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State Geothermal Commercialization Programs in Seven Rocky Mountain States

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STATE GEOTHERMAL COMMERCIALIZATION PROGRAMS IN SEVEN ROCKY MOUNTAIN STATES

Semi-Annual Progress Report
January-July 1981

May 1982

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For the U. S. Department of Energy
Idaho Operations Office
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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 is contributing to the awareness and development of this valuable alternative energy source. This document describes and attests to the accomplishments and findings of these seven commercialization teams during the last half of calendar year 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 make up subsequent chapters 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.

During the last reporting period, the coordination of the state team efforts was turned over to EG&G Idaho, Inc. 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, 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. 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. 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 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 as means to effect 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 (ADPs)

This task 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 Area Development Plans generate the targets for the Site Specific Development Analyses.

1.3.5 Site-Specific Development Analyses (SSDAs)

Using targets identified by ADPs or other selection processes, the Site-Specific Development Analyses 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 Plan (TPPPs)

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 commercialization.

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 commercialization program progresses, the emphasis is changing 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 commercialization 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	2	9	58	69	70
Montana	0	0	0	0	3	22	46	71	71
New Mexico	1	4	10	15	8	12	12	32	47
North Dakota[b]	0	0	0	0	0	71	0	71	71
South Dakota[c]	0	0	0	0	17	18	NA	35	35
Utah	1	1	0	2	6	8	35	49	51
Wyoming	0	0	0	0	2	29	6	37	37
Totals	2	5	11	18	38	169	157	364	382

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

b. 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.

c. 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 364 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. Further definition of resource prospects and leasing activity will be given in future reports.

2.2 Highlights of State Accomplishments

In the chapters 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			Number of Federal Lease
	State	Federal	Total	State	Federal	Total	Appications[a]
Colorado	16,728	34,926	51,654	4	17	21	48
Montana[b]	-0-	10,687	10,687	-0-	6	6	97
New Mexico	13,210	225,710	238,920	41	123	164	508
North Dakota	-0-	-0-	-0-	-0-	-0-	-0-	-0-
South Dakota	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Utah	239,746	459,138	698,884	244	275	519	657
Wyoming	1,150	7,448	8,598	1	4	5	92
Totals	270,834	737,909	1,008,743	290	425	715	1,402

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

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 items.

2.2.1 Colorado

- The Pagosa Springs district heating system, a major geothermal success, was dedicated November 21.

- The Glenwood Springs well drilling was successful. The 155 ft deep well produced 1200 gpm of 122°F water for office, townhomes, and commercial building heating.

- The City of Alamosa spudded a geothermal well November 8. Planned uses are for space heating and barley malting applications.

2.2.2 Montana

- A feasibility study for geothermal district heating in the city of Barber was completed.

- Interest is increasing by greenhouse operators to use geothermal energy due to rising energy costs.

- Day to day responses to individual questions continued to be the most effective outreach mechanism.

2.2.3 New Mexico

- The city of Truth or Consequences Senior Citizens Center retrofit space heating systen was completed in February 1981.
- An area Development Plan was prepared for Dona Ana County where the greatest interest in geothermal development is being shown in the state.
- The New Mexico R&D program has spent about $1.7 million for geothermal research and development.
- The Energy and Minerals department awarded $175,000 to Sandyland Nurseries for a drilling program.

2.2.4 North Dakota

- Area Development Plans have been completed for the Roosevelt-Custer and the Lewis and Clark regions.
- Site-specific development plans are being prepared for the city of LaMoure, the Menoken plant of the North Dakota Concrete Products firm, and the city of Dickinson.
- The Jamestown district heating and cooling project, the state's first, went on line.
- Three bills affecting geothermal development were passed by the 1981 legislature.
- Individual groundwater heat pump installations continued to account for greatest geothermal use, while district heating systems interest is increasing.

2.2.5 South Dakota

- Development emphasis continued to be on space heating and agricultural users.
- The city of Lemmon is a prime candidate for the development of a district heating system.
- A geothermal energy user's conference was held February 26 in Pierre.
- Groundwater heat pumps have a great potential for space heating in the eastern part of the State.

2.2.6 Utah

- A major geothermal bill was passed by the legislature.
- Phillips Petroleum and Utah Power and Light announced plans to initiate power production at Roosevelt Hot Springs with a 20MW(e) pilot plant.
- The Orum Mountain Geothermal Unit, west of Delta, was formed by Phillips Petroleum Company. Permitting, planning, and design are in progress.
- Site Specific Development Analyses are in progress for Crystal Hot Springs, Belmont Hot Springs, New Castle, and Midway.
- The Crystal Hot Springs Resort at Honeyville completed initial renovation work.
- Utah Roses placed a second set of greenhouses under geothermal operation.

2.2.7 Wyoming

- Area Development Plans were completed for the Big Horn Basin, Fremont County, and Converse/Natrona.
- Site specific development data for the Midwest/Edgerton area shows the Salt Creek Oilfield to be a conspicuous thermal anomaly.
- A Site Specific Development Plan was completed for the Thermopolis area.
- A study of the South Fork subdivision near Cody shows that a district heating system will be cost competitive.
- HB283, specifying that the extraction of heat is a beneficial use of water, passed the legislature on February 26.

3.0 OBSERVATIONS AND CONCLUSIONS

3.1 Outreach Mechanisms

- 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.

- 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.

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

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

- 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, and future efforts should include more of this type of outreach.

- 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.

- The state team activities continue to gravitate to technical assistance activities and away from planning. 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.

- 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. Therefore, removal or mitigation of these items should occur to accelerate geothermal energy development and use.

- The interest in geothermal development is increasing, but it is tempered with the realization that restriction in federal program funding will limit development activities.

- 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 pertetuity bonding regulations.

COLORADO GEOTHERMAL COMMERCIALIZATION PROJECT

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Prepared by

Richard H. Pearl and Kevin P. McCarthy

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COLORADO GEOTHERMAL COMMERCIALIZATION PROJECT SEMIANNUAL PROGRESS REPORT, JANUARY-JUNE 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

1.3.1 Team Members:

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

1.3.2 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 included the preparation and mailing of a monthly newsletter and a groundwater heat pump pamphlet. Both of these requirements have been meet. 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.

1.4 Project Benefits to the State and D.O.E.

Citizens of the State are becoming aware that the geothermal resources of Colorado can be put to beneficial use. Industrial base of Colorado is increasing due to new industries using geothermal energy. D.O.E. benefits: Geothermal energy use increasing, energy dependence of the nation decreasing.

2.0 SPECIFIC DESCRIPTIONS AND PROJECTS

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). In the following tables (1-4) the site numbers refer to figure 1.

TABLE 1. 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
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	?

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
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	?
13 Penny Hot Springs	56	60-90	0.166-0.486	?
14 Col. Chinn Well	42	NA	0.018	?
15 Conundrum Warm Spring	38	40-50	0.004	?
16 Cement Creek	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	?

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
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	?
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
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		?

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

Site	Highest Measured Surface Temp. (°C)	Estimated Probable Subsurface Temp. (°C)	Estimated Probable Heat Content (BTU's x 1015)	Depth
11 Glenwood Springs	51	60	0.38	30-100 m
41 Pagosa Springs	58	80-150	0.023	90-200

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

- o <u>Inferred</u>. A psing or thermal well has been located, field measurements of pH, temp., or discharge made, and in most instances geothermometer model analysis run.

- o <u>Potential</u>. 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. From this information an intelligent estimate can be made of the size and magnitude of the Resource.

- <u>Proven</u>. Test wells have been drilled, and the production well may have been drilled.

