stratigraphic studies, and water quality studies. A computer library system (WATERCAT) based on water well data from the Mesozoic and Cenozoic aquifers above the Pierre Formation was developed. The stratigraphic and water quality data contained in WELLFILE were updated and expanded.

Phase II activities included developing structural, isopach, and sand/shale ratio maps of the Cretaceous Inyan Kara Formation. The Inyan Kara Formation is a widespread aquifer of moderate depth and good to moderate quality. Temperature data currently available for this formation indicates that the Inyan Kara is likely to be an important hydrothermal aquifer in much of North Dakota.

The Resource Assessment Team is presently evaluating two other potential hydrothermal aquifers of Mesozoic Age--the Fox Hills and Hell Creek formations. Phase III activities will also include assembling a user-oriented catalog of potential hydrothermal aquifers in the state.

Most of the shallow alluvial and glacial drift aquifer systems that are commonly used for domestic purposes are also good sources of geothermal energy. These sources are more local in extent than the Mesozoic and Cenozoic age aquifers and provide low temperature groundwater resources that can be used effectively in groundwater heat pump applications. Information on these shallow aquifers is readily available from county groundwater studies.

The United States Geological Survey is also compiling hydrothermal data for the state. They are summarizing depth, temperature, and water quality data for all major Mesozoic and Cenozoic aquifer systems. This information has not been published but is available to the geothermal commercialization team on a site specific basis.

2.2 Area Development Plans

One of the first tasks of the state commercialization team was to match up the potential geothermal prospects in the state with the potential applications of the geothermal energy. The state was divided into eight substate regions for analysis, and area development plans were completed for the Roosevelt-Custer Region and the Lewis and Clark 1805 Region.

The area development plans indicate that several aquifer systems with geothermal potential underlie both regions. The geothermal fluids are low to moderate temperature and are most suitable for residential and commercial space heating and cooling, agricultural uses, and low temperature industrial processes. The plans also outline the permit requirements for geothermal development in North Dakota, environmental concerns, and the economics of geothermal energy systems.

Since the characteristics of North Dakota's geothermal resources are similar throughout the state, area development plans were not written for the remaining six regions. Resource information and appropriate applications are now handled on a site-specific basis.

2.3 Site Specific Development Plans

Individual groundwater heat pump installations for residential and commercial space heating purposes continue to account for the greatest implementation of geothermal energy in North Dakota. During 1981 the state team was contacted by a growing number of communities and private developers who were interested in using geothermal energy for larger-scale community and demonstration projects. The projects described are in various stages of planning or are already under construction.

Dickinson

In September 1981 the University of North Dakota Engineering Experiment Station was awarded a grant by the United States Department of Energy to conduct a preliminary engineering and economic study for a geothermal district heating system in Dickinson. The study investigated using approximately 160°F groundwater from the Dakota Group aquifer system to heat a proposed 581-acre residential and commercial development on Dickinson's west edge. They also investigated the feasibility of treating the water after the heat had been removed to provide a source of potable water to help meet the city's domestic needs.

The study substantiates both the economic and technical feasibility of a combined geothermal district heating and water supply system for the city of Dickinson when compared to conventional energy sources and alternative methods of obtaining potable water in the area.

LaMoure

The city of LaMoure operates a community health care facility, which houses a clinic, dental and optometric offices, and the county nursing services. Concern over rising fuel oil prices prompted city officials to seek a more efficient, less costly system for heating and cooling the 5,000 square foot building. LaMoure is situated over a shallow groundwater aquifer that produces abundant quantities of 45 to 47°F groundwater and is an excellent site for utilizing a water-to-air groundwater heat pump system.

To encourage the implementation of this community demonstration project, the geothermal commercialization program has awarded the city of LaMoure a matching grant amounting to $5,000.00. Local contractors and suppliers will provide the equipment and labor, thereby benefiting the local economy and providing local experience with geothermal energy systems. The estimated completion data for the project is March 31, 1982.

North Dakota Concrete Products, Menoken

North Dakota Concrete Products produces concrete products, such as concrete culverts, pre-stressed bridge beams, pilings, and miscellaneous items. Their Menoken plant uses a steam curing process to accelerate the concrete curing time so that 28 day strength is obtained within 24 hours. The present boilers used to produce this steam are oil fired.

TPI, Inc., a Bismarck consulting firm, was awarded a grant in 1980 by the United States Department of Energy to evaluate the economic feasibilty of utilizing warm water from the Dakota Sandstone Formation (estimated at 97°F) as an alternative energy source. A water-to-water heat pump system was investigated to replace the existing boiler system.

TPI concluded that, although operating costs for the geothermal system are considerabley lower than those for the fuel oil system, they are not substantial enough to provide an acceptable rate of return on the initial investment at today's cost of money. The study did recommend that the economics be re-examined if a nearby housing development of industrial enterprise can be found to utilize the geothermal waste water and offset some of the initial cost, or if the price of energy continues to rise at a rate above the overall rate of inflation.

Oakes

Foss Associates, a Fargo engineering firm, is drawing up plans to retrofit the fuel oil heating system in the Oakes public school to a geothermal groundwater heat pump system. Geothermal energy is expected to meet the total space heating needs of an existing 40,000 square foot classroom structure and a new 15,000 square foot gymnasium. A test well drilled to the shallow Oakes aquifer verified that an adequate flow of 48 to 49°F water is available to meet the project's 550 gallon per minute requirement.

Patterson Hotel, Bismarck

The Patterson Hotel is a 70 year-old historic landmark located in downtown Bismarck. After two years of delay, developers have finally received guarantees of Housing and Urban Development funding and are proceeding with plans to renovate the structure into elderly housing units. These plans include converting the present natural gas heating system to geothermal energy.

A feasibility study conducted by Kohl and Schwartz Engineering, a Bismarck engineering firm, in July 1980 indicates that geothermal energy can satisfy all of the building's heating requirements. A 3,000 foot well drilled to the Dakota Sandstone Formation would provide approximately 86°F groundwater, and a groundwater heat pump system would be used to heat and cool the building. The geothermal fluids beneath the Patterson are also under artesian pressure of 40 to 60 pounds per square inch at the well head and could conceivably eliminate the need for well pumps.

Rolla

The city of Rolla will become the first North Dakota, and possibly the first United States, city to establish a dual-purpose community water system. (Ephrata, WA, has initiated a similar project, but project engineers anticipate that Rolla's project will be on-line at an earlier date).

A groundwater heat pump system will extract energy from Rolla's municipal water supply system (estimated between 44 and 48°F) to heat and cool the city's new 8,500 square foot senior citizen and day care center. The estimated 500,000 gallons of water a year used for heating the building will be returned to the production aquifer through a return well.

Funds for the project were provided by a Housing and Urban Development Block Grant, and local contractors are involved in the design and construction. The expected completion date of the project is April 1, 1982.

2.4 Public Outreach Program

North Dakota has implemented several strategies for educating and informing a large segment of the North Dakota populace. Among them are a monthly newsletter, news media releases, speeches to civic and business organizations, and personal contacts with individuals and businesses.

2.4.1 Outreach Mechanisms

The geothermal newsletter, "Geothermal News", was initiated in September 1980 with a mailing of 600; it now reaches approximately 1,500 individuals and businesses each month. Each edition features current or proposed geothermal projects in the state plus other items of special interest to North Dakotans.

The geothermal commercialization program's achievements have received statewide news media coverage on several occasions. These included news articles on geothermal project developments, radio broadcasts originating from Belcourt and Bismarck, and one-half hour public service television interview carried by four major stations in the state in March 1981. The Ground Water Heat Pump Journal, published by the National Well Water Association, has also carried several articles describing North Dakota's contributions to geothermal energy development, which have generated considerable interest from out-of-state and foreign firms in the North Dakota geothermal program and groundwater heat pump brochures.

During the past two years, team members have made presentations at 14 civic and business organizations including the annual meetings of the North Dakota Association of Professional Engineers and the North Dakota Home Builders Association. The team has also attended geothermal project open houses in Jamestown and Hankinson to distribute information and answer questions and have participated in a one-day workshop on geothermal groundwater heat pumps in Fargo, North Dakota, in January 1982.

2.4.2 Consultants List

One of the methods employed to encourage the geothermal industry in North Dakota was to compile a list of well drillers, heat pump installers and distributors, engineers, and other professionals involved or interested in geothermal development. This list is distributed to individuals seeking advice or assistance with their geothermal projects.

2.4.3 Groundwater Heat Pump Brochures

In cooperation with the University of North Dakota Engineering Experiment Station, North Dakota has published two brochures on groundwater heat pumps. The first brochure, "Geothermal Groundwater Heat Pump: An Efficient Way to Heat and Cool Your Home", is a general explanation of groundwater heat pump operation and economics for the North Dakota homeowner. The second brochure, entitled "Geothermal Groundwater Heat Pump Equipment Selection Procedures for Architects, Designers, and Contractors", is more technically oriented. Both brochures have been widely distributed in and out of state.

2.4.4 Groundwater Heat Pump Monitoring Program

In November 1980 the University of North Dakota Engineering Experiment Station received funding from the Old West Regional Commission to conduct a one-year monitoring study of ten groundwater heat pump installations in the state. Operational parameters to be determined by the program included actual energy savings, operational or maintenance problems, net energy extracted from the groundwater supply, and variations in system performance based on design differences and local groundwater temperatures.

The results of the study are very encouraging and support the premise that groundwater heat pump systems are an efficient and economic alternative to conventional heating systems in North Dakota. The study demonstrated that the groundwater heat pump is competitive on an annual cost basis with fuel oil and electric resistance systems in all areas of the state and with natural gas in some areas.

2.4.5 Systems Inventory

The North Dakota State Health Department is developing an Underground Injection Control Program, which will include rules and regulations for geothermal disposal wells. Program personnel are furnishing the Health Department with updated information on the location of geothermal installations in the state plus water temperature, well depths, and disposal methods. It is anticipated that this inventory information will also serve as a valuable data base for the State Industrial Commission when they begin formulating the rules and regulations for the Geothermal Resource Development Regulation Act.

2.4.6 Legislation

In 1979 there were no state laws regulating geothermal development or providing economic incentives for geothermal energy installations. This changed during the 1981 state legislative session when three bills dealing specifically with geothermal energy were passed.

House Bill 1362, which became law on July 1, 1981, gave the State Industrial Commission the authority to regulate the exploration, development, and utilization of geothermal resources in the state. The act provides general guidelines for the Industrial Commission to follow; specific rules and regulations will be formulated by the Commission at a later date. Geothermal energy extraction facilities used for private residential heating and cooling purposes are specifically exempted from the law, but permits will probably be required for industrial and commercial uses of geothermal energy.

The Industrial Commission's jurisdiction is not exclusive and does not affect the jurisdiction of other government agencies. The geothermal developer in North Dakota is also subject to regulations and permit requirements related to water appropriation and discharge. All of the local, state, and federal regulations for geothermal energy development are outlined in this handbook entitled "Geothermal Institutional Handbook for the State of North Dakota".

North Dakota now has the distinction of being one of only four states that allow tax incentives for geothermal energy devices. At the request of sponsoring legislators, North Dakota geothermal team members were actively involved in providing information and economic statistics on geothermal energy and in testifying at legislative committee hearings in support of the bills.

Any North Dakota taxpayer, whether an individual or a corporation, who installs a geothermal energy device on or after January 1, 1981, may now claim a state income tax credit of five percent per year for three years for the actual cost of acquisition and installation of such a device. The 1981 legislature also approved an expanded property tax exemption for geothermal energy systems. The exemption is valid for five years following the date on which the system is installed. These incentives should prove beneficial to North Dakotans by bringing the initial costs for geothermal energy systems more in line with initial costs for conventional heating and cooling systems.

2.4.7 Financial Planning Assistance

North Dakota's Geothermal Program has helped more individuals determine the economic feasibility of installing a geothermal energy system as opposed to a conventionally fueled heating system. In addition, program personnel has located funding for several geothermal studies and have helped developers apply for public and private financial assistance. These efforts are listed below:

Organization	Funding Source	Project Description
TPI, Inc. Bismarck	U.S. Department of Energy	Feasibility Study "Economic Analysis for Utilization of Geothermal Energy by North Dakota Concrete Products Company"
Kohl & Schwartz Engineering, Inc. Bismarck	U.S. Department of Energy	Feasibility Study "Geothermal HVAC Mechanical System Feasibility Evaluation for Patterson Hotel, Bismarck, ND"
University of North Dakota, Engineering Experiment Station	Old West Regional Commission	Performance Study "Performance Monitoring of Select Groundwater Heat Pump Installations in North Dakota"
University of North Dakota, Engineering Experiment Station	U.S. Department of Energy	Engineering and Economic Study "Dickinson Geothermal Study"

City of LaMoure	North Dakota Energy Office Geothermal Program	Provided for $5,000.00 matching grant for community demonstration project
Patterson Hotel Developers	Geothermal Loan Guarantee Program	Assisted hotel owners develop their geothermal project and write a funding proposal
St. Mary's High School New England		Identified potential private funding sources
Maryvale Convent		Assisted convent director in contacting private funding and engineering firms
Carlson Homes Bismarck		Helped owners develop a geothermal demonstration project and write a grant proposal to the Department of Energy
City of Lemmon, SD		Assisted South Dakota Energy Office personnel in trying to locate financial aid for a district heating system project in Lemmon

2.4.8 Groundwater Heat Pump Industry Developments

Probably the most significant achievement of the State Commercialization Program has been the establishement of a flourishing, new industry in North Dakota.

When the program was initiated in September 1979, there was only one groundwater heat pump installation on-line in the state. That first heat pump had to be purchased directly from a manufacturer in Florida because there were no groundwater heat pump distributors operating in North Dakota. Since that modest beginning, over 100 geothermal systems have come on-line, and there are now groundwater heat pump distributors and installers located across the state.

With a typical installation cost of approximately $5,300.00, the groundwater heat pump industry has already generated in excess of one-half million dollars. If current growth predictions are correct, this figure will top the million dollar mark in 1982 and over two million in 1983. This economic growth has created new jobs and employment opportunities in the well drilling, electrical, plumbing, heating, and other related fields.

Many of the program activities have been aimed at educating North Dakotans as to the advantages of this relatively new heating and cooling system and at encouraging North Dakota businessmen and professionals to become directly involved in developing North Dakota's geothermal potential. The results of these efforts have proven very successful.

A typical groundwater heat pump system uses one-third to one-fourth as much energy as would a conventional heating and cooling system. Table 1 provides an estimate of possible energy on-line through the year 2000. These figures are based on the number of geothermal projects on-line as of June, 1981 and the rate of growth apparent between June and December 1981.

TABLE I

PROJECTED ENERGY (BTU's) ON-LINE

	June 1981	Dec. 1981	1982	1983	1984	1985	1990	1995	2000
Residential	1.32×10^{9} (19)	5.27×10^{9} (76)	1.05×10^{10} (152)	2.1×10^{10} (304)	4.2×10^{10} (608)	7.66×10^{10} (1108)	2.5×10^{11} (3608)	4.23×10^{11} (6108)	5.96×10^{11} (8608)
Commercial	5.0×10^{8} (2)	2.0×10^{9} (8)	4.0×10^{9} (16)	8.0×10^{9} (32)	1.6×10^{10} (64)	2.85×10^{10} (114)	9.1×10^{10} (364)	1.54×10^{11} (614)	2.17×10^{11} (864)
Total BTU's	1.82×10^{9}	7.27×10^{9}	1.45×10^{10}	2.9×10^{10}	5.8×10^{10}	1.05×10^{11}	3.41×10^{11}	5.77×10^{11}	8.13×10^{11}

NOTE: The numbers in parentheses represent the projected number of homes or commercial establishments that will be utilizing geothermal energy to meet their total space heating and cooling needs.

SOUTH DAKOTA GEOTHERMAL COMMERCIALIZATION PROJECT

SEMI-ANNUAL PROGRESS REPORT

JULY - DECEMBER, 1981

PREPARED BY

Phil Lidel

SOUTH DAKOTA OFFICE OF ENERGY POLICY

WORK PERFORMED UNDER CONTRACT NO. DE-FC07-81ID12012

U.S. DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE

1.0 INTRODUCTION

1.1 Scope of Project

The scope of the South Dakota commercialization effort is to inform and assist the people of the state in the use of geothermal energy. The bottom line is to match the user with the resource and to get the geothermal BTU's on-line as soon as possible. Technical and community assistance combined with a strong outreach program were the vehicles used the last 6 months of 1981 to achieve the scope.

Philip and Lemmon are receiving community assistance from Eliot Allen and Associates. Philip is looking for funding sources to further develop district heating from the discharge from the Haakon County School. Lemmon is trying to put together a financial package to provide space heating to a 14 block downtown area. Lemmon submitted a UDAG proposal to HUD August 31, 1981 which would require funding of $2,158,000. The title and description of the proposed project is "Development of the first phase of a multi-tiered geothermal utility that will provide lower-cost energy for existing residences and businesses and concomitantly stimulate new commercial and industrial investments". Geotherml/terra-heat workshops sponsored by the Office of Energy Policy were presented at Rapid City October 9th and Sioux Falls October 10th. Other significant events occurring in the latter half of 1981 are: (1) The seven Rocky Mountain Basin and Range state commercialization teams held their meeting in Custer State Park September 9-10, 1981. (2) The geothermal heating system at St. Joseph's Indian School, Chamberlain, South Dakota went on-line October 29th. The cascade type system uses two centrifugal heat pumps to boost the heating water to design temperature. (3) A local groundwater heat pump distributor has installed 41 groundwater heat pumps in the past few months.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

Baseline data for geothermal prospect identification is itemized in Tables I, II, and III. Table I was developed from a resource inventory conducted during the summer of 1980 by the Stanley County Extension Service and contained in an as yet unpublished report. Table II is data developed from the 3 successful P.O.N. projects in South Dakota. Table III itemizes data collected from technical assistance requests received by the state team. All the prospects have temperatures less than 150°C and are proven resources.

The leasing regulations have not changed since the South Dakota Geothermal Energy Handbook was published.

TABLE I

DEL JENSEN'S INVENTORY - SUMMER 1980

	County Name & Type	Location S TWP R	Temp. (^{o}C)	Flow (GPM)	Use
1.	Stanley (w)		56	200	Stock Pond
2.	Stanley	5-8-25	46	60	Heat Buildings & Swimming Pool
3.	Stanley	7-6-25	41	75	Heat Home
4.	Haakon	6-1-25	71	200	Heat School
5.	Haakon	1-1-20	66	158	Heat County Shop, Domestic
6.	Lyman	31-105-76	38	40	Space Heating
7.	Lyman	23-104-72	22	40	Domestic
8.	Lyman	28-104-74	38	5	
9.	Lyman	34-105-77	41	40	Heat Garage
10.	Haakon	6-6-8	27	3	
11.	Haakon	6-6-18	21	15	Domestic & Stock Water
12.	Haakon	13-6-22	56	200	Stock Water
13.	Haakon	5-11-21	47	40	
14.	Haakon	33-5-22	68	200	Space Heating & Grain Drying
15.	Haakon	33-5-22	54	250	Stock Water
16.	Haakon	5-22	54	200	Stock Water
17.	Hughes	29-111-78	41	60	Space Heating Home with GWHP
18.	Hughes	28-109-75	27	12	Domestic
19.	Hughes	28-110-74	27	50	Domestic
20.	Hughes	28-110-76	21	40	Heats Shop Floor
21.	Hughes	28-109-75	16	2	Stock Water
22.	Sully	6-116-77	29	62	Waters Garden
23.	Sully	7-115-80	28	30	Corrosion Problems
24.	Sully	29-113-80	27	80	Stock Water
25.	Sully	3-114-80	30	35	Groundwater Heat Pump
26.	Sully	19-114-79	27	15	

Table I - Cont'd

	County Name & Type	Location S TWP R	Temp. (^oC)	Flow (GPM)	Use
27.	Sully	12-114-78	29	50	Corrosion Problems
28.	Stanley	33-3-25	51	30	
29.	Sully	19-114-80	24	80	Pipes in Shop Floor
30.	Stanley		21	15	
31.	Stanley	6-8-26	44	40	Pipes in Home
32.	Stanley	26-8-25	41	150	Heats Shop
33.	Stanley	3-5-25	53	100	Heats 2 Homes
34.	Stanley	5-8-25	44	42	Corrosion Problems
35.	Stanley	28-5-25	44	60	
36.	Stanley	5-5-26	57	60	
37.	Stanley	25-3-26	40	15	
38.	Stanley	10-3-26	54	80	Pipes in Basement Floor
39.	Stanley	1-3-26	27	10	Stock Watering
40.	Stanley	36-3-29	56	30	Stock Watering
41.	Stanley	18-4-31	40	72	Stock Water
42.	Stanley	29-105-8	10	Pumped	Stock Water
43.	Stanley	9-109-79	32	90	Stock Water
44.	Stanley	7-109-79	10	10	Domestic
45.	Stanley	36-109-79	10	50	Stock Water
46.	Stanley	36-109-79	21	50	Domestic
47.	Stanley	20-109-79	42	70	Stock Water
48.	Stanley	20-109-79	38	60	Pipes in Door
49.	Stanley	35-109-76	32	25	Domestic
50.	Stanley	26-109-76	32	-	Stock Water
51.	Stanley	35-109-76	34	20	Groundwater Heat Pump
52.	Stanley	26-109-76	32	70	Stock Water
53.	Stanley	23-9-27	36	66	Stock Water
54.	Stanley	27-7-26	35	42	
55.	Stanley	Ft. Pierre	33	90	Heats Home With Gas in Water
56.	Stanley	30-9-27	41	100	Stock Water

TABLE II
RESOURCE DATA FROM DEMONSTRATION PROJECTS

Location	Depth Meters	Temp. ^{o}C	Flow GPM	Use
Philip (Haakon Co.)	1300	69	300	Space, water and district heating
Diamond Ring Ranch Haakon County	1253	67	170	Space heating and grain drying
St. Mary's Hospital Hughes Co. - Pierre	663	41	375	Domestic water preheating & space heating

TABLE III

RESOURCE DATA FROM TECHNICAL ASSISTANCE REQUESTS

Location	Depth Meters	Temp. °C	Flow GPM	Proposed Use
Dupree Ziebach County	1370	59	66	Space Heating For School Complex
Evans Plunge Hot Springs, SD	Spring	28	2500	Space Heating
VA Center Hot Springs, SD	Spring	27	1600	Space Heating
Ed Brunner Nisland, SD Rancher	1350	52	1400	Space Two Houses and a Shop
City of Polo Hand County	483	36	100	District Space Heating
Vermillion, SD Clay County	Reservoir	11	Pumped	Heat Library
Wessington, SD Hand County	335	27	50	Space Heating Public Buildings
Eureka, SD McPherson County	636	21	348	District Space Heating
Faulkton, SD Faulk County	366	22	225	Space Heat School Complex
Eugene Boettger Rural Baltic S.D. Horse Breeder, Minnehaha Co.	85	12	Pumped	Space Heat Home

Table III - Cont'd

Location	Depth Meters	Temp. °C	Flow GPM	Proposed Use
Ray Herman, Rural Presho, S.D. Rancher Lyman Co.	579	48	110	Space Heating For 3 Houses, Machine Shed, Shop, and Barn
St. Joseph Indian School, Chamberlain, S.D. Brule County	290	24	1000 4 wells	Space Heat School Complex of 153,000 ft^2 (operating)