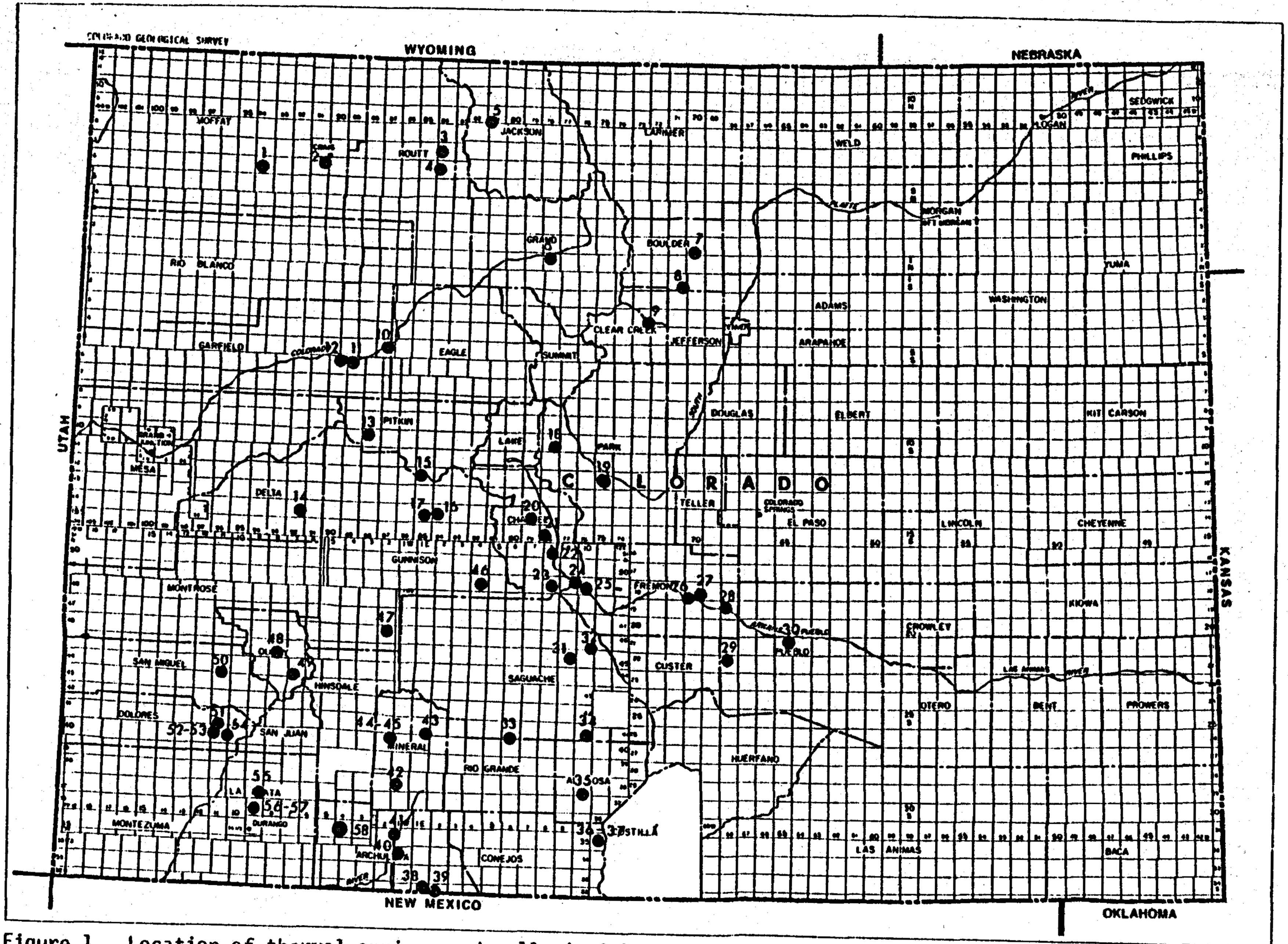

Figure 1. Location of thermal springs and wells in Colorado. Numbers identify thermal areas.

2.1. Leasing

Table 5 lists current non-competitive leases on Federally owned lands, Table 6 lists current competitive Federal leases [Known Geothermal Resource Areas (KGRAs)]. 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
Occidental Pet. Inc.	80.00	49N, 8E	Chaffee	11/75
Occidental Pet. 50% Petro-Lewis Corp. 50%	1,280.00	49N, 8E	Chaffee	11/75
Occidental Pet. 50% Petro-Lewis Corp 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 Corp. 50%	915.84	49N, 8E	Chaffee	7/75

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	5/74
C.A. Underwood	2,840.00	41N, 10E	Saguache	
Chaffee Geothermal*	360.00	49N, 8E	Chaffee	
Total	7,986.61 acres			

Source: Colorado State Board of Land Commissioners

* Acreage assigned from Occidental Petroleum

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 started planning the drilling of their User Coupled Drilling Program funded well. At Glenwood Springs two commercial developers, Wright Water Engineers and the Redstone Corp. initiated plans for the drilling of geothermal wells.

2.3.2 Site Specific Development Plans-Completed or in Preparation

No 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

2.5 Site Aggregations of Prospective Geothermal 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

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

USE	AREA
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 Ouray Hot Springs Waunita Hot Springs
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	
Space heating	Glenwood Hot Springs Alamosa Ouray Hot Springs Poncha Hot Springs Warm Water Wells east of Castle Rock (Park West Corp.)

2.6 Institutional Analysis

Coe and Forman (1980) prepared and published an analysis of the Colorado geothermal institutional framework. This is a lengthy document, 27 pages, and will not be summarized here. Copies have been distributed to D.O.E. and others.

In the July-December, 1980 Semi-Annual Progress Report it was noted that several problems had developed which 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

Outreach activities during the first 6 months of 1981 consisted of: Newsletter, meetings with individuals either in their or our offices, answering letters and telephone calls of inquiry.

2.7.2 Summary of Contacts and Results

Following contacts were made during the period January-June, 1981

January: The project was shorthanded during January, and a staff member was actively sought. Help was provided to the City of Ouray regarding its desires to develop the geothermal resources located within the city.

February: Advice and/or assistance was provided to the following:

Craig Sabatke
Forward Delta County, Inc.
P.O. Box 1129
Delta, Colorado 81416

David Carpenter
Western Slope Energy Research Center
Hotckiss, Colo.

Ray Kitayama
P.O. Box 537
Brighton, CO
Greenhouses

Loyd Hershey, Consulting Geologist
Canon City, Colo.
Greenhouses

Mr. Cap Allen
Consulting Engineer
Durango, CO

Mr. Willaim Blankenship and
Mr. Lloyd Duttall,
Information about Mineral Hot Springs.

Royal Gorge Flower Farms
1313 South St.
Canón City, CO 81212

David C. Bachman
242 County Rd. 12B
Ridgway, CO 81432

Cascadia Exploration Corp.
3358 Apostol Rd.
Escondido, CA 92025

Dr. Jay Kunze
Energy Services, Inc.
Idaho Falls, Id and
City of Alamosa
Regarding City of Alamosa well funded by D.O.E.

March:

Mr. Roy Haubert
WESTEC Services, Inc.
3511 5th Ave.
San Diego, CA
San Luis Valley

George Gault
Box 760
Cedearedge, CO. 81413
Ouray

Meetings:

Wright Water Engineers
Glenwood Springs

Forward Delta, Inc.
Delta, CO

Dr. David Bachman
Ridgway, CO

City of Ouray Officials

Norma Swanson
Lake City, CO.

Chet Rouviere
Cebolla Hot Springs, CO.

April:

Lew Huntington
1312 W. 4th Ave. #304
Broomfield, CO 80020

Peggy Wrenn
Div. Renewable Energy Resources
Colo. Office of Energy Conserv.

May:

U.S. Bureau of Reclamation
Hydrosalinity Prob. Id. and Quantif.
Dotsero-Glenwood Springs Unit
Meeting, Glenwood Springs

George Gault,
Cederedge, CO.

Mr. Reeves, owner
Waunita Hot Springs, CO.

Dr. Feachou, Prof.
Western State College
Gunnison, CO.

Bill Ray
City Manager,
Pagosa Springs, CO.

Cap Allen, Consulting Engineer
Durango, CO

Tim Hale, V. Pres.
Pikes Peak Greenhouses
Colorado Springs, CO.

Michael Hercules, Owner
Eldorado Springs, CO

William Sageser
Tamarron Resort

Bob Wright, Rancher
Fairplay, CO.

Lee Wooderson, Consultant
Canon City, CO.

Jack Green
Denver Mayor's Office
Denver, CO.

June:

Meeting with Marketing Advisory Comm.
Denver, CO.

Sunshine Fair
Alamosa, CO.

Tim Haley
Pikes Peak Greehouses
Colorado Springs, CO.

Dr. Jay Kunze,
Energy Services Inc.
Idaho Falls, Id.

Roberta Edwards
Box 12225
Oklahoma City, Ok

Wright Water Engineers
Glenwood Springs, CO.

Mr. David Crockett
4301 S. 1500 E.
Salt Lake City, UT

Michale Wellund
ARCO Exploration
P.O. Box 2819
Dallas, TX

Armand Van Velthoven
Heritage Flowers
3159 W. Colorado Ave.
Colorado Springs, CO.

Herb Ventker
Royal Gorge Greenhouses
Canon City, CO.

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 July-December, 1980 Semi-Annual Report that the Colorado Commercialization Team strongly believed that geothermal development in Colorado was on the edge of a break through. While the Team still harbours those thoughts they are tempered with the realization that due to Federal budget cuts the development of geothermal resources in Colorado could be curtailed.

This is seen in recent developments in the San Luis Valley, and at Pagosa Springs. With D.O.E. User Coupled Drilling funds the City of Alamosa has just 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.

The State of Colorado has an economic development program to encourage industrial development in economically distressed areas such as the San Luis Valley and Pagosa Springs. 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.