2.2 Area Development Plans

2.2.1 State Geothermal Planning Areas

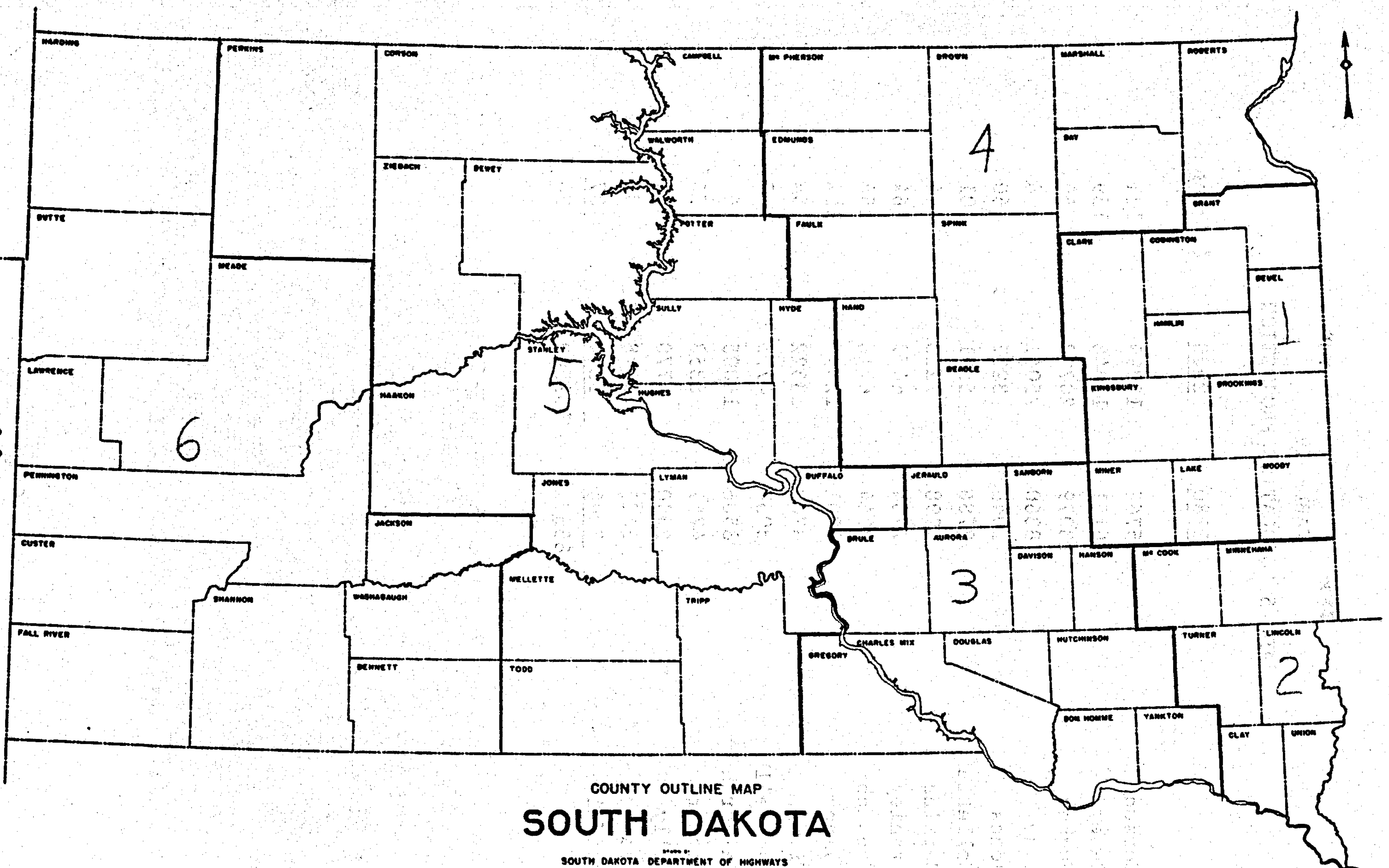
The state geothermal planning areas were redefined in the July - December 1980 semi-annual report to 6 areas. These areas conform with the District Planning and Development Commissions (COGS) in South Dakota (Figure 1). This modification will facilitate the flow of information from the COGS to the energy office.

The priorities for the present contract year will be to analyze the data obtained from N.M.E.I. and the State Planning Bureau for areas 5 and 6. These areas overlie the Madison Formation which is the only resource providing geothermal energy for direct use. ADP's 5 and 6 will be completed in the present contract year.

Population projections for the two areas obtained from the State Planning Bureau are shown in Tables IV and V.

2.3 Site Specific Development Plans

Prospective candidates for SSDP's are Lemmon, Philip, Midland, Polo and St. Joseph's Indian School at Chamberlain. Lemmon, Philip, and Midland have been described in previous reports. The draft copy of the Geothermal Feasibility Analysis for the Polo School District #29-2 prepared by Hengel Associates contains essential data for a SSDP.



COUNTY OUTLINE MAP

SOUTH DAKOTA

SOUTH DAKOTA DEPARTMENT OF HIGHWAYS
RESEARCH AND PLANNING DIVISION

AREA DEVELOPMENT PLANS

TABLE IV

ADP 5 POPULATION PROJECTION

	1980	2020	% Change
Corson	5768	13299	131
Dewey	6151	15948	159
Hughes	13079	20792	59
Todd	8360	25041	196
Jones	2049	3287	60
Mellette	2786	5591	101
Perkins	4998	7213	44
Stanley	2734	4477	64
Ziebach	2644	6716	154
Lyman	4801	12097	152
Tripp	8760	13522	54
Campbell	3038	4775	57
Walworth	8506	14005	65
Potter	4757	8358	76
Sully	2590	4770	84
Hyde	2625	4378	67
Buffalo	2046	5240	107
	85691	169509	98

TABLE V

ADP 6 POPULATION PROJECTION

	1980	2020	
Bennett	3600	8145	126%
Butte	8278	11860	43%
Fall River	7326	9107	24%
Haakon	3075	7310	138%
Jackson	1664	3126	88%
Lawrence	19015	27085	42%
Meade	20343	39236	93%
Pennington	70687	126144	79%
Shannon	10682	36950	246%
Washabaugh	1836	5684	210%
Custer	4923	5701	16%
Harding	2006	3253	62%
	153435	283601	85%

However, the report also indicates two obstacles that may curtail the development of a geothermal system. The first obstacle is with the resource. The existing 483 meter well is located in the Dakota Formation. The South Dakota Department of Water and Natural Resources can't find a record of a water use permit being issued for the well. The DWNR has been restricting the use of water in the Polo area for domestic purposes only. The water pressure in this formation has been dropping at a rate of 1 foot of head per year. Therefore, the issuance of a permit for geothermal use will not be automatic.

The second obstacle is that expanding the geothermal system from heating the school to a district heating concept is economically marginal.

The St. Joseph's Indian School geothermal went on-line October 29, 1981. The funding for the project came entirely from donations and from the Catholic church.

The school complex consists of 7 buildings with a square footage of 150,000. Conventional fuel replaced was #2 oil priced at $1.25/gal. The school was using 151,000 gallons of fuel annually.

The resource is from 300 meter wells yielding 24°C water at 1200 gpm. The S.D. DWNR required the school to plug "wild" wells equal to 1000 gpm to replace the water required for the project.

The system is a two stage cascading type using two centrifugal heat pumps. The first stage uses the source water to heat 1222 gpm of domestic water to 54°C (COP 4.22). The second stage heats 791 gpm of water to 88°C using the 1222 gpm from stage 1. Overall COP of the system with both pumps in operation is 2.44 derived by:

Thermal Input to Units
Electrical Input to Units X 3413

Cost Savings Per Year = $142,000

Payback Period = 7 years

Power Costs = 5.56¢/kw

Power Escalation Rate = 10%

Alternate Fuel Escalation Ratio = 15%

Installed Cost = 1,072,908

COP = 2.44

-0- Tax Rate

Cost of Capitol = 10%

An energy management system was installed that performs the following functions:

A. Monitor and control flow from source wells to the first stage heat pump. Measure flow, temperature, and pressure at each well.

B. Provide demand control for heat pumps.

C. Vary the water temperature of the system in direct relationship to system load.

D. Provide BTU to totalization of usage for each building.

E. Control ventilation loads, etc.

Preliminary data was obtained from the school for the month of December.

A. The system only had to run at 40-50% of design capacity.

B. The highest usage varied from 750-800 gallons/minute.

C. The cost was $5,000 less than anticipated.

2.4 Time Phased Project Plans

The three demonstration projects went on-line in November of 1980 and have been described in previous semi-annual reports. A summary of the projects is follows:

1. Haakon School District 27-1

Location: Philip, South Dakota, 80 miles east of Rapid City, Population 1000

Resource Data:

Well Depth: 1300 meters

Date Completed: 2-23-79

Completion Techniques: Open hole

Well Temperature: 69°C

Flow Rate: 300 gpm (18.9 l/S)

Summary: The Madison Formation extends under the western half of South Dakota and into the bordering states of Wyoming, Montana, and North Dakota. Most Madison wells in South Dakota are naturally flowing with temperatures ranging from 43°C to 77°C.

System Features:

Application: Space, water, and district heating.

Heat Load: 5.5×10^6 BTU/hr

Yearly Utilization: 9.53×10^9 BTU/yr

Energy Replaced: Electricity - 122,989 KWH
Fuel Oil - 54,729 gallons
Propane - 23,858 gallons

Facility Description: 5 school and 8 business district buildings.

Summary: The school heating project has stimulated the development of a business district heating system. In addition, Little Scotchman Industries, the city water plant and county maintenance use geothermal fluids from other wells for space heating.

2. Diamond Ring Ranch

Location: 50 miles west of Pierre in Haakon County.

Resource Data:

Well Depth: 1253 meters

Date Completed: 1959

Completion Technique: Open hole

Well Temperature: 67°C

Flow Rate: 170 gpm (10.7 l/S)

Summary: The Madison Formation extends under the western half of South Dakota and into the bordering states of Wyoming, Montana, and North Dakota. Most Madison wells in South Dakota flow with temperatures varying from 43°C to 77°C.

System Features:

Application: Space heating and grain drying

Heat Load: 3.35×10^6 BTU/yr

Yearly Utilization: 7.87×10^9 BTU/yr

Energy Replaced: Electricity - 185,288 KWH
Propane - 49,415 gallons

Facility Description: The geothermal water heats six structures and provides energy for a 700 bushel/hr grain dryer.

Summary: Two heating loops circulate water through water to air heat exchangers and fan coil units to provide space heating for the hospital, barn, mobile homes, shop, employee's home, and owner's home. An additional loop provides hot water to the grain dryer.

3. St. Mary's Hospital

Location: Pierre, South Dakota, Hughes County

Resource Data:

Well Depth: 663 meters

Date Completed: April 21, 1979

Completion Technique: Perforated casing

Well Temperature: 41°C

Flow Rate: 375 gpm (23.7 1/S)

Summary: The Madison Formation extends under the western half of South Dakota and into the bordering states of Wyoming, Montana, and North Dakota. Pierre is located on the eastern edge of this formation.

System Features:

Application: Domestic water preheating and space heating.

Heat Load: 5.55×10^6 BTU/hr

Yearly Utilization: 11.44×10^9 BTU/yr

Energy Replaced: Fuel Oil - 115,000 gallons

Facility Description: The 7710 m^2 hospital and a new 6038 m^2 addition are served.

Summary: Three plate-type heat exchangers provide make-up air heating, space heating via fan coil units and domestic water preheating. The new addition heating system is designed to utilize the geothermally heated water in the hot deck coil of the air handling units and the heat pump.

2.5 State Aggregation of Prospective Geothermal Utilization

Polo could be a TPPP if the institutional problem concerning the well permit is overcome. The problem is fully described in Section 2.3.

The energy savings, monetary savings, and project milestone chart are taken from the Hemel Associates TA report.

A. Using water from the existing well and a new well for district heating the energy and monetary savings would be:

Energy Savings (assuming conversion to heat pumps and an electrical consumption of 11,600 BTU/KWH)

		NET SAVINGS
High school:	101,934 KWH/yr	1.18×10^9 BTU/yr
Residences:		
6 with electric heat	91,218 KWH/yr	1.06×10^9 BTU/yr
5 with fuel oil	2,590 gal/yr	0.02×10^9 BTU/yr
6 with propane	4,512 gal/yr	0.024×10^9 BTU/yr

Commercial:

2 with electric heat	56,978 KWH/hr	0.66×10^9 BTU/yr
1 with fuel oil	981 gal/yr	0.007×10^9 BTU/yr
2 with propane	2,850 gal/yr	0.014×10^9 BTU/yr
TOTAL ENERGY SAVINGS		2.97×10^9 BTU/yr

Monetary Savings: (Net after deducting cost of heat pump operation)

High School:	$4,900/year
Residences:	
6 electric	4,650/year
5 fuel oil	1,030/year
6 propane	1,180/year
Commercial:	
2 electric	$2,910/year
1 fuel oil	390/year
2 propane	740/year
TOTAL MONETARY SAVINGS	$15,800/year

The energy savings using geothermal water to preheat the domestic water would be 2100 KWH per year or 7.2×10^6 BTU/year.

$$\text{Simple Payback Period} = \frac{\text{System Cost}}{\text{Energy Cost Savings}}$$

$$\text{SSP} = \frac{\$411,000}{\$\ 15,800} = 26.0 \text{ years}$$

B. Project Milestone Chart Activity

Activity	Completion Date
1. Approval of TA Report	4-30-82
2. Obtain Water Use Permit	8-31-82
3. Environmental Assessment	11-30-82
4. Design Time	2-28-83
5. Bidding Time	4-30-83
6. Construction	10-31-83

2.6 Institutional Analysis

The institutional factors have not changed since the publication of the South Dakota Geothermal Energy Handbook in October of 1980.

2.7 Public Outreach Program

2.7.1 Outreach Mechanisms

Every form of communication has been used to provide information and technical assistance to the people of South Dakota. The geothermal slide program and the National Water Well Association's groundwater heat pump slide program have been shown to service clubs across the state. Geothermal/terra heat workshops were held in Rapid City and Sioux Falls. Terra heating resources were discussed at both locations by experts from WEPL and EG&G. Items included earth tubes, solar panels, and ice ponds. Jim Winterton of the S.D. Department of Water and Natural Resources covered the institutional aspects of direct use and groundwater heat pumps. Dr. J. P. Gries, Dr. Dan Carda and Fred Steece gave talks on the South Dakota geothermal resource and environmental aspects of development. The demonstration projects were described by consultants that worked on the projects. Virgil Herriot presented a presentation on the groundwater heat pump for residential applications. A panel discussion was moderated by Phil Lidel in Rapid City. A tour of the Missouri Basin Municipal Power Agency was conducted by Vic Simmons in Sioux Falls. The building has a Westinghouse Templifier geothermal heating system. Approximately 45 people attended the workshop in Sioux Falls and 30 people in Rapid City.

The EG&G Technical Assistance program has been publicized widely in the state. Ray Herman and Ed Brunner have received technical assistance for existing wells on their ranches.

The cities of Polo and Lemmon have received technical assistance in the form of feasibility studies. In addition, Lemmon has submitted a proposal to HUD for a UDAG grant. Eliot Allen and Associates are providing community assistance to the cities of Lemmon and Philip. The goal in these two cities is to put together a financial package for district heating program. The state team has given groundwater heat pump information to many private citizens across the state. A local Pierre groundwater heat distributor has installed 41 units in the area in the past year.

The South Dakota state team and the South Dakota School of Mines and Technology hosted the Rocky Mountain Basin and Range Federal-State commercialization meeting at Custer State Park in September.

2.7.2 Summary of Contacts and Results

Contacts are continuing with city officials of Wessington, Dupree, Eureka, Philip, and Lemmon also with the West River COGS. Private individuals have indicated an interest in both direct use and groundwater heat pump assisted geothermal energy. A detailed listing of the more important contacts is in Appendix A.

2.7.3 Overall Prospectus for Future Geothermal Commercialization

The future development of geothermal energy lies within the private sector. The completion of the geothermal system for an office building in Sioux Falls and a school complex at Chamberlain with private funds is an encouraging indicator for future projects within the state. The outreach program and the demonstration projects are the tools that created the interest in geothermal energy in the state.

The proliferation of groundwater heat pump distributors across South Dakota was caused by the demand for groundwater heat pumps from private individuals. This demand was promoted by the state outreach program. Geothermal energy consultants across the state now have the expertise to install systems in South Dakota. This expertise was developed with the help of the state commercialization effort.

The range of geothermal energy projects that will develop in South Dakota is as follows; (1) district heating, (2) crop drying, (3) space heating, (4) feed lot warming, (5) livestock pen warming for poultry and hogs, (6) paper and pulp, (7) dairy farming (milk chilling and pasteurization), (8) wool drying, (9) baths, (10) bottling, (11) greenhousing, (12) irrigation, (13) aquaculture, and (14) hydroponics.

3.0 Summary of Major Findings and Recommendations

The goal of the state team has been to inform and educate the private sector in the advantages of using geothermal energy within the state. The achievement of this goal would ease the dependency of

South Dakotans on conventional fuels and give them an alternative that is a local resource.

The technical assistance, community assistance, and outreach programs have given the private sector the necessary tools to continue geothermal energy projects after the Federal-State assistance is gone.

The development of geothermal energy will continue in South Dakota if:

(1) An information center is established in the state that has updated data on local uses of geothermal energy.

(2) Low cost loans for district heating can be obtained from financial institutions, foundations, or the government.

(3) The public can be shown that the payback period for geothermal systems justify the up-front costs.

(4) The mystery is taken out of the resource showing that it is a dependable, environmentally safe, renewable energy source.

APPENDIX A

CONTACTS AND RESULTS

1. Gerald Beutler
   1203 J Avenue
   Eureka, SD
   Phone: 284-2334
   Reason: Asked for T.A., received NMEI's groundwater heat pump program.

2. George Halder
   Design & Construction
   P.O. Box 69069
   St. Paul, MN 55169
   Phone: 612-725-7302
   Reason: Asked for and received resource information for Hot Springs. (He is conducting a feasibility study for post office.)

3. Gene Boeptger
   Box 28A RR 1
   Baltic, SD 57003
   Reason: Ran NMEI Heat Pump Model for him. (Not feasible.)

4. George Budney ETEC
   Energy Systems Group
   P.O. Box 1449
   Canoga Park, CA
   Reason: District space heating

5. Eileen Byrne
   HUD
   26th Floor, 1405 Curtis St.
   Denver, CO 80202
   Phone: 303-837-5121
   Reason: Presently working with Lemmon UDAG grant.

6. Gerald Cerfoss
   Wessington, SD
   Phone: 458-2255
   Reason: Town board member interested in geothermal energy.

7. Bob Clark
   Dupree School Superintendent
   Dupree, SD
   Phone: 365-5140
   Reason: Lead man for Dupree technical assistance.

8. Eliot Allen & Associates
   5006 Commercial St. SE
   Salem, OR 97306
   Phone: 503-371-4561
   Reason: Experts on financial packages for geothermal development. Working with Philip and Lemmon.

9. Rod Galland
P.O. Box 59
Lemmon, SD 57638
Phone: 374-3742
Reason: Lead man for Lemmon geothermal system.

10. Ken Gibb
6th District Planning
Rapid City, SD 57701
Phone: 394-2681
Reason: Interested in reactivating Douglas/ Box Elder geothermal project.

11. Dick Howard
Asst. Secretary
Dept. of Water & Natural Resources
Foss Building
Pierre, SD 57501
Phone: 773-3151
Reason: Negotiating with DOE for resource assessment contract.

12. Jim Hutmacher
Box 294
Chamberlain, SD
Phone: 734-6631
Reason: Well driller for St. Joseph's School, has geothermal energy in his shop.

13. Jerry Lang
Enter Tribal Court of Appeals
Box 617
Ft. Thompson, SD 57339
Phone: 245-2400
Reason: Asked about geothermal alcohol production at Lower Brule.

14. David Miller
P.O. Box 105
Mitchell, SD 57301
Reason: Received information on groundwater heat pumps.

15. Chuck Mize
Dunham Associates
528 Kansas City Street
Rapid City, SD 57701
Phone: 348-1850
Reason: Lead engineer for Lemmon technical assistance.

16. Joe Muller
P.O. Box 610
Hot Springs, SD 57747
Phone: 745-5165
Reason: Requested T.A. for Evans Plunge, referred to EG&G.

17. Keith Osberg
Huron Drilling Company
Huron, SD 57350
Phone: 352-3538
Reason: Driller gives talk on geothermal groundwater heat pumps.

18. Robert Patterson
P.O. Box 149
Philip, SD 57567
Reason: Requested information on geothermal alcohol plants.

19. Roby, Quintal, Everson
321 West 6th
Mitchell, SD 57301
Phone: 996-7543
Reason: Consultants on St. Joseph's School geothermal project.

20. Bob Schoon
Science Center
USD Campus
Vermillion, SD
Phone: 212-5895
Reason: Subsurface geologist and driller for SDGS.

21. Vic Simmons
Missouri Basin Municipal Power Agency
100 N. Phillips
P.O. Box 984
Sioux Falls, SD 57101
Phone: 338-4042
Reason: Conducted tour of office building that has geothermal system.

22. Terry Stofferahn
State Engineer's Office
Foss Building
Pierre, SD 57501
Phone: 773-3466
Reason: Interest in geothermal system for capitol complex.

23. Lowell Thomas
Administrator
St. Joseph's Indian School
Box 89
Chamberlain, SD 57325
Phone: 734-6021
Reason: Has data on geothermal system installed in the school.

24. Herb Vandelman
USGS
Huron, SD
Phone: 352-8651
Reason: Resource assessment.

GEOTHERMAL DIRECT USE CONSULTANTS

Dunham Associates
528 Kansas City Street
Rapid City, SD 57701
Larry Beckwith, Chuck Mize
Phone: 348-1850

Hengel & Associates
115 St. Joseph Street
Rapid City, SD 57701
Ray Hengel
343-8432

Re/Spec
P.O. Box 725
Rapid City, SD 57709
Paul Gnirk
Phone: 343-7868

Kirkham, Michael & Associates
9110 W. Dodge Road
Omaha, NE 68114
Bob Sullivan
Phone: 402-393-5630

Mintech
P.O. Box 214
Rapid City, SD 57701
Phone: 348-7777

TSP West, Inc.
731 St. Joseph Street
Rapid City, SD 57701
Phone: 343-6102

Banner Associates
P.O. Box 1140
Rapid City, SD 57701
Phone: 343-0222

GROUNDWATER HEAT PUMP CONSULTANTS

Art deWit
DeWild, Grant, Reckert & Assoc. Co.
1113 East 14th Street
Sioux Falls, SD 57104
Phone: 339-4157

Roby, Quintal & Everson
321 West 6th
Mitchell, SD 57301
Ray Roby, Bob Quintal
Phone: 996-7543

Virgil Herriott
Sioux Valley Empire Electric
P.O. Box 216
Colman, SD 57017
Phone: 534-3536

Midwest Geothermal Energy Inc.
P.O. Box 1422
Huron, SD 57350
Reuben Pastians
Phone: 362-6145

Ed Lacey
Trent, SD 57065
Phone: 428-5636

Merriman Drilling
Beresford, SD

Marvin Fry
Pierre, SD

Midwest Resource Energy Supplies
Madison, SD

Edward Pullen
Rapid City, SD
Phone: 342-6407

UTAH GEOTHERMAL COMMERCIALIZATION PROJECT

SEMIANNUAL PROGRESS REPORT

JULY-DECEMBER, 1981

Prepared by

Ward Wagstaff
Stanley Green

Utah Division of Water Rights

Work Performed Under Contract No. DE-FC07-79ID12016

U.S. Department of Energy

Idaho Operations Office

TABLE OF CONTENTS

UTAH GEOTHERMAL COMMERCIALIZATION PROJECT

SEMIANNUAL PROGRESS REPORT, JULY-DECEMBER, 1981

1.0 Introduction

The Utah Geothermal Commercialization Project is part of a regional program funded by the U.S. Department of Energy and the State of Utah. The objective of the program is to foster the development of geothermal resources in each state through public information services, technical assistance, planning, and public outreach. The program was also intended to provide DOE with program support information.