3.0 Summary of Major Findings and Recommendations

The more direct technical assistance type work undertaken in late 1980 and 1981 was a major step in the project's evolution. This action brought the team in contact with more potential developers, and was thus able to provide a wide range of advice and assistance. It appears that 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 PROGRESS REPORT

January-June, 1981

Prepared by

Jeff Birkby

Department of Natural Resources & Conservation

32 South Ewing

Helena, Montana 59620

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

U.S. Department of Energy

Idaho Operations Office

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TABLES

1.0 INTRODUCTION

Since its inception in 1978, the Montana Geothermal Program has realized substantial and tangible results in promoting geothermal energy within the state. Originally the program provided little technical assistance or outreach. Instead, the original goals of the program were to develop energy scenarios for what might happen in the future, and to gather baseline data on the state's geothermal resources. Gradually the state's efforts have turned more toward site-specific assistance and public relations efforts, with noticeable results. Work on Area Development Plans and Time Phased Project Plans has been completed or stopped, and almost all of the team's efforts are now spent on individual project assistance and public relations efforts.

Staff changes occurred during this reporting period. Gary Lippert, who was hired in October 1980, left the program in March 1981 to return to North Dakota. Jeff Birkby, who had been with the program since 1979 and 1980, was rehired after he finished a six-month stint in graduate school. Michael Chapman left the program in June of 1981 to work full-time on solar energy projects for the state. Currently Jeff Birkby is the only full-time member of the geothermal program, and with the reduced funds available from federal sources, it is doubtful that additional staff will be hired in the near future.

Clearly the state geothermal program has benefits both to Montana and DOE. Montanans are much more aware of the potential that direct use geothermal and groundwater heat pumps have for the state. Requests for information on geothermal have increased steadily since the program's inception, and several projects have come on-line in part due to the support of the geothermal program. DOE has benefitted directly from our efforts by having a well documented baseline analysis of the state's geothermal resources. These analyses have been used by regional and federal offices of DOE in preparing budgets and national energy estimates.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

A list of flow rates, surface temperatures and reservoir temperatures for the major Montana geothermal resources is presented in Table 1. A summary of current uses and project utilizations for all of Montana's geothermal resources will be presented in the next mid-term report.

2.2 Area Development Plans

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

2.3 Site Specific Development Plans

A major feasibility study for the city of Baker was completed in April. The city of Baker was awarded a $5,000 Appropriate Technology grant to study the feasibility of using Madison Formation water for district heating. The geothermal program was instrumental in acquiring this grant, and visited Baker several times to promote interest in the project.

The engineering study found that at the present time cheap natural gas rates make a district heating system economically unattractive. However, projected increases in natural gas rates may make the system feasible as early as 1989

2.4 Time Phased Project Plans

No time phased project plans were compiled during this work period. No further TPPPs are planned Montana's state geothermal program.

Table 1. Surface Temperature, Observed Flows, and Calculated Reservoir Temperatures of Selected Montana Geothermal Resources

Resource	Observed Surface Temperature (°C)	Observed Flow (liters/min)	Calculated Reservoir Temperature (°C)[2]
Proven			
Ennis	33°	57	129°
New Biltmore	53°	380	71°
Camp Aqua	50°	1900	100°
Potential			
Alhambra	56°	570	96°
Boulder	76°	950	136°
Bozeman	55°	3800	80°
Broadwater	62°	285	118°
Camas	45°	200	100°
Chico	45°	500	58°
Elkhorn	48°	400	65°
Granite	51°	140	80°
Gregson	70°	1000	118°
Hunter's	59°	5000	78°
Jackson	58°	1000	125°
La Duke	65°	500	73°
Lolo	44°	100	83°
Norris	52°	334	107°
Pipestone 1, 2	57°	300	88°
Hot Spring			
Potosi 1, 2, 3	50°	2300	60°
Silver Star	72°	228	131°
Sleeping Child	45°	437	125°
Warm Springs	77°	600	79°
White Sulphur Springs	46°	1500	125°
Wolf Creek	68°	1189	77°
Marysville KGRA	103°	----	122°

Hot Spring	Observed Surface Temperature (°C)	Observed Flow (liters/min)	Calculated Reservoir Temperature (°C)[2]
Inferred Resources			
Anaconda	22°	---	75°
Anderson's	25°	---	30°
Anderson's Pasture	26°	340	45°
Apex	25°	---	76°
Avon	26°	---	---
Bear Creek	24°	114	---
Bearmouth 1	20°	---	35°
Bearmouth 2	20°	---	35°
Beaverhead Rock	27°	380	---
Bedford	24°	5700	30°
Blue Joint 1	29°	1020	45°
Blue Joint 2	29°	850	45°
Bridger Canyon	20°	---	25°
Brook's	20°	304,000	25°
Brown's	24°	12,914	30°
Carter Bridge	28°	---	40°
Deer Lodge	26°	---	40°
Durfee Creek	21°	57,000	30°
Gallogly	49°	456	56°
Garrison	25°	---	35°
Green Springs	26°	---	---
Greyson	18°	---	25°
Landusky 1	21°	2280	35°
Landusky 2	---	---	---
Landusky Plunge	24°	11,400	30°
Little Warm Springs 1	---	---	---
Little Warm Springs 2	22°	4560	35°
Little Warm Springs 3	23°	---	35°
Lodgepole 1, 2, 3	30°	10,260	35°
Lowell's	19°	4275	30°
McMenomey Ranch	19°	---	---
Nimrod	20°	760	30°
Plunkett's	17°	15,200	20°
Puller's	44°	570	90°

Hot Springs	Observed Surface Temperature (°C)	Observed Flow (liters/min)	Calculated Reservoir Temperature (°C)[2]
Quinn's	43°	247	99°
Renova	50°	---	---
Sloan Cow Camp	30°	---	85°
Staudermeyer Ranch	28°	6796	45°
Sun River	30°	1900	35°
Toston	16°	33,984	20°
Trudeau	23°	---	23°
Vigilante	24°	1900	35°
Warner	18°	---	23°
West Fork Swimming Hole	26°	1869	30°
Lucas'	42°	---	60°
Ringling	48°	---	60°
Symes'	40°	---	102°

Source: Sonderegger, 1979, Montana Bureau of Mines and Geology, Butte, Montana. unpublished data.

2.5 State Aggregation of Prospective Geothermal Utilization

A summary of current and predicted geothermal use in Montana will be presented in the June-December 1981 report. Several changes in earlier predictions (most notably Bozeman Hot springs and Camp Agua) will be reported on in that report.

2.6 Institutional Analysis

No work was done on institutional analyses during this time period. A steady number of requests have been filled for the newly published Montana Geothermal Handbook.

2.7 Public Outreach Programs

The outreach mechanisms used during this period were similar to those used in the past. Personal contact with geothermal developers continued to have the most impact on the rate of geothermal activity within the state. Television interviews were also effective in sparking interest in the potential geothermal developers. Geothermal presentations to large groups such as county fairs were effective, as were presentations to small organizations. Day-to-day answering of specific questions phoned in to the office continued to be one of the most effective (and time-consuming) outreach activities.

2.7.1 Summary of Contacts and Results

JANUARY

Interviewed on Missoula TV station. Discussed drilling in progress at Camp Agua. As a result of the appearance, received several letters and development. Sent out several geothermal direct use brochures to interested developers.

Met with representatives from the town of Hot Springs in northwestern Montana. The town is seeking funding for a district heating system. Put them in touch with several funding sources, and conducted a preliminary assessment of the feasibility of converting to geothermal.

Provided techncial assistance to a geothermal greenhouse builder from Avon. Assisted with heating system design.

Gave two slide show presentations to area high schools on geothermal.

FEBRUARY

General -- Many requests for information on geothermally heating greenhouses were received. We sent out a questionaire to members of the state nuseryman's association to assess the interest in geothermal. Many greenhouse operators are concerned about their heating bills, and would consider using heat pumps or direct use geothermal. Will try to schedule a greenhouse workshop later in the year.

Assisted the town of Ennis in a feasibility study for geothermal district heating (with the help of NMEI). A grant for the project has been submitted to the Institutional Buildings Grants Program.

Visited White Sulphur Springs to encourage them to apply to the Institutional Buildings Grants Program for design money for a geothermal district heating system. The town is considering submitting the proposal.

Gave two presentations on geothermal energy at the Montana Agri-Trade Exposition.

MARCH

Held a meeting on geothermal energy options in Ronan. Followup requests on specific information on heat pumps and moderate temperature well development were answered. Assisted in the design of a closed-loop piping system for low-capacity wells.

Assisted the owner of Broadwater Health Club in locating a heavy duty pump to test his wells for maximum sustainable flow.

Answered two requests for geothermal information from high school science classes.

APRIL

Spent much of the month on the road delivering several talks on geothermal energy and the problems of financing systems. Received several thank you letters from people attending energy fairs where geothermal presentations were given.

MAY

Provided technical assistance to the Sleeping Buffalo Resort in northeastern Montana. Coordinated technical asssitance for the resort with EG&G Idaho. Determined that a flow test would be necessary prior to final system design.

Visited the Fort Belknap Indian Reservation to assess geothermal potential. The tribe has a 100 degree F well that they would like to develop for greenhouse heating or soil warming. Sent them several studies done on related systems elsewhere in the nation.