In 1977, the Utah Division of Water Rights contracted with the DOE to perform these functions in Utah. Personnel working on the Utah project are Stanley Green, Directing Appropriations Engineer in the Division and Project Supervisor; L. Ward Wagstaff, engineering and technical analyst; and Connie Walker, information and marketing specialist.

The primary benefit of the geothermal commercialization project in Utah has been that potential developers and users have a resource to which they can turn for general information on resource locations and characteristics and for advice in dealing with the laws and regulations governing geothermal development. The State Team has also gathered information which has been helpful to various state agencies in their regulatory activities. The project has provided the U.S. DOE with data from the state level and has acted as a contact point within the state for the DOE.

2.1 Geothermal Prospect Identification

During the period of July to December 1981, no new deep wells were drilled for high temperature exploration or for direct heat. Several deep temperature gradient wells were drilled and several companies conducted temperature gradient surveys. At Roosevelt Hot Springs, several well tests were conducted and in November the first electrical power produced from geothermal resources entered the Utah Power and Light distribution grid.

Phillips Petroleum Company, operator for the Roosevelt Hot Springs geothermal unit, tested several production and injection wells at the Roosevelt prospect in preparation for the planned 20 MWe power plant. Phillips used portable sled-mounted test equipment to monitor the pressure, flow, temperature, and chemical characteristics of each well. During the tests, which were conducted in August and September, the hot steam and water were discharged into closed sump pits.

In conjunction with tests on Phillips well RHS 54-3 at Roosevelt Hot Springs, a new turbine which is designed for use in wet steam geothermal applications was tested. Steam and hot water from the well were used to power a prototype rotary separator turbine. The separator turbine separated the steam from the water and generated about 1.6 MWe from the water component. During the test the steam was vented to the atmosphere and the water was reinjected. A more detailed discussion of the test and the rotary separator turbine is included in Section 2.4.2 of this report, "Time-Phased Project Plans".

Exploratory activities were also conducted at other areas in the state. Union Oil Company of California drilled deep temperature gradient wells at Joseph Hot Springs in Sevier County and at Newcastle in Iron County. Both areas have been the site of geothermal exploration in earlier years, but these wells were the first deep temperature gradient wells drilled. Union has not yet released the results of the drilling.

During the first half of 1981 Phillips Petroleum established the Drum Mountain Unit in Juab and Millard Counties west of Delta. The area is fairly remote and does not contain surface manifestations of geothermal resources, but Phillips has apparently found areas where the temperature gradients are high enough to warrant further exploration. To date Phillips has drilled several temperature gradient surveys in the area but have not confirmed the resource through deep drilling. As part of the unitization agreement, Phillips committed to drill a deep exploration well in the prospect; the well will probably be drilled during the summer of 1982.

The Drum Mountains prospect is evidently typical of many geothermal resource systems in the basin and range geological province. A number of similar resource areas have been discovered in the basin and range province, particularly in Nevada. Since there are no surface manifestations of the resource, the exploration techniques are quite complex, but the possibility that a resource of this type has been found in Utah offers promise that other similar areas may be discovered.

The hydrothermal resource at Crystal Hot Springs in southern Salt Lake County has been confirmed as a viable source of energy and has been used for two heating seasons to heat the Utah Roses Inc. greenhouses. The demonstrated viablility of the resource has prompted considerable interest among potential developers, and a number of them have filed for water rights on the resource. However, the production capacity and areal extent of the resource has not been determined. A short-term artesian flow test was conducted on State well USP/TH-1 early in 1981, but the results were inconclusive. In July 1981 a group of consultants, state agency representatives, and developers met to discuss the results of the investigations to that point and to outline the data gaps which still existed. The general conclusion of the meeting was that even though extensive studies have contributed to an understanding of the resource and the geologic structures which account for it, a long-term pump test is necessary in order to determine the production and recharge capacity of the system. The Utah Energy Office and the Utah Division of Facilities Construction and Management are in the process of setting up a long-term pump test of well USP/TH-1, the proposed production well for the State Prison space heating project. The test will probably be conducted in early summer of 1982 and should provide needed data about the resource area in general and the prison well in particular.

New state geothermal leases issued by the Utah Division of State Lands are found in Table I. A short summary of high temperature geothermal resources is found in Table II and Figure I. Table III is a brief summary of moderate temperature resources in the state.

2.2 Area Development Plans

Area Development Plans (ADP's) were intended to indicate, in a general way, the opportunity for hydrothermal development within a specific sub-state area. This is accomplished by matching projected energy demand for the area with the estimated energy potential of geothermal resources within the area. This information could be used to target likely sites for

Table I New Geothermal Leases

County/ Leaseholder	Size (Acres)	No. of Leases	Location	Date Issued
Iron				
Mark H. Alldredge	1916	1	T32,33S, R16W	7/13/81
Millard				
Elwood A. Gee	1149	1	T19,20S, R7W	8/17/81
Sevier				
Jack E. Blankenship	373	2	T25S, R3W	9/28/81

Table II High Temperature Geothermal Prospects

Prospect	Measured Temp. (°C)	Well Depth	Estimated Power Capacity	Notes
Roosevelt Hot Springs (Proven)	265	365-2130 m (1200-7000 ft)	200-500 MWe	20 MWe pilot plant under construction
Thermo (Potential)	177-205	2225m (7300 ft)	--	Well drilled by Republic in 1977, May be suitable for binary power system.
Drum Mountains	--	--	--	High temperature gradients reported, State and Federal unitized by Phillips.

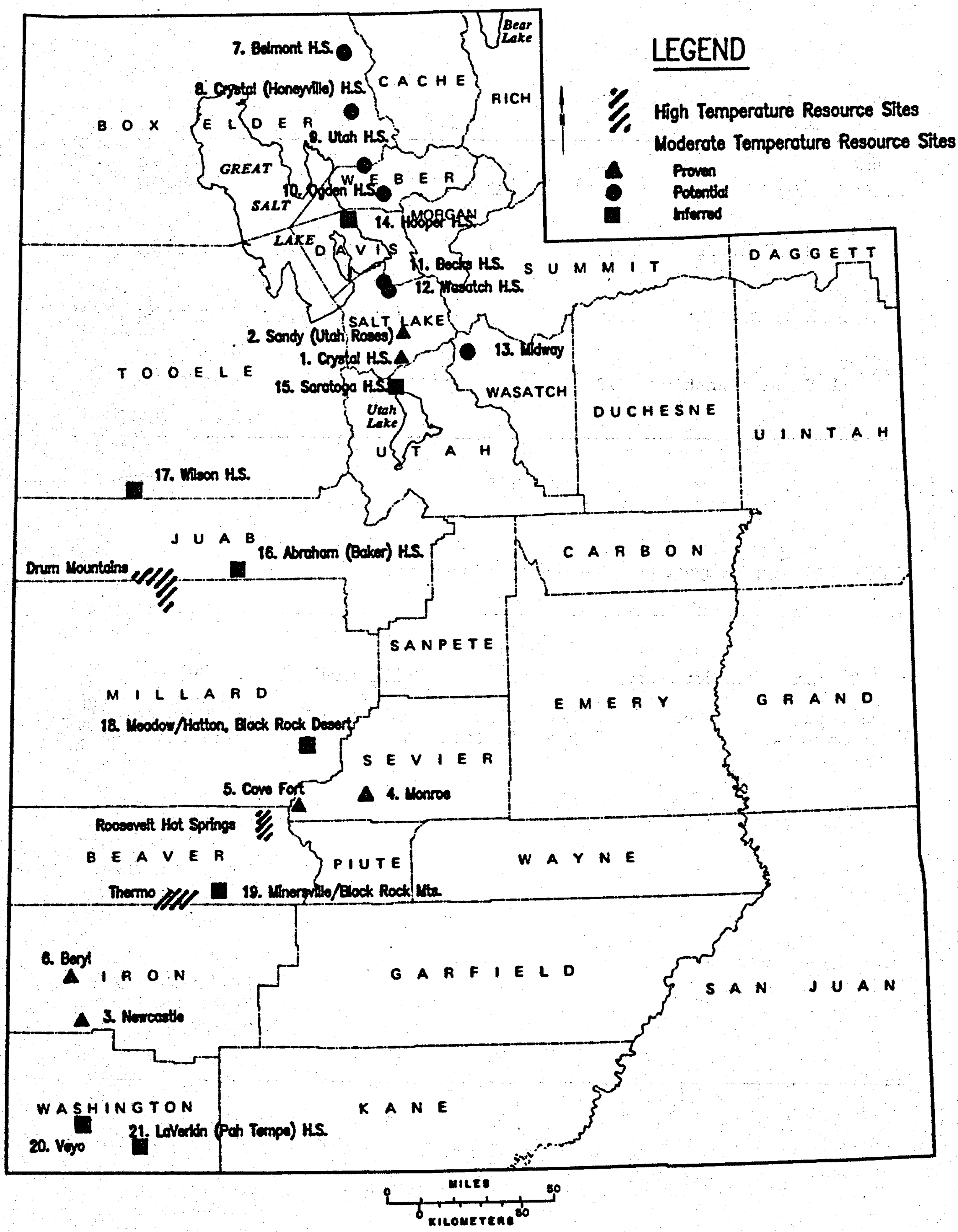


Figure 1. Geothermal Resource Sites in Utah

Table III Moderate Temperatures & Geothermal Resource Sites in Utah

No.	Prospects	Classification	Temperature (°C)	Status
1.	Crystal Hot Springs	Proven	90	Utah Roses - in operation Utah State Prison - in progress.
2.	Sandy City	Proven	50	Utah Roses - in operation.
3.	Newcastle	Proven	96	Christensen greenhouses - in operation.
4.	Monroe	Proven	74	Resort in operation; City district heating abandoned.
5.	Cove Fort	Proven	173	Planned ethanol plant has been postponed indefinitely.
6.	Beryl	Proven	149	Deep exploratory well drilled in 1978; no development currently planned.
7.	Belmont	Potential	45	Owners would like to develop space heating project.
8.	Crystal (Madsen's)	Potential	60	Currently used for resort.
9.	Utah	Potential	59	Has been used for greenhouses.
10.	Ogden	Potential	57	Was used for resort; currently abandoned.
11.	Becks Hot Springs	Potential	55	Not in use; heavily mineralized.
12.	Wasatch Hot Springs	Potential	40	May be used for space heating.
13.	Midway	Potential/ Proven	46	Several springs used for resorts, space heating.
14.	Hooper Hot Springs	Inferred	60	Hot spring
15.	Saratoga Hot Springs	Inferred	--	Used for resort.
16.	Abraham (Baker) Hot Springs	Inferred	82	Not in use.
17.	Wilson Hot Springs	Inferred	61	Remote hot springs.
18.	Meadow/Hatton, Black Rock Desert	Inferred	--	Exploration by major companies.
19.	Minersville/ Black Mountains	Inferred	--	Exploration by major companies.
20.	Veyo	Potential/ Inferred	32	Hot springs used by resort, exploration in areas.
21.	LaVerkin (Pah Tempe Hot Springs)	Potential/ Inferred	42	Hot springs used by small resort.

geothermal development within the state, and would also be useful to state, regional, and local planning agencies.

The first step in the ADP process was to divide the state into appropriate areas for analysis. Counties were grouped together on the basis of geographic, demographic, cultural and economic factors as well as the nature and distribution of the hydrothermal resources within each county.

After defining the planning areas, estimates of energy demand through the year 2020 were made. Industrial energy projections were made by the New Mexico Energy Institute using industrial data from the state. Residential and commercial energy projections were made using past consumption data and population growth projections.

Estimates of the energy potential of the hydrothermal resources were made using known temperature and flow data. Reservoir capacities were estimated in some cases. Usually, the energy potential of the hydrothermal resources was very difficult to estimate with any degree of confidence, and although the use of surface temperature and flow data yielded conservative results, it provided a systematic approach to the estimates.

Information generated by the ADP process has been published earlier and will not be duplicated in this report. Maps of the planning areas and tables of the results are found in the Semiannual Progress Reports for January 1980, July 1980, and January 1981.

2.3 Site Specific Development Analysis

Site Specific Development Analyses (SSDA's) are intended to portray the details of the development of a particular project at a specific geothermal resource site. A site specific analysis generally includes the following features: a step-by-step outline of development procedures; general estimates of when each step would occur and how long it will probably take to complete; a preliminary analysis of the technical and economic feasibility of the project; and a fairly detailed analysis of the institutional and other factors which must be observed and which might hinder or prevent the successful completion of the project. Site specific analysis are more detailed and technical than area development plans, and are related to a specific development at a specific site; as such, they offer more insight into the real problems and potential for development at a given site.

2.3.1 Candidate Geothermal Sites and Applications

Proven or potential resource sites may be candidates for site-specific development analyses. "Proven" sites are those where the presence of a commercial resource has been confirmed by drilling. "Potential" sites are those where reliable subsurface data are available, e.g., temperature gradients, stratigraphic drilling results, etc. "Inferred" sites are those where some indicators of geothermal resources are present but no subsurface data are available.

Candidate sites for site specific analysis are listed in Table III. The sites are classified into two categories--those sites where projects are already in progress, and sites which appear to be good prospects for development but for which no specific project plans have been announced.

2.3.2 Site Specific Development Plans Completed or in Preparation

During the period of July-December 1981 no new site specific analyses were undertaken. The cost/benefit analysis which was done in cooperation with the Salt Lake Redevelopment Agency was re-evaluated in December 1980. The results of that study and of the re-evaluation are found in the semiannual reports for July-December 1980 and January-June 1981.

2.4 Time-Phased Project Plans

A Time-Phased Project Plan is a detailed analysis of a specific development at a specific site. It is more specific and detailed than a site specific development analysis. The time-phased plan analyzes a specific development in terms of the specific steps necessary to bring the development to fruition, their sequence and relationship with each other, their duration, and actual-time estimates of when each step will begin and end. The project is thus analyzed at all stages of progress, including pre-leasing activities; leasing; exploration; reservoir confirmation and development; development negotiations such as partnership or unit negotiations; permitting by state, local, and federal agencies; plant construction; and distribution system construction.

2.4.1 Active Demonstration /Commercialization Projects

Active or firmly planned geothermal projects are candidates for time-phased project plans. Table IV is a listing of sites within Utah which are candidates for time-phased project plans.

The major project in Utah is the power plant planned by Utah Power and Light for Roosevelt Hot Springs in Beaver County. The development at Roosevelt was the subject of a time-phased project plan in 1979, which is not included in this report. The current status of the project at Roosevelt Hot Springs is discussed in Section 2.4.2, "Time-Phased Project Plans".

The Utah Roses greenhouses at Crystal Hot Springs near Bluffdale were heated with geothermal fluids beginning in the fall of 1980. During the summer of 1981, an additional set of greenhouses was constructed, bringing the total area under cultivation to approximately 130,000 square feet, or nearly 3 acres. During the following heating season (1981-1982), both sets of greenhouses were heated by 180° F water from the 410 foot production well. An injection well was drilled by Utah Roses to dispose of the spent fluids, but the well was not used for injection during the first heating season because of completion problems. The well has since been repaired and was used for reinjection during the 1981-1982 heating season.

Preliminary design of the Utah State Prison space heating project, also at Crystal Hot Springs, has been completed by CH2M Hill of Salt Lake City. The Utah Division of Facilities Construction and Management will accept bids for the final design early in 1982. A long term pump test on the production well for the prison, well USP/TH-1, is planned for early

Table IV Active Geothermal Projects

Site (Developer)	Application	Resource Characteristic	Geothermal Energy Requirements	Status of Project
Crystal Hot Springs (Utah Roses)	Greenhouses	Reported Artesian flow at 90°C	Development as supported by resources, up to about 234 x 10^9 Btu's/yr.	About 130,000 ft^2 of greenhouses in operation.
Crystal Hot Springs (State of Utah)	Space Heating	Artesian flow up to 600 gpm at about 80°C.	Initial phase, minimum security building, 10.9 x 10^9 Btu's/yr. Possible eventual development to 55.7 x 10^9 Btu's/yr.	Preliminary design has been completed, production well has been drilled. Well to be tested in summer 1982, Project in operation by fall 1982.
Sandy City (Utah Roses)	Greenhouses	1,527 m well with slight flow of 50°C water.	Greenhouse conversion from natural gas, about 70.0 x 10^9 Btu's/ yr.	Well provides base load heating to about six acres of greenhouses.
Newcastle (Christensen Bros.)	Greenhouses	Two wells: 152 m well producing at 96°C, other well similar. Water quality good.	Development expected to grow as supported by the resource.	First set of greenhouses in operation; additional greenhouses planned by Christensen Bros. and also by major hydroponics firm.
Crystal (Madsen's) Hot Springs	Resort	Hot Springs, 56°C. Flow about 100 lps.	Multiple use for recreation and space heating.	Initial renovations have been completed.
Midway (Several Individuals)	Space Heating (Homes)	Maximum measured temp. 46°C. Hot groundwater system.	Water from springs now used for several resorts and homes.	A number of resorts and private homes currently use water from the springs for space heating and recreation. Several individuals plan to drill in order to heat homes.
Utah Valley (Arrowhead Greenhouses)	Greenhouses	Warm well supplies water at about 35°C.	Small greenhouse operation.	A small, family-run greenhouse operation uses warm water from shallow well, has been in operation for about 5 years.

summer 1982. During the 30-day pumping phase and the 7- to 10-day recovery phase of the test the production well and several other springs and observation wells will be monitored. The pump test should provide needed information about the production capacity of the well, the production and recharge characteristics of the system, the areal extent of the resource, and the potential for interference between the various wells at the site.

The Utah Roses greenhouses at Sandy, about six miles north of Crystal Hot Springs, were heated during the 1981-1982 heating season using warm fluids from a 5000 foot well drilled adjacent to the greenhouses in 1980. Although the well produces only about 200 gpm of 122° F water, it is adequate to provide base load heating at considerable savings to Utah Roses.

A small geothermally heated greenhouse at Newcastle in Iron County was successfully operated for the second year. The greenhouse, owned by Christensen Brothers' Ranch, is heated with boiling water (225° F maximum temperature) from a shallow well. Another hot well on the property has been sold to Troy Hygro-Systems Inc. of East Troy, Wisconsin, which intends to construct and operate an additional set of greenhouses. Christensen Brothers have a geothermal lease agreement with Union Oil Company under which Union has the rights to resources at depths greater than 500 feet. Union recently drilled a deep temperature gradient well at Newcastle but the results have not yet been made public.

Several other geothermal projects which have been in operation for some time are resorts at Belmont Hot Springs, Crystal Hot Springs (Honeyville), the Homestead and Mountain Spaa in Midway, Saratoga Hot

Springs, Monroe Hot Springs, Veyo Hot Springs, and La Verkin (Pah Tempe) Hot Springs. Table IV contains a summary of these projects.

2.4.2 Time-Phased Project Plans

A time-phased project plan for the development of the high temperature resource at Roosevelt Hot Springs was completed and published in the summer of 1979. The plan outlined the steps of exploration, permitting, and construction of a 55 MWe power plant by Phillips Petroleum Company and a utility (which was at that time unspecified). Shortly after the time-phased plan was completed, Phillips announced plans to initiate development with a 20 MWe pilot plant which, if successful, would be followed after several years by full-sized 55 MWe plants. The small plant will provide operating experience, reservoir production data, and revenue while the larger plants are being permitted and constructed.

The time-phased project plan for Roosevelt Hot Springs was published in the Utah Geothermal Progress Report for January-June 1979 and is not included in this report. However, the current status of the project will be briefly reviewed.

Major milestones in the development of the resource were reached in 1980 when the ATO consortium (AMAX Exploration, Inc., Thermal Power Company, and O'Brien Resources Corporation) signed the unit agreement with Phillips. Later that year Utah Power and Light company signed a contract to buy steam from Phillips and to generate and distribute the electricity.

A third major milestone for the development of the resource at Roosevelt and for Utah in general was reached in November 1981 when the first electrical power generated from geothermal resources in Utah entered the Utah Power and Light distribution grid. Hot water and steam from Phillips well RHS 54-3 was used to power a prototype rotary separator turbine, which in turn drove the generator which produced the electricity.

The rotary separator turbine is an experimental unit which was tested at Roosevelt Hot Springs under a joint agreement between Phillips Petroleum Company, Utah Power and Light, Biphase Energy Systems, and the Electric Power Research Institute. The rotary separator turbine utilizes both the liquid and steam phases of the geothermal fluid to produce power. Steam and hot water are piped to the first stage of the separator turbine where the flow is divided and injected into the separator through four nozzle jets. The water impinges on a plate wheel rotor spinning at the same speed as the entering water. The steam goes to the center of the rotor and is separated from the water similarly to a conventional steam separator. The water passes through openings along the outer perimeter of the first rotor into an inner chamber where it impinges against an impellor which drives the generator. A second plate wheel rotor then recovers the water and discharges it, still pressurized, for reinjection.

The steam is separated from the water at the first plate wheel rotor and is gathered at the center. It is then piped to a conventional steam turbine which also powers the generator.

The output from the rotary separator turbine using only the water phase was about 1.6 MWe; if the steam turbine had been operating, it would have produced about 5 MWe, for a total of about 6.6 MWe. Based on test data, the rotary separator turbine can produce from 15% to 40% more power from a given geothermal well than a conventional steam turbine by itself.

To formally announce the installation and operation of the rotary separator turbine, the companies sponsoring the test held an open house and tour of the geothermal facilities at Roosevelt Hot Springs. Utah Governor Scott M. Matheson was the guest of honor and the keynote speaker at the open house. About 300 state, federal, and local officials, together with other guests, attended the open house.

In addition to testing the rotary separator turbine, Phillips Petroleum Company tested several wells for production and injection characteristics. The wells which were tested may be used to supply steam to the 20 MWe power plant. In addition, at least two new production wells will be drilled.

The 20 MWe power plant is scheduled for operation in the spring of 1984. The developers will use the results of the rotary separator turbine tests and the operation results from the initial plant to determine whether or not large central power plants are more economical than wellhead generators such as the rotary separator turbine.

2.5 State Aggregations of Prospective Geothermal Applications

Using information supplied by the Utah Geothermal Team, the Physical Science Lab at New Mexico State University made geothermal energy use projections to the year 2020. These projections were estimates of the amount of new geothermal energy which would become economical each year under a given set of assumptions.

The results of the Physical Science Lab projections were presented in the Semiannual Progress Report of the Geothermal Commercialization Project for July 1980. The reader is referred to that report for the tabulated and plotted results of the aggregated projections.