Visited Hot Springs, provided technical assistance on how best to develop an exploration program to increase the flow of the existing springs for possible use in space heating.

JUNE

Attended a conference on small business enterpreneurs, sponsored by the Montana Small Business Association.

Presented a seminar on geothermal energy to a statewide meeting of Extension Service personnel in Bozeman.

Met with developers of a geothermally heated ethanol plant near Camas to discuss reinjection permits and other legal requirements.

NEW MEXICO GEOTHERMAL COMMERCIALIZATION PLANNING

SEMI-ANNUAL PROGRESS REPORT

January, 1981 - July, 1981

Prepared by:

Dennis Fedor

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 Project

This project was developed as a mission-oriented program aimed at accelerating the commercial utilization of geothermal resources. It 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. This was accomplished through the marketing strategies of public outreach, brokerage functions, and mini-engineering evaluations of specific resources and the appropriate direct-heat applications.

1.2 Objectives

In this market planning effort of the state geothermal energy commercialization, critical evaluation is made of the potential geothermal energy use, the availability of geothermal energy, and prospective user needs and applications.

In order to explore and assess all marketing possibilities for geothermal commercialization, the New Mexico state team, in conjunction with NMEI, is investigating both on-site and off-site energy consumers with special emphasis on colocated users and the appropriate site-specific direct-heat applications. This project mode has provided a basis for promotional marketing activities aimed at specific resource sites and potential adoptees of geothermal energy and concurrently supporting potential or current end-users of geothermal energy with technical assistance. This effort has inevitably provided 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 Chief, Energy and Minerals Department, Santa Fe, NM

Roy Cunniff, State Geothermal Program Coordinator; Chief Engineer, NMSU Campus Project, Physical Science Laboratory, NMSU, Las Cruces, NM

Dr. Larry Icerman, NMEI Coordinator; Director of New Mexico Energy Institute, Las Cruces, NM

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

Kay Hatton, Mining and Minerals Division Coordinator; Geologist, M & M Division, Energy and Minerals Department, Santa Fe, NM

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

The compilation and charting was made of the estimated geothermal energy potentially available from the prospect areas and sites as a function between now and the year 2020.

Tables 1 to 3 list areas and sites of geothermal prospects in the state of New Mexico as these have been identified by various criteria, for both electric and direct thermal uses.

The prospective sites and areas are broken down in the first list to those which are (1) proven, (2) potential, and (3) inferred.

The definitions used are those recommended by Meyer (December 1978):

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

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

Inferred sites or areas are those identified by (1) surface 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	Closson
	Kilbourne Hole	Columbus Area
	Radium Springs	Guadalupe Area
	San Diego Mountian	Jemez Reservoir
		Lordsburg
		Lower Frisco Hot Spring
		Prewitt Area
		Socorro
		Southern Tularosa Basin
		White Sands (Town)

DIRECT THERMAL (20°C < T > 150°C)

PROVEN	POTENTIAL	INFERRED
Animas	Albuquerque	Closson
Faywood	Black Mtn. - W. Mesa	Crown Point
Gila Hot Spring	Cliff Area	E. San Augustin Plain
Jemez Springs	Derry H.S.	Fort Wingate
Los Alturas	Mesquite-Berino	Garton Well
Ponce De Leon	Mimbres H.S.	Jicarilla Apache Res.
Truth or Consequences	Ojo Caliente	Little Blue Mesa
	San Diego Mtn.	Mamby H.S.
Radium Springs	San Ysidro	Mancisco Mesa
	Socorro	Montezuma H.S.
	Turkey Creek H.S.	Southern Tularosa Basin
	Upper Frisco H.S.	Tohatchi

Source: Swanberg, C., 1980
PSL/NMEI, 1980

TABLE 2

STATE OF NEW MEXICO

PROVEN, POTENTIAL AND INFERRED DIRECT THERMAL APPLICATIONS

SITE	LATITUDE/ LONGITUDE	TEMPERATURE (°C) SURFACE	SUBSURFACE	ESTIMATED VOL. (km³)	ESTIMATED POWER (MWe -30 YRS PROVEN	POTENTIAL	INFERRED
Albuquerque	35° 05' 106° 45'	27	30°	3.0			0.0449
Faywood H.S.	32° 108°	33' 00'	54	1.0			
Gila H.S.	33° 12' 108°	68 12'	125				
Jemez Springs	35° 47' 106° 4'	73	103	3.0		0.0206	0.6150
Los Alturas	32° 16' 106° 42'	55	120	3.0			0.5635
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	35° 37'		52°				
San Ysidro	35° 30' 106° 40'	50	80	1.0			0.0206
Socorro	34° 2' 106° 56'	33	35	3.0			0.0135
T or C	33° 9' 107° 15'	36-46	100	1.0		0.0269	0.4563
Animas	32°8 5'	102	144	3.0	____	.0359	0.4102
					0	0.0834	2.1508

Source: PSL/NMEI Data File, 1980

TABLE 3

STATE OF NEW MEXICO

PROVEN AND POTENTIAL ELECTRIC APPLICATIONS

SITE	LATITUDE LONGITUDE	TEMPERATURE (°C) SURFACE	SUBSURFACE	ESTIMATED VOL. (km³)	ESTIMATED ENERGY (MWe) PROVEN	POTENTIAL	TOTAL
Animas (Lightning Dock)	32° 85' 108° 50'	102	170	3.3		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' 107° 58'	30-85	93-130	3.3		5	30
San Diego Mtn			125	1.00		5	20
					50	370	2037

Source: PSL/NMEI Data File, 1980

2.2 Area Development Plans

2.2.1 State Geothermal Planning Areas

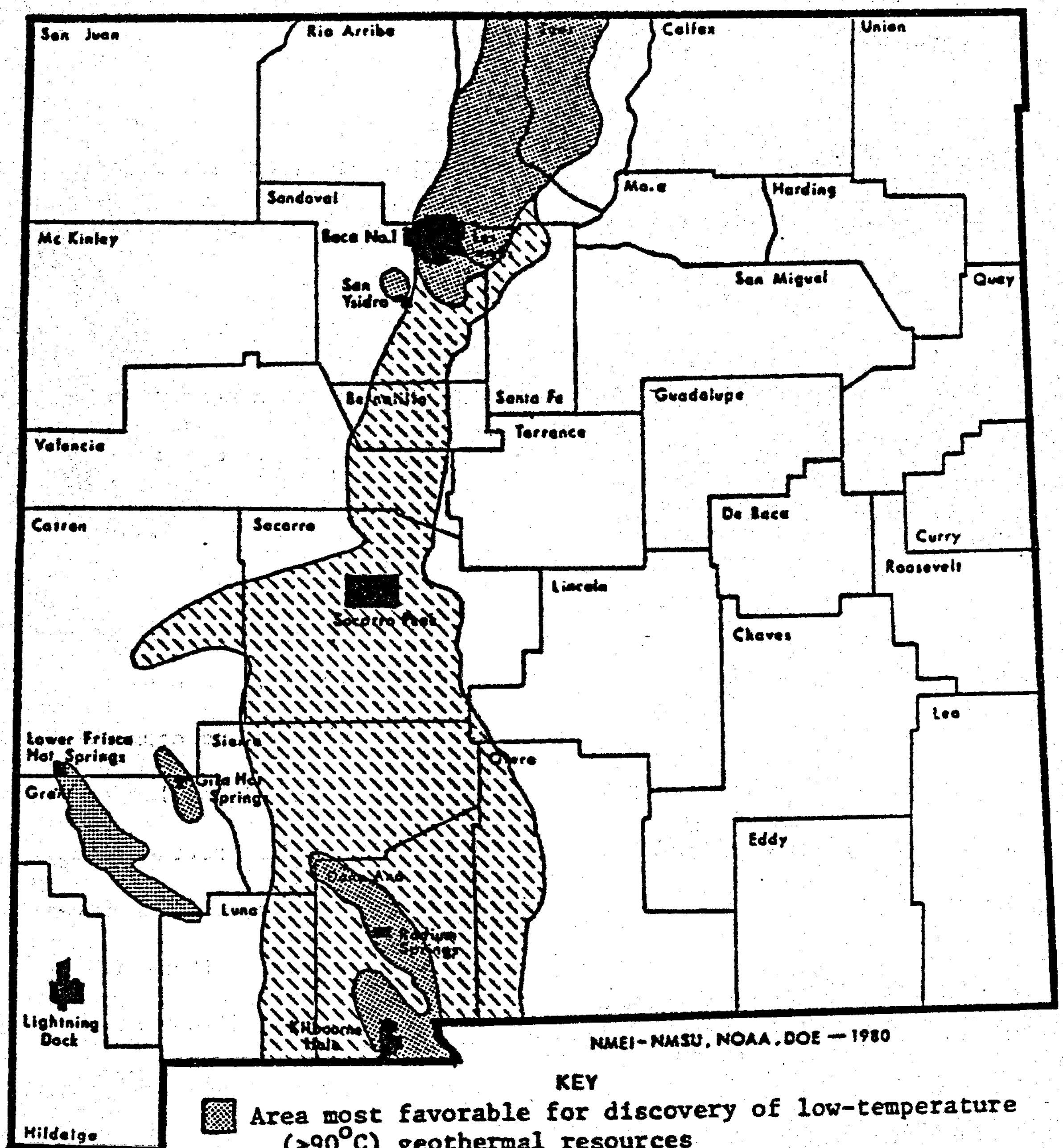
The New Mexico State Team has defined 1 (one) substate geographical area for which the development and utilization of geothermal energy prospects are likely between now and the year 2020.

The first-priority target areas for development planning are centered on the Rio Grande River Valley throughout its entire length within the state.

2.2.2 Specific Area Development Plan: Dona Ana County

This county is emerging as the first area of intense study and planning activity by private and government entities. The strong local interest and community leadership shown for geothermal energy for economic considerations plus the adjacent overflowing economic growth pattern of El Paso, Texas provides the basis of selection for the area development plan. A number of research investigations of the geothermal potential here have been conducted. There are two KGRA's in the county: Radium Springs and Kilbourne Hole. The Kilbourne Hole KGRA, located next to the U.S. - Mexico border, and Radium Springs, KGRA have potential electrical generation capacity.

The Dona Ana Area Development Plan involves first, the investigation of the area attributes such as geography, population, economy and attitudes of the residents. Second, the energy demands of the area were considered for both current and projected needs by the Standard Industrial Code and fuel types. Third, the current and future geothermal energy development is described.



GEOTHERMAL RESOURCES OF NEW MEXICO

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

A possible schedule of activities has been estimated. It should be kept in mind that actual development is entirely dependent on the actions of the entrepreneurs.

Outside the Baca Location, Dona Ana County has the second largest geothermal heat potential in the state.

The county has numerous hot water wells and hot springs in addition to the two KGRA's. The geothermal potential considering all sites is 0.9899 Quad BTU's for 30 years for direct thermal use.

Dona Ana County is one of the fastest growing areas in the state. The total county population is about 80,000 and the Las Cruces SMSA stands at about 51,000. Both the expanding industrial and governmental sectors are contributing to a robust economy in the county.

To a great degree, large-scale greenhouse operations are very suitable to conversion with the use of heat from geothermal water depending on the resource and the location.

2.3 Site Specific Development Plans

2.3.1 Candidate Geothermal Sites

The specific resource sites and energy applications (residential, commercial, industrial, and agri-business) which are candidates for the SSDP are identified and briefly described as follows:

Animas/Lightning Dock

Current Application: Space-heating of 1 house

2 geothermally heated greenhouses with total 130,000 square feet. Geothermal irrigation and soil warming system for fruit orchard.

Anticipated Application: Additional 500,000 square feet area of geothermally heated greenhouse. Site of DOE's 1979 AET grant in Region 6 of $20,000 to Tom McCants.

Resource Data:	Surface Temperature	102°C
	Subsurface Temperature	144°C

Estimated Energy Potential: 7,849 x 10^{-8} quad

Estimated Reservoir Size: 3.3 km^3

Las Alturas

Current Applications: Space-heating of President's House/University Center of New Mexico State University and source of domestic water supply for Las Alturas subdivision.

Anticipated Application: Space heating: Sandyland greenhouse, NMSU campus, land development subdivision district heating.

Resource Data:	Surface Temperature	48°C
	Subsurface Temperature	120°C

Estimated Energy Potential: .0056 quad

Estimated Reservoir Size: 6.0 km^3

Truth or Consequences

Current Applications: Several resort spas, bathhouses and pools, spaceheating of Yucca Lodge. Preheated boiler feedwater and hot-water supply for Carrie Tingley Hospital, plus the geothermal therapeutic pools.

Anticipated Application: Spaceheating of senior citizens center, Yucca Gardens condominium building complex and commercial buildings.

Resource Data:	Surface Temperature	45°C
	Subsurface Temperature	100°C

Estimated Energy Potential: 7.2×10^{-11} quad

Estimated Reservoir Size: 1.0 km^3

Albuquerque

Applications: Current: Heat pump spaceheating of nine-story office building (Sandia Savings).

Projected: Large user spaceheating: West Mesa Airport, West Mesa High School, U of A campus pre-heat boiler system, district heating of future subdivisions on the West Mesa.

Resource Data: Surface Temperature 27°C

Subsurface Temperature N/A

Estimated Energy Potential: 0.004 quad

Estimated Reservoir Size: 3.0 km^3

Jemez Springs

Current Application: Bathhouse, greenhouse spaceheating

Projected Application: Spaceheating of village municipal buildings

Resource Data: Surface Temperature 73°C

Subsurface Temperature 103°C

Estimated Energy Potential: 0.0206 quad

Estimated Reservoir Size: 3.3 km^3

2.4 Time Phased Project Plan

2.4.1 Active Demonstration/Commercialization Projects

There are 9 geothermal developments in the state that are currently active demonstration and commercialization projects. All of these projects are considered to be candidates for the time-phased project plans.

Of those projects, 6 are demonstration projects that were initiated by the New Mexico Energy and Minerals Department and cost shared with federal and private funding sources.

1. Carrie Tingley Hospital at the City of Truth or Consequences. This is a geothermally preheated hot water system designed, installed and operated by the BDM Corp. The project utilizes an old active well system that provides natural hot water for the hospital's two therapeutic pools. The project commenced on March 1, 1980 and began operations with a ribbon-cutting ceremony on September 18, 1980. The system was monitored until June 31, 1981. The capacity of the system is equipped to handle 170,350 liters of continuously pumped well water (43°C) which contains a useful heat content of 12,000 BTU/min. Due to the relocation of hospital operation to Albuquerque, the geothermal system, as well as the physical plant, is inactive until the property is sold and operations restarted.

2. University President's House/University Center, NMSU, Las Cruces. This is a space-heating project for the residence for which a well has been

drilled into the Los Alturas Geothermal Anomaly which underlies the residence. The space-heating system uses 50°C water from a depth of 137 meters (450 ft.) at a flow rate of 64.3 liters/min. The project started June 28, 1979, the construction was completed in September 1980, and the residence was occupied in December, 1980. The monitoring and reporting continues 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 l/m 57°C (125°F). The objective is to construct and operate the geothermal greenhouse using runoff water from the hot spring and produce native plants for waste tailings reclamation projects by Kennecott Copper Corporation. This development is being constructed and operated by handicapped labor from the Southwest Services for Handicapped Children and Adults which owns the greenhouse. Initiation of this project was on June 18, 1979 and is completed at this writing. The project contract ends December 31, 1981.

4. City of Truth or Consequences Senior Citizens Center. This is a retrofit space-heating project which will tap the underlying artesian themal water basin under the city. The well water temperature in the area averages 43°C. The attempt to get geothermal water was unsuccessful when a 250 foot dry well was drilled on city property. An existing old well was connected to the city's Senior Citizens Center to supply up to 100,000 BTU/hr during peak demand period. The complete design, installation and monitoring of the spaceheating system was completed by February 1981. The project was commenced on June 28, 1979 and will terminate December 31, 1981.

5. Solar-assisted geothermal greenhouse, Taos. The resource is the Ponce de Leon Hot Springs near Ranchos de Taos. The springs discharge 1,305,977 liters per day at 35°C at an elevation of about 2,256m. The project will analyze and determine the use of a geothermal heat recovery system to provide thermal energy for greenhouse spaceheating for growing cash crops (for 5,574m^2) and other commercial processes. This project uses technology transfer from power plant waste heat recovery and is 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.

6. L'eggs Products, Inc., Mesilla Park. This project evaluated the potential resource and the engineering for bringing geothermal energy on line for industrial process at the hosiery manufacturing plant. A 1,800 feet test well was drilled on the plant site on May 12, 1980. No appropriate resource was found but a warm bottom hole temperature of 32°C was encountered and there was a noticeable increase in temperature gradient near the bottom hole. It was determined from a series of economic and engineering studies that the development of a deep resource would not be economically suitable for the company's requirement and needs.

With the exception of some aged hot spring resort spas, most private business enterprises utilizing geothermal energy in the state started in the 1960's. The most significant developments are listed here:

1. Baca Location geothermal power plant demonstration program, Jemez Mountains. The resources of the project area inside the Valles Caldera include both a liquid and vapor-dominated reservoir. 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. The main production and injection zone is the lower Bandelier Tuff; the upper Bandelier forms the caprock. Since the first geothermal well was acquired in 1963, Union Geothermal of New Mexico has drilled 23 wells and probably 10 to 15 more wells may be needed for the proposed 50 MWe plant. Final approval of the environmental impact statement was made in May of 1980. Authorization for construction is still pending from the Public Service Commission and additional water rights are needed from the State Engineer's Office before construction can begin.