2.6 Institutional Analysis

In February 1981 the Utah Legislature passed the Utah Geothermal Resources Conservation Act. The legislation was the result of several years of work and preparation on the part of the sponsors of the bill. Its purposes are to clarify and define the regulatory authority of the State Engineer, define the nature of rights to geothermal resources and how they are aquired, define the relationship between geothermal rights and water rights, specify the conditions and provisions for enforced unitization by the State Engineer, and provide for the appeal process. The passage of the geothermal legislation was a major step in facilitating the orderly development of the state's geothermal resources, particularly the high temperature resources. A more complete discussion of the geothermal legislation is contained in the Semiannual Progress Report for January-June 1981.

Several issues related to geothermal development remain unresolved and still should be considered for legislation. Among these isssues are tax incentives for geothermal utilization, particularly for direct heat use; exemption of small district heating systems from public utility regulation; and authorization for municipalities and other governmental or quasi-governmental entities to form district heating or energy distribution systems.

As geothermal development in Utah has progressed, a number of problems related to regulation have become apparent. One of these is associated with the disposal of spent geothermal fluids. Reinjection has generally been accepted as the best method of disposal because it avoids problems of contamination of surface waters, maintains pressure and water levels in the hydrothermal reservoir, and extracts the energy of the resource more efficiently through recirculation. However, experience has demonstrated that reinjection may not be attractive for various technical, hydrological, or environmental reasons. Also, reinjection requires the drilling of an additional well, which has become a major economic concern for most projects.

On the other hand, if reinjection is not used for disposal, then usually surface disposal is the next likely alternative. Surface disposal avoids many of the technical difficulties associated with reinjection, but carries environmental and hydrologic problems as well as the administrative and regulatory problems associated with them. Environmental impacts are a major consideration, since the developer must obtain discharge permits from both the Utah Bureau of Water Pollution Control and the U.S. EPA. In addition, surface disposal must be approved by the Division of Water Rights as being consistent with the water right application and with water right policy for the area. To date, applicants have been encouraged to use reinjection, and applications for surface disposal have been considered on an individual basis.

Another potential problem which has arisen, particularly for high temperature resources or where the fluids are highly mineralized, is the application of air quality regulations. In January 1982 the Utah Bureau of

Air Quality took over primacy from the U.S. EPA for the establishment and enforcement of air quality standards for Utah. It is not yet clear how the Bureau of Air Quality will choose to apply the standards; Phillips Petroleum Company has expressed grave concerns over the possibility that strict and inflexible application of the standards could restrict or even preclude geothermal well drilling and testing operations in the Roosevelt Hot Springs prospect.

2.7 Public Outreach

The public outreach program for Utah has consisted of several component activities. One of these is basic public education about geothermal resources and the potential for their development in Utah; a second is more specific response to information requests from individuals, governmental agencies, researchers, geothermal companies, and government contractors; a third is technical assistance to prospective users; a fourth is marketing, or an active effort to reach industrial, private, and public users, both directly and through appropriate state and local agencies; and a fifth is assistance in preparing geothermal legislation.

In November 1981 Connie Walker, who handled much of the public outreach program, left the project.

Outreach activities for Utah for the period July-December 1981 included the following:

—Newsletter: The "Utah Water/Geothermal Report" continued under the direction of Connie Walker. The newsletter is distributed to over 250 recipients each month and has received continued reader response and support.

—Displays and Energy Fairs: The State Team exhibited the Utah Geothermal Display and distributed information at several energy fairs and county fairs throughout the state. The State Team participated in fairs at Mount Pleasant (Sanpete County), Spanish Fork (Utah County), and Hurricane (Washington County).

--Public Contacts and Information: The State Team has continued to disseminate geothermal information, respond to information requests from various sources, and to advise potential geothermal developers.

The funding for the Utah Geothermal Commercialization Program will end probably in mid 1982. For this reason and because the staff for the project has been reduced, outreach activities will be limited. Plans for 1982 are to continue the newsletter, probably until about midsummer; to curtail the use of the display for energy fairs; and to continue to give presentations and distribute information on request. Some functions of the commercialization project, such as information requests, will be continued by the Division of Water Rights as part of its general regulatory responsibilities.

2.7.2 Summary of Contacts and Results

The state team has continued to work closely with new and on-going projects, including the power plant at Roosevelt Hot Springs, the Utah State Prison project, and developers and operators at numerous hot springs, resorts, and greenhouses throughout the state. The state team has also responded to a large number of inquiries about specific or general geothermal utilization in Utah. Many of the contacts and interactions will continue after the Commercializaton Program has ended.

2.7.3 Overall Prospectus for Future Geothermal Commercialization

The general nature of geothermal activity in Utah has changed over the last few years. Activity in direct heat utilization has decreased substantially; in fact, the only project which appears at this time to be progressing towards a successful conclusion is the State Prison geothermal space heating project (several other successful projects are already in operation). Although a number potential developers have expressed interest in geothermal direct heat, no new projects have actually been undertaken.

On the other hand, development of high temperature resources is progressing well. The geothermal field at Roosevelt Hot Springs is being developed for commercial production of the resource and construction has begun on the initial power plant at the site. In addition, the discovery of the Drum Mountains unit indicates that more high temperature resources may be found in Utah. Continued exploration by major companies also indicates a potential for further discoveries.

It is likely that the current trends will continue for some time. The decline in direct use activity is due to several factors, including the general poor condition of the nation's economy and the marginal economics of many direct use projects. It is to be expected that the growth of direct use will be slow until general economic conditions improve.

3.0 Summary of Major Findings and Recommendations

Short summaries of the more important conclusions are as follows:

--The potential for geothermal development in Utah is substantial, but barriers or hindrances to development still exist. Often a resource is owned by someone who doesn't have the financial backing or interest to pursue development himself, but who anticipates making a fortune from the resource and thus is very difficult for a serious developer to deal with. Along the Wasatch Front, for example, most geothermal occurences are apparently related to deep circulation through fault and fracture systems, and few of them are high temperature and high quality resources. Development so far has clustered around the resource sites which appear to be the best (such as Crystal Hot Springs), but lower quality resources are not developed. As a result, development must be limited at the better resources areas while other sites remain undeveloped.

--Some issues still need to be resolved by legislation, as mentioned earlier. Geothermal development, particularly direct heat utilization, would be enhanced by tax incentives, exemption of small district heating systems from public utility regulation, and authorization for municipalities and other governmental and quasi-governmental entities to form district heating systems.

--An organized and continuing geothermal advocacy group is needed in Utah. A number of regulatory barriers to geothermal development exist, some of which might best be handled through legislation and others by close work with the respective regulatory agencies. Several problems which geothermal developers have already or will encounter appear to be unnecessary in terms of a reasonable interpretation of the regulations; however, at this point no mechanism exists (at least within state government) to resolve these problems. A task force or ad hoc committee set up by the local section of the Geothermal Resources Council might be able to work for these changes; however, the support of the geothermal community in Utah would be essential to any efforts of this kind.

WYOMING GEOTHERMAL COMMERCIALIZATION PROJECT
SEMIANNUAL PROGRESS REPORT
JULY - DECEMBER 1981

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IDAHO OPERATIONS OFFICE

CONTENTS

WYOMING GEOTHERMAL COMMERCIALIZATION REPORT

SEMIANNUAL PROGRESS REPORT, JULY-DECEMBER 1981

1.0 INTRODUCTION

1.1 Purpose of Project

The purpose of the Wyoming Geothermal Commercialization Program is to match known geothermal resources with potential users and applications. The program office provides the public with all types of geothermal information and serves as a communications link to the Wyoming geothermal resources assessment data.

1.2 Objectives

The objectives of the Wyoming Geothermal Commercialization Office (WGCO) are as follows:

- To bring about a general understanding of geothermal energy, and promote the use of geothermal energy in Wyoming
- To create a working relationship, and exchange of information with other state and federal agencies involved in geothermal development
- To contribute to the accomplishment of national geothermal energy goals of the U.S. Department of Energy
- To develop usable plans that will help to predict and encourage geothermal development in Wyoming
- To maintain regional ties with other western states, and the geothermal organizations (public and private sectors) that are located in the western states
- To assess and attempt to reduce the institutional barriers and other obstructions to the development of geothermal energy in Wyoming

1.3 Technical Approach and Team Members

The WGCO approach is primarily a planning and advocacy effort. Technical assistance on specific geothermal developmental problems is provided upon request within the limitations of available time and capabilities of staff members. The office works in cooperation with state agencies, businesses and concerned citizen groups to develop a general awareness of geothermal energy. Development plans produced by the WGCO provide specific information that will aid in the development of geothermal resources in Wyoming.

The team members are:

E. Gerald Meyer	Principal Investigator
Karen Marcotte	Program Director
Patti Burgess-Lyon	Research Associate
Ruth Tebbutt	Senior Secretary
Janice Roman	(replaced R. Tebbutt)

1.4 Project Benefits to the State and DOE

Increased overall awareness of geothermal energy development potential benefits both the state of Wyoming and DOE. The significant steps towards developing a district heating system for the town of Thermopolis are directly related to WGCO efforts in this direction. The collection and dissemination of geothermal technical data to potential developers increases the pace of actual development dramatically. An additional benefit to DOE from the WGCO is the continuing input of data to the overall aggregation of geothermal development information in the United States.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

TABLE 1. PROVEN DIRECT-USE THERMAL PROSPECTS

Resource	Temperature (°C)	Depth (m)
Thermopolis	32 - 70	< 666
Cody	38 - 47.5	185 - 500

(Source of information in Table 1: Heasler, Henry P. A Summary of Geothermal Potential and Development in Wyoming, prepared for the Interstate Oil Compact Commission, Midyear Meeting, June 28-30, 1981, pp. 2-3.)

TABLE 2. POTENTIAL DIRECT-USE THERMAL PROSPECTS

Resource	Temperature (°C)	Depth (m)
Salt Creek (Midwest)	49 - 77	300 - 1,500
Countryman Well	50	1.500
Little Sheep Mountain Spring	18, 20	Hot Spring
Sheep Mountain Springs	21	Hot Spring
Saratoga Hot Springs	30-54	Hot Spring
Douglas Warm Spring	30	Hot Spring
Conant Creek Springs	16	Hot Spring
Ft. Washakie Hot Springs	44	Hot Spring
Jakeys Fork Spring	20	Hot Spring
Little Warm Spring	25	Hot Spring
Sweetwater Station Springs	30 - 31.5	Hot Spring
Warm Spring Creek Springs	29	Hot Spring
Auburn Hot Springs	62	Hot Spring
Johnson Springs	46	Hot Spring
Alcova Hot Springs	54	Hot Spring
Horse Creek Springs	23 - 24	Hot Spring
Immigrants Washtub	21	Hot Spring
Kendall Warm Springs	29.5	Hot Spring
Steele Hot Springs	35.5, 39	Hot Spring
Big Fall Creek Springs	16	Hot Spring
Abercrombie Warm Springs	27	Hot Spring
Astoria Springs	37	Hot Spring
Boyles Hill Springs	30	Hot Spring
Granite Falls Hot Springs	45	Hot Spring
Huckleberry Hot Springs	61	Hot Spring
Jackson Lake Hot Springs	24-72 (1966-1972)	Hot Spring

Kelly Warm Spring	27	Hot Spring
North Buffalo Fork Springs	33.5, 45	Hot Spring
Teton Valley Warm Springs	18	Hot Spring

NOTE: Both the potential and proven resource lists exclude all thermal features of Yellowstone Park.

(Source of springs list in Table 2: Breckinridge, R. and B. Hinckley, Thermal Springs of Wyoming, Bullet in 60, Wyoming Geological Survey, 1978.)