2. The Animas Valley geothermal greenhouses. Operators: Tom McCants and Dale Burgett. The two commercial operations are described together because of the same underlying resource, identical characteristics, energy-use applications and geothermal energy-requirements.

The resource is the "Animas hotspot", a very shallow anomalous aquifer, where abundant water of 102°C (215°F) is obtained at depths of less than 29 meters. The thermal anomaly has no surface manifestations and it is very geophysically conspicious in a 1 square mile section. This apparently is a fault-controlled feature adjoining a sediment-filled basin.

The 2 greenhouse operations overlying the thermal anomaly use 3600 BTU/min and 1700 BTU/min with no thermal drawdown. The thermal capacity is used for the production of various high-price floral plants particularly roses.

3. Geothermal heat pump system of Sandia Savings Building, Albuquerque. Two aquifers, at 90' and 270' deep, supply cool and warm waters according to

the seasonal demand. Two wells are involved in this operation. The shallow well supplies cool water with a temperature range from 17°C to 21°C (60° to 70°F). The deeper well supplies warm water at 26° to 27°C. 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/h and cooling requires 3,467,182 BTU/h. (Hatton, 1977).

2.5 State Aggregation of Prospective Geothermal Utilization

Estimates are made of the total geothermal energy on-line for the planning area as a function of time.

Possible Economical Geothermal Energy On-Line (10^{12} BTU)

(Data Source PSL/NMEI Data File, 1980)

ADP	1985	1990	2000	2020
#1	2.47	8.09	23.0	48.7
2	0	0	0.77	0.81
3	1.87	5.37	13.13	26.1
4	0.72	1.79	2.47	3.22
5	0	0.89	4.43	6.99
6	0	0	0	0
7	0.65	4.38	11.40	23.2
8	0	0	0	0

ADP KEY

1. Dona Ana County
2. Albuquerque Area - Bernalillo, Torrance and Cibola
3. Los Alamos, Rio Arriba, Sandoval, Santa Fe and Taos
4. Sierra and Socorro
5. Catron, Grant, Hidalgo, and Luna
6. Chaves, Eddy, Lea, Lincoln and Otero
7. McKinley, San Juan, and Valencia
8. All northeastern counties

2.6 Institutional Analysis

2.6.1 Overview of State Legislation

Legislation regarding regulatory conflicts, geothermal leasing, and district heating authority was not feasible during the 1980 legislative session due to the administrations reluctance to put substantive issues on the call.

It is possible that some difficulties in the relationship between appropriate rights and correlative rights for geothermal resources may potentially be resolved through administrative action.

The district heating legislation and amendments to state geothermal leasing policies may not be examined until the 1982 session.

A review of state statutes and extensive discussions and correspondence with Steve Reynolds and D.E. Gray, who have been extremely receptive and helpful in this review, yielded these salient findings:

With the assistance of the state engineer's office and the NUSL, the following findings were made:

- 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, this may be achieved through conditions placed on geothermal fluid appropriations which waive prior rights protection vis-a-vis other geothermal appropriators.

- The State Engineer's jurisdiction does not extend outside of declared groundwater basins. The appropriative rights/correlative rights conflict therefore cannot be resolved in these areas by means of conditions 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 2500 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, and it 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 geothermal demonstration projects. The stipulation is made that awards be made only on the basis of equally matching funds from private or federal sources.

2.7 Public Outreach Program

The goal of this program is to increase awareness and acceptance of geothermal energy and to promote the use of our geothermal resources by industry, commerce, agriculture and government. This program is designed to expedite the direct applications of geothermal energy by 1) identifying geothermal application concepts 2) potential resource end-users 3) identifying potential funding for end-users serving a broker function between end-users government and private developers and 4) providing engineering and technical assistance to potential end-users.

2.7.1 Outreach Mechanisms

The New Mexico Outreach Program is oriented primarily to assisting selected potential end-users who were identified either in the early planning work of the state's O/R geothermal energy development or through the completed marketing analysis, referred to as the "New Mexico Assessment of the market potential of Geothermal Energy". These potential end-users were selected on the basis of their energy consumptions, need for alternative source of energy supply, energy-use planning attitude, and enthusiasm. More technical assistance requests were generated through this marketing survey project than all of the other outreach mechanisms combined. Each case is handled with individual meetings to define the problems, goals and needs, and then usually followed up with mini-economic and engineering studies. A literature search of technical equipment is sometimes made or information of various types on consultants may be supplied according to the requestor's needs.

The other outreach mechanisms are:

- State EMD research and development program
- DOE Region 6 Appropriate Energy Technology Small-Grants Program
- State Geothermal Demonstration Program
- Energy Extension Service
- New Mexico Energy Institute/NMSU
- DOE Technical Assistance Program

The New Mexico R&D program has spent approximately $1.7 million for geothermal research and development. Geophysical and engineering projects have been funded by R&D funds and this source of funding has generated numerous contacts and projects in New Mexico.

The geothermal team reviews geothermal proposals, makes staff recommendations to the R&D Review Board, monitors funded projects and transfers the technology developed under R&D to the citizens of New Mexico.

The appropriate energy technology small-grants program is another area where state team has provided help through information dissemination on the program and its application procedures. Critical review and recommendations were provided to the NM Energy and Mineral Department, the participating agency for DOE in this state.

In 1979, New Mexico awarded $200,000 to six contractors for geothermal space-heating demonstrations. These demonstration projects are New Mexico's way of leading by example and they are our announcement that New Mexico has viable geothermal resources that can be developed now.

In November, 1980, a call for proposals was issued by EMD for demonstration projects to be cost-shared with the state's $600,000 demonstration program. In January, the R&D committee reviewed 5 applications that were received by the deadline of Monday, January 5. On the basis of recommendations from the R&D review committee, EMD made one award in April to Sandyland Nurseries for a $175,000 drilling program.

Demonstration monitoring is continuing on the construction, operation and evaluation of the six projects and eventually the information and experience will be transferred to the public and to potential developers. The demonstrations also offer the monitor the opportunity to assist developers in administrative and permit procedures and thereby gaining practical experience that will be useful to future developers.

The geothermal team has worked with the Energy Extension Service to transfer to the public, updated information and materials on geothermal energy relating to resource availability, space-heating, agricultural applications, industrial uses and commercial applications.

The DOE technical assistance program is generating much interest among potential users by encouraging serious planning and development of a prospective application. The first TA request came from Mr. Karl Kortimeir of Truth or Consequences and the subcontract was awarded to Mr. Kelly Summers, a consulting hydrologist.

2.7.2 Summary of Contact and Results

All of the contacts made this past year 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 the viability of geothermal as an alternative energy resource. New Mexico now finds itself in a position of not only having five active demonstrations but also having an acute interest in geothermal shown by a broad spectrum of our community.

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 has been actively developing and constructing the drilling for geothermal system on the campus. The university has successfully completed several wells and obtained state and DOE financial assistance for the campus domestic hot-water heating system. This system will be on-line in February of 1982.

EMD personnel have been working with community leaders in Dona Ana County to identify potential users. Initial information has furnished prospects in the areas of space-heating for a retirement center, a city hospital, apartment complex, greenhouse operations, process heat for a pet food processor, and geothermal application for some dairies.

All in all, New Mexico's geothermal future continues to be bright and its activity is increasing. The EMD is taking a very active role in geothermal R&D, demonstration, outreach and commercialization and this effort should expedite development.

3.0 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

The following are the State Team's findings and recommendations:

1. Outreach effort has increased substantially and has raised the geothermal profile.

2. New Mexico's Research and Development fund has had a substantial impact on geothermal development, technology transfer, and outreach.

3. New Mexico's Geothermal Demonstration Program has provided the biggest boost to geothermal development and the $200,000 appropriation has been developed into six projects valued at more than $500,000. The new $600,000 appropriation has generated one project and more are expected in the near future.

4. The determination and delineation of potentially commercial resources should be improved and refined.

5. Specially trained and experienced geothermal personnel should be made available to the states for 30-90 days to assist the states in organizing and enhancing their operations. Examples: resource planning, well drilling, contracting, electrical generation, space-heating engineering.

6. State and Federal agencies have to realize that loan guarantees address a symptom not the illness. Major technical efforts must be made to reduce geothermal risks by improving the technology, especially technologies associated with exploration, well drilling and reservoir identification. Prime emphasis must be placed on reducing or eliminating the huge risk associated with "first holes." This program must have provision for many initial wells, and have maximum access by small and medium-size energy users.

REFERENCES CITED

- Hatton, Kay, 1970. Report to the State Legislature Regarding Senate Joint Memorial No. 2: Feasibility of Heating and Cooling of the State Capitol Complex and other state-owned institutions with geothermal energy.

- PSL/NMEI Data File, 1980. DOE Regional Geothermal O/R Project Database on New Mexico resources.

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

TABLE A-1

TOTAL ACREAGES OF GEOTHERMAL LEASES - NEW MEXICO

Federal Leases	
Total Acreages of Competitive Lease in KGRA's: (51 Leases)	87,540
Total Acreages of Non-competitive Leases: (72 Leases)	138,170
State Leases	
Total Acreages of State Leases: (41 Leases)	13,210
TOTAL OF ALL ACREAGES LEASED	238,920

TABLE 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 Springs, KGRA, T21S, R1W	02/01/78 ($8.29)
Anadarko Production	18,476.45 (9)	Kilbourne Hole, KGRA, T27 & 28S, R1W	07/01/75 ($10.06- ($30.50 & $10.63)
Chevron USA	2,198.48 (3)	Radium Springs, KGRA, T21S, R1W	12/01/77 & 12/01/78 ($30.50 & $10.63)
N.K. Hunt	360.00 (2)	Radium Springs, KGRA, T21S, R1W	12/01/78 ($56.00)
HIDALGO			
Amax Exploration	6,580.43 (3)	Lightning Dock, KGRA, T25S, R19 & 20W	Various ($3.13, $8.11 and $13.07)
Aninoil USA, Inc.	1,271.64 (1)	Lightning Dock, KGRA, T25S, R19W	01/01/77 ($1.99)
J.E. Blakenship	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 Co.	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 & $5.31)
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 Hatton, Kay, 1980

TABLE 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	06/11/75
C.L. Hunt	13,730.68 (6)	T27S, R1 & 2W & T20S & 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

TABLE A-3 (Cont'd)

FEDERAL ACTIVE NON-COMPETITIVE GEOTHERMAL LEASES - NEW MEXICO

COUNTY & LESSEE	SIZE, ACRES & (NO. OF LEASES)	LOCATION	DATE ISSUED
HIDALGO (cont'd)			
Sun Oil Company	1,280.00 (1)	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	05/29/75
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
SIERRA			
Fluid Energy Corp.	12,182.93 (5)		

TABLE A-4

STATE LEASES - NEW MEXICO

COUNTY & LESSEE	SIZE, ACRES & (NO. OF LEASES)	DATE ISSUED
Chevron	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

Source: New Mexico State Land Office

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	• Private Consultant on geothermal greenhouses
American Ground-water Hydrologists Contact: Dr. William Turner 2300 Candelaria Road, NW Albuquerque, NM 87107	(505) 345-9505	• Geothermal exploration & geothermal resource suitability surveys
G.A. Baca and Assoc., Ltd. 330 Garfield St. 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, NM 87106	(505) 848-5302	• Project design engineering and management • Designed system for Carrie Tingley Hosp. • Engineers & scientific planning services.
Bridgers & Paxton Consulting Engineers, Inc. Contact: Mr. Frank H. Bridges 213 Truman Street, NE Albuquerque, NM 87108	(505) 265-8577	• Heat pump specialists • Designed systems for Albq. 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 years experience in materials and system use of hot springs water at Gila H.S.
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 W. Griggs Las Cruces, NM 88001	(505) 526-3221	

CONSULTANTS/CONSULTING FIRMS (Cont'd.)

Name	Phone	Remarks/Expertise
CH2M Hill Engineers • Mr. Bob Dart P.O. Box 22508 Denver, CO 80222	(303) 771-0900	• Engineers, planners, economists & scientists
• Mr. John Austin Box 8748 Boise, Idaho 83707	(208) 345-5310	• Consultant on Boise Idaho District Heating Project
• 3620 Wyoming Blvd NE Albuquerque, New Mexico	(505) 292-1262	
Coonce, C. A. & Associates Contact: Mr. Pat Coonce 12324 Pineridge, NE Albuquerque, NM 87112	(505) 296-1089	• Water system engineers
Coupland and Moran Associates Contact: Mr. Dan Romero Electrical Engineer 200 Altez, SE Albuquerque, NM 87123	(505) 296-5573	• Electrical & mechanical engineering
Cunniff, Mr. Roy State Geothermal Prog. Coordinator Physical Science Laboratory Box 3-PSL NMSU Las Cruces, New Mexico 88003	(505) 522-9349	• Private Consultant • PI on NMSU campus space-heating project • Technical Advisor for all state demonstration projects
DuMars, Charles Dr. 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, NW Albuquerque, New Mexico	(505) 898-8000	
Energetics Corporation Contact: Mr. L. Dale Clark, Pres. 833 E. Arapaho Road, Suite 202 Richardson, Texas 75081	(214) 783-4731	
Energy Resources Exploration, Incorporated Contact: Mr. Bob Grant 9720 Candelaria, NE Suite D Albuquerque, NM 87112	(505) 296-6226	• Geologist

CONSULTANTS/CONSULTING FIRMS (Cont'd)

Name	Phone	Remarks/Expertise
Gebhard Thomas Mr. Private Consulting Engineer 5819 Westmont Drive Austin, Texas 78731	(512) 4535577	• Planning & feasibility studies
GeoProducts Corporation Contact: Mr. Kenneth Boren, Pres Oakland, California 94612	(415) 893-8365	• A resource developer using hybrid concepts with biomass.
GeoThermal Services, Inc. Contact: Mr. Barry Williams, Project Supervisor 10072 Willow Creek Road San Diego, California 92131	(714) 566-4520	• Heatflow and gradient hole drilling • High temperature geophysical logging • Geothermal consulting
Goodrich, Mr. James L. Goodrich - Bartlett & Associates 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 Hwy, 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	• Private consultant • 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	

CONSULTANTS/CONSULTING FIRMS (Cont'd)

Name	Phone	Remarks/Expertise
Mancini, Dr. Thomas Mechanical Engr. Dept. 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., NE Suite 398-W Albuquerque, New Mexico 87110	(505) 881-0991	
Republic Geothermal, Inc. Contact: Mr. Gerald Huttrer, Mgr. Exploration P.O. Box 3388 Santa Fe Springs, CA 90670	(213) 945-3661	
Shain, Joe Engineers 1519 Pacheco Santa Fe, New Mexico 87501	(505) 983-1297	
Solar America, Inc. Contact: Mr. David Chavez 2620 San Mateo, NE Albuquerque, New Mexico 87110	(505) 883-0959	• Project design, engineering and management for geothermal greenhouses
Summers, W.K. & Associates, Inc. Contact: Mr. W.K. Summers President & Senior Geologist P.O. Box 684, 904 Cuba SE 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	
Application Center Contact: Mr. Jerry Yowell 2500 Central Avenue, SE Albuquerque, New Mexico 87131	(505) 277-3622	• Conducted state energy consumption study for New Mexico

CONSULTANTS/CONSULTING FIRMS (Cont'd)

Name	Phone	Remarks/Expertise
WESTEC Services, Inc. Contact: Mr. Peter Sherwood, Regional Manager 505 Marquette Avenue, NW 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 production.
Western Energy Planners, Ltd. Contact: Mr. Jerry Tuttle 11000 Candelaria NE, Suite 112W Albuquerque, New Mexico 87112	(505) 296-4070	• Energy systems including economic & engineering systems

New Mexico Geothermal Commercialization Interest

RESOURCE DEVELOPERS (EXPLORATION AND LEASE-HOLDERS)

Name	Phone	Areas of Interest
AMAX Contact: Mr. Dean Pillsington or Mr. Harry Olson 7100 W. 44th Ave. Wheat Ridge, Colorado 80033	(303) 420-8100	• Rio Grande Rift • Animas Valley • Valles Caldera
American Drilling & Grouting Co. Clinton, Mississippi		• Dona Ana County
Aminoil USA, 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) 526-1404	• Drilled wells on land he owns at Radium Springs. Wants resource user.
Chaffee Geothermal, Ltd. Contact: Mr. Jay Dick, Mgr. 1776 S. Jackson, Suite 1000 Denver, Colorado 80210	(303) 692-9496	• Las Cruces/Las Alturas anomaly
Calvert Exploration Co. 1000 City Center Bldg. Oklahoma City, OK 73102	(405) 239-6251	
Chevron Resources Co. Contact: Mr. Eric Layman P.O. Box 3722, 595 Market St. San Francisco, California 94119	(415) 894-2889	• Radium Springs • Socorro • Lordsburg-Animas
Earth Power Corp. 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 & LEASE-HOLDERS) (Cont'd.)