TABLE 3. INFERRED DIRECT-USE THERMAL RPOSPECTS

Resource	Temperature (°C)	Depth (m)
Bighorn Basin Wind River Basin Green River Basin Powder River Basin Great Divide Basin Washakie Basin	all≈ 90 - 150	usually over 3

A description of these basin resource areas is as follows: "Hot water is found in these basins due to the Earth's normal increase in temperature with increasing depth (the increase in temperature with depth is called geothermal gradient). Certain water-bearing rock units in these basins are folded deep enough (usually over 3 km (10,000 feet)) such that the surrounding rocks heat the water.

This type of geothermal system exists only in the deep central portions of the basins where drilling for a moderate temperature geothermal resource is uneconomical. However, since many of the water bearing rocks such as the Madison Limestone, Tensleep Sandstone, or Mesaverde Formation also sometimes contain oil, deep holes are drilled into these rock units. If hydrocarbons are not encountered, the drill holes are plugged even if hot waters are found. What would be extremely useful in Wyoming is a streamlining of regulations that would easily allow the transferring of these oil exploration holes to municipalities or individuals for hot water utilization."

(Source: Heasler, Henry P. A Summary of Geothermal Potential and Development in Wyoming, prepared for the Interstate Oil Compact Commission, Midyear Meeting, June 28-30, 1981, pp.2-3)

2.2 Area Development Plans (ADP's)

2.2.1 State Geothermal Planning Areas

Nine geothermal planning regions were developed by the WGCO in 1979. The nine areas do not include Yellowstone National Park, where geothermal development is not promoted. A map of the planning areas has been published in several past editions of the Semiannual Progress Report.

2.2.2 Specific ADP's Completed or in Preparation

ADP's of the following areas have been completed and published by the DOE:

- Big Horn Basin ADP (Big Horn, Washakie Park and Hot Springs Counties)
- Fremont County ADP
- Converse/Natrona ADP (Converse and Natrona Counties)

2.3 Site-Specific Development Analysis (SSDA's)

2.3.1 Candidate Geothermal Sites and Applications

Table 4 lists candidate geothermal sites and their applications.

TABLE 4. CANDIDATE GEOTHERMAL SITES AND APPLICATIONS

Site	Applications
Midwest/Edgerton	greenhousing
Midwest/Edgerton	aquaculture
Midwest/Edgerton	district heating
Auburn/Afton	dairy industry process heat
Auburn/Afton	greenhousing
Auburn/Afton	aquaculture
Auburn/Afton	Space heating and district heating

Note: A more detailed description of the Auburn/Afton and Midwest/Edgerton sites was included in the January-June 1981 Semiannual Progress Report.

2.3.2 SSDA's Completed or in Preparation

Thermopolis/East Thermopolis SSDA. The Thermopolis SSDA was completed and published by the DOE.

Recent developments in Thermopolis subsequent to publication of the SSDA are as follows:

- Advisory Work Group of the DOE/HUD district heating project met August 19, 1981 for the first time. Subsequent meetings were held once a month throughout the reporting period.
- Thermopolis was selected to receive Community Assistance from the DOE contractor Elliot Allen and Associates.
- A proposal submitted by the town of Thermopolis for some limited hydrologic tests was approved by the Wyoming Water Development Commission on October 29, 1981.
- The DOE/HUD feasibility study is scheduled for completion on June 1, 1982.
- The proposed district heating system would have the following heat load parameters:
    1. Residential Load-180,600 MMBTU/yr.
    2. Business Load-73,800 MMBTU/yr.
    3. Public Building Load-63,800 MMBTU/yr.
    4. Total Annual Expected Geothermal System Loading-318,200 MMBTU/yr.

Source: Steve Goering, Coury and Associates, Denver, Colorado

Cody SSDA. The Cody SSDA was completed in final form during the reporting period, but has not yet been published by the DOE.

The Cody report includes major sections on site description, resource evaluation, potential applications of the resource, heat exchangers, corrosion prevention, and a discussion of the leasing, permitting and financial considerations involved in geothermal development.

The Cody SSDA also contains a detailed economic analysis for three district heating scenarios that have been proposed for development in the Cody region. The estimated annual energy demand for each of the proposed district heating systems is listed below:

- Case I - Small Cody Heating District
  annual heat demand = 29,400 MMBTU/yr.
- Case II - Large South Fork Subdivision

annual heat demand = 9,470 MMBTU/yr. (100 homes)
=18,940 MMBTU/yr. (200 homes)
=28,410 MMBTU/yr. (300 homes)
=39,770 MMBTU/yr. (400 homes)

° Case III - Small South Fork Subdivision

annual heat demand = 2,545 MMBTU/yr.

2.4 Time Phased Project Plans

None

2.5 State Aggregation of Prospective Geothermal Use

A summary of the projected energy use for ADP's and SSDA's is shown in Table 5.

TABLE 5. ENERGY-USE SUMMARY

	Energy Use (MMBTU/yr.)			
Project Area	1981	1985	2000	2020
ADP's				
Big Horn Basin	85,000	444,190	650,000	800,000
Fremont County	1,000	10,000	50,000	100,000
Converse/Natrona	500	25,000	50,000	115,000
Carbon/Albany	1,000	10,000	25,000	25,000
Powder River Basin	500	1,000	1.000	1.000
Western	10,000	50,000	125,000	200,000
Southeastern	0	0	0	0
Northeastern	0	0	0	0
Southwestern	0	0	500	1,000
Total ADP's	98,000	540,190	901,500	1,242,000
SSDA's				
Thermopolis	55,000	318,200	460,000	600,000
Cody	35,000	125,990	190,000	200,000
Midwest	0	25,000	50,000	115,000
Afton/Auburn	10,000	50,000	125,000	200,000
Total SSDA's	100,000	519,190	825,000	1,115,000

2.6 Institutional Analysis

The major emphasis of the WGCO's institutional effort went into an attempt to secure funding for geothermal energy through the Wyoming state government. A proposal was developed for funding of a cooperative geothermal effort in Wyoming, including program goals that would incorporate resource assessment, and planning/commercialization.

Additional institutional analysis has been required for the ongoing district heating feasibility study in Thermopolis. The Wyoming Resource Assessment Team and the Town officials of Thermopolis did receive a grant from the Wyoming Water Development Commission. Clarification of many procedural questions in regard to hydrologic testing has also been obtained through the appropriate state offices.

An investigation into geothermal insurance and the availability of tax incentives for geothermal development was conducted by WGCO staff during the reporting period. Results of those investigations were printed in the monthly newsletter of the WGCO.

A U.S. Senate subcommittee hearing on geothermal leasing in areas adjacent to National Parks was held in Casper, Wyoming on December 12, 1981. The purpose of the hearing was to hear testimony in regard to Senate bills 1516 and 669. These two bills were being studied by the Subcommittee on Public Lands and Reserved Water. The hearing was chaired by Senators Wallop (Wyoming), and Melcher (Montana). Most of the discussion concerned geothermal leasing in the Island Park area, and subsequent potential effects on the thermal features of Yellowstone. Wyoming Geothermal Resources Assessment Team members and WGCO staff members attended the hearing.

The WGCO has also been investigating the institutional procedure for turning an unsuccessful mineral exploration hole into an accessible geothermal well if hot water is found. A streamlining of this procedure, and clarification of the issues and agencies involved could be very helpful to potentialgeothermal developers in the state.

2.7 Public Outreach Program

2.7.1 Outreach Mechanisms

- Distribution of published information produced by the WGCO and the Wyoming Resources Assessment Team
- Responses to informational requests that come into the WGCO by mail and telephone
- "The Geothermal News," a monthly WGCO newsletter with a circulation of 600
- Toll-free in state telephone number
- Public presentations to professional, public, civic, and academic organizations
- Radio interviews and newspaper releases
- Expanded use of informational workshops

2.7.2 Summary of Contacts and Results

- Numerous trips have been made to Thermopolis by the WGCO. The Thermopolis City Council voted to apply for the HUD/DOE district Heating Program Grant upon recommendation by the WGCO. This grant was awarded last spring for a total of $50,600. The WGCO is now involved in the Work Assessment Group in an advisory capacity to the City Council on the District heating project. An additional grant for $60,000 was awarded to Thermopolis by the Wyoming Water Development Commission. The $60,000 will be used for some limited hydrologic testing in the Thermopolis region.
- A commercial greenhouse has been built by Mr. Tom Berry in Thermopolis, Wyoming. The greenhouse measures 34 feet by 96 feet, and uses 126°F water from Mr. Berry's private well. Tomatoes, cucumbers, and peppers are being grown for commercial distribution in the area. Mr. Berry may expand his operation to include a second geothermal greenhouse. The WGCO gave extensive assistance in technology transfer to this project.
- An informational packet of materials entitled "Opportunities for Use of Geothermal Energy in Wyoming Industries" became available from the WGCO in November, 1981. The packet contains a copy of the Wyoming Geothermal Institutional Handbook, and materials on the utilization of geothermal energy for the following industries:

-Sawmills and Planing Mills

-Fluid Milk Processing

-Ready-Mix Concrete

-Industrial/Commercial space heating of buildings that are 20,000 Ft. or larger

Descriptions of the industrial processes, and the potential applications for geothermal energy are discussed for each of the industries listed above. In addition, a preliminary economic analysis was completed for each industry.

° Two geothermal energy meetings were held in Cody, Wyoming during December, 1981. The topic of both meetings was the geothermal energy potential of the Cody and South Fork regions of Park County. The first presentation was to the Cody Chamber of Commerce, and the second presentation was a town meeting open to the public. Both presentations were well attended. A citizens ad hoc committee has been formed in Cody to further interest in the potential geothermal developments there.

° The WGCO has received a great deal of publicity through news releases and radio interviews with staff members. Use of these two forms of the media appear to be very effective in Wyoming. A large increase in informational requests was noted after each of the media news events.

2.7.3 Overall Prospectus for Future Geothermal Commercialization

° Additional geothermal development is likely to occur in the Thermopolis and Cody regions in the very near future. Development will largely occur in the form of space heating provided by district heating systems in these two communities.

In addition, significant space heating and agribusiness developments may occur in the Midwest/Edgerton and Auburn/Afton areas. The WGCO will continue to work with these communities in regard to the impact that geothermal energy may have on the dairying, greenhousing, and potential aquaculture industries of these areas.

Individuals working for several major oil companies have been working with the WGCO in regard to their electrical power needs in Wyoming oilfields. It appears probable that development of a geothermal power system using a Rankine cycle generator will be the solution to oilfield power needs. Large quantities of water and investment capital are available at most of the major oilfields in Wyoming.

The use of groundwater heat pumps and heat pipe bridges is expected to become more widespread in Wyoming in the next few years.

Hybrid systems, utilizing the abundant Wyoming advantages of geothermal, solar and wind energy will also become more widely used. The development of a Wyoming private sector experienced in these alternative energy forms will speed the development of hybrid systems.

3.0 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

Awareness of geothermal energy and its potential for utilization in Wyoming has increased dramatically, as shown by the increase in inquiries received by the WGCO, high attendance at public meetings and the continued growth of our newsletter mailing list.

WGCO recommendations of actions that could be taken to facilitate geothermal energy in Wyoming are as follows:

- Increase financing opportunities for district heating projects (i.e. continue existing programs into fiscal years 1982 and 1983, and initiate other community assistance programs aimed at locating funding sources for geothermal development).
- Create financial assistance for retrofit to geothermal from fossil fuel sources. This would be a major incentive for industries and residential users to convert fuel systems.
- Increase state support of geothermal energy development.
- Streamline state and federal leasing requirements and legislatively create a uniform definition of a geothermal resource.
- Create a simpler method for potential geothermal developers to utilize abandoned mineral exploration wells without the capital-intensive "in perpetuity" bonding regulations.
- Provide state and federal funds for planning and resource teams. Without the public awareness of the alternative energy choices available, changes in energy form selection cannot be made. The current attempt to launch the infant geothermal industry of Wyoming on it's own, without public sector assistance, is premature.