Name	Phone	Areas of Interest
Geoproducts Corporation Contact: Mr. Kenneth Boren, Pres. 1330 Broadway Oakland, Calif. 94612	(415) 893-8365	• Medium to low temperature resource developer • hybrid geothermal - wood residue electrical generation - ethanol production
Gulf Mineral Res. Co. 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 Bldg. 1401 Elm Street. Dallas, Texas 75202	(214) 748-1300	• Radium Springs • Kilbourne Hole
McCulloch Geothermal Corp. 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 Co. Contact: Mr.Richard Lenzer P.O. Box 239 Salt Lake City, Utah 84110	(801) 364 2083	• Lightning Dock KGRA
Southland Royalty Co. Contact: Jere Denton 1000 Ft. Worth Club Tower Fort Worth, Texas 76102	(817) 390-9200	• Radium Springs • Las Cruces
Sunoco Energy Dev. Co. Contact: Mr.John Knox 12700 Park Central, P.O. Box 9, Suite 1500 Dallas, Texas 75251	(214) 233 2600	• Jemez Mtns.
Texaco, Inc. Coal & Energy Resources Contact: Mr. Russ Criswell P.O. Box 2100 Denver, Colorado 80201	(303) 861-4220	

RESOURCE DEVELOPERS (EXPLORATION & LEASE-HOLDERS) (cont'd)

Name	Phone	Areas of Interest
Thermal Power Co. Contact: Mr. Louis de Leon 601 California St. San Francisco, California 94108	(415) 981-5700	• Socorro Peak KGRA
Union Geothermal of New Mexico Contact: Mr. Richard O. Engebretsen P.O. Box 15225 Rio Rancho, New Mexico 87174	(505) 897-1776	• Developer of the Baca Geothermal Electric Power Generating Project

PRIVATE AND COMMERCIAL USERS (CURRENT OR POTENTIAL)

Name	Phone	Remarks/ Areas of Interest
AMDEC Corp. (formerly under Western Development Corp.) Las Cruces, New Mexico 88001		• Large home developer seeking potential district heating system for subdivision: High Range Home (atop the Las Alturas anomaly
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, Randy Inc. Building Contractor T or C, New Mexico	(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 Pl. N.W. Socorro, New Mexico 87801	(505)835-3979	
Burgett Floral Co. 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 Rt. 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, Mgr. 1776 S. Jackson, Suite 1000 Denver, Colorado 80210	(303) 692-9496	• Las Cruces/Las Alturas anomaly
Chino Greenhouses, Inc. Contact: Mr. Brian Fritz 1235 Urania Ave. 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/ Areas of Interest
Clemens, Mr. Clifford R. 221-25 Manor Road Queens Village, New York 11427		• Resident atop the Los Alturas 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		• Los Alturas anomaly
Kilde, Dale Lang Corp. P.O. Box 2125 Gallup, New Mexico 87301		• Construction 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 recepient 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 Co. Contact: Mr. George Mauro P.O. Box 468 Ojo Caliente, New Mexico 88054		• Seeking capital venture and technical assistance for retrofit space-heating

Name	Phone	Remarks/ Areas of Interest
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 • To relocate in Dona Ana County
Roses, Incorporated Contact: Mr. James C. Krone Executive V.P. 1152 Haslett Road Haslett, MI 48840	(517) 339-9544	• National clearinghouse for rose growers • Researching geothermal energy option for its members
St. Ann's Hospital Contact: Ms. Dee Rush Administrator 800 E. Ninth Truth or Consequences, New Mexico 87901		• Prospect for retrofit space-heating
Sandyland Nurseries Contact: Mr. Frank Cobb, President P.O. Box 546 Mesilla Park, New Mexico 88047	(505) 523-8621	• 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 W. College Ave. Silver City, New Mexico 88061	(505) 388-1976	• Faywood Hot Springs greenhouse state demonstration proj.

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

Name	Phone	Remarks/ Areas of Interest
Tellyer Development Co., 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, NM 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 E. 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 Corp. 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 N. Austin Ave. 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 Co. Inc. Department G 170 Great Neck Road Great Neck, New York 11021	(800) 645-3757	
Industrial Systems Corp. 1025 Lake Road Medina, Ohio 44256	(216) 725-8500	
Patterson Kelly Co. Divisions of HARSCO Corp. 115 Burson Street East Stroudsburg, Penn. 18301	(717) 421-7500	
Process Equip. Supply Salt Lake City, Utah	(801) 278-9944	
Skyline Sales Co. Salt Lake City, Utah	(801) 486-7114	
Trawter Inc. Texas Division P.O. Box 2289 Wichita Falls, Texas 76307	(817) 723-7125	

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 Ass.
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, NE Albuquerque, New Mexico 505 265-3381)		

Low Temperature Electrical Generation

Name	Phone	Remarks
Barber-Nichols Engineering Co. 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, President 7714 Laurel Suite 2 Cincinnati, Ohio 45243	(513) 271-7001	

Pipe & Fittings

Name	Phone	Remarks
Albuquerque Heating & Plumbing Company Contact: Mr. Gene Stalen Albuquerque, New Mexico		

SUPPLIERS (CURRENT AND PROSPECTIVE) (Cont'd.)

Pipe & Fittings (Cont'd.)

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
Mansville, John Sales Corp. P.O. Box 14624 Albuquerque, New Mexico 87111	(505) 294-1158	• Fittings - John Bell, Kernco Inc Albuquerque, NM
Perma Pipe (BHT Engineering Co. Inc) 1218 Wyoming El Paso, Texas 79902	(915) 533-1231	

Pumps

Name	Phone	Remarks
Alpha Southwest, Inc. 205 Rossmoor Road, SW Albuquerque, New Mexico 87102		
Berkeley Pumps Rodgers & Company, Inc. 2615 Isleta Blvd, SW Albuquerque, New Mexico 87105		
Centerlift, Inc. 5421 Argosy Avenue Huntington Beach, Calif. 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 No. Copia El Paso, Texas 79927	(915) 562-3785	
Gould Water Systems Lucas Drilling Company 10058 Northloop El Paso, Texas 79927		

SUPPLIERS (CURRENT AND PROSPECTIVE) (Cont'd.)
Pumps (Cont'd.)

James, Cooke & Hobson Inc.
2817 E. Yandell
El Paso, Texas 79925

TP Pump & Pipe Company
1842 Two NW
Albuquerque, New Mexico 87102

TRW Reda Pumps (505) 325-4648
Contact: Mr. Jim Rosser
P.O. Box 131
Farmington, New Mexico 87401

Turbines & Power Systems

Name	Phone	Remarks
Barber-Nichols Engineering Co. 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

5/81

NORTH DAKOTA GEOTHERMAL COMMERCIALIZATION PROJECT

SEMI-ANNUAL PROGRESS REPORT

JANUARY-JUNE, 1981

Prepared by

Bruce A. Gaugler, Program Coordinator
Jill D. Ritz, Writer/Editor

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

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose of Project

The North Dakota Geothermal Commercialization Project was established as a cooperative effort between the United States Department of Energy (DOE) and the State of North Dakota to stimulate the commercialization of geothermal energy in the state.

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.

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.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

North Dakota has a tremendous store of geothermal energy. Many of the aquifer systems that underlie the state are good sources of low to moderate temperature geothermal fluids, suitable for space heating and cooling, agricultural uses, and low temperature industrial processes. The temperatures of North Dakota's geothermal fluids are not presently considered adequate for electrical generation; however with the development of the Rankine cycle engine, this may soon change.

Both the United States Geological Survey and the North Dakota Resource Assessment Team are compiling hydrothermal data for the state. The United States Geological Survey is summarizing the depth, temperature, and water quality data for all major Mesozoic and Cenozoic aquifer systems. The data are not expected to be published until late 1981, but information is currently available to the state commercialization team on a site specific basis.

During Phase II of their evaluation of the state's hydrothermal resources, the North Dakota Resource Assessment Team concentrated on obtaining data and evaluating potential hydrothermal aquifers of Mesozoic and Cenozoic age, with particular emphasis on the Cretaceous Inyan Kara Formation. The results of these studies are detailed in the report, "An Evaluation of Hydrothermal Resources of North Dakota: Phase II Final Technical Report." The report is available from the University of North Dakota, Engineering Experiment Station, Grand Forks, ND (Bulletin #81-05-EES-02).

The Inyan Kara Formation is a widespread aquifer of moderate depth (fig. 1). Although no reliable temperature data are available for this formation, it is likely to be an important hydrothermal aquifer in much of North Dakota. In general, the total dissolved solids in the formation water range from about 2000 mg/l in the southeast part of the state to about 14,000 mg/l in the western part of the state.

During Phase III of their study, the Resource Assessment Team will be evaluating two other potential hydrothermal aquifers--the Fox Hills and Hell Creek formations of Mesozoic Age. They also plan to assemble a user-oriented catalog of data collected during their studies of potential hydrothermal aquifers.

Using information available from the United States and North Dakota Geological Surveys and the North Dakota State Water Commission, the state commercialization team has conducted a detailed analysis of the depth, temperature, and water quality data for the major aquifer systems in the Lewis and Clark 1805 Region. This report is included in the area development plan, "Geothermal Energy Development Potential in Lewis and Clark 1805 Region, North Dakota."

As part of their Phase II activities, the Resource Assessment Team's field crews ran temperature logs in suitable groundwater observation holes and in two "holes-of-convenience" drilled by other agencies or interests, which were cased as heat-flow determination sites. During Phase III, the Resource Assessment Team will attempt to gain access to several additional holes-of-convenience into or through the Cretaceous shales. The results of this examination will indicate heat-flow patterns over the state.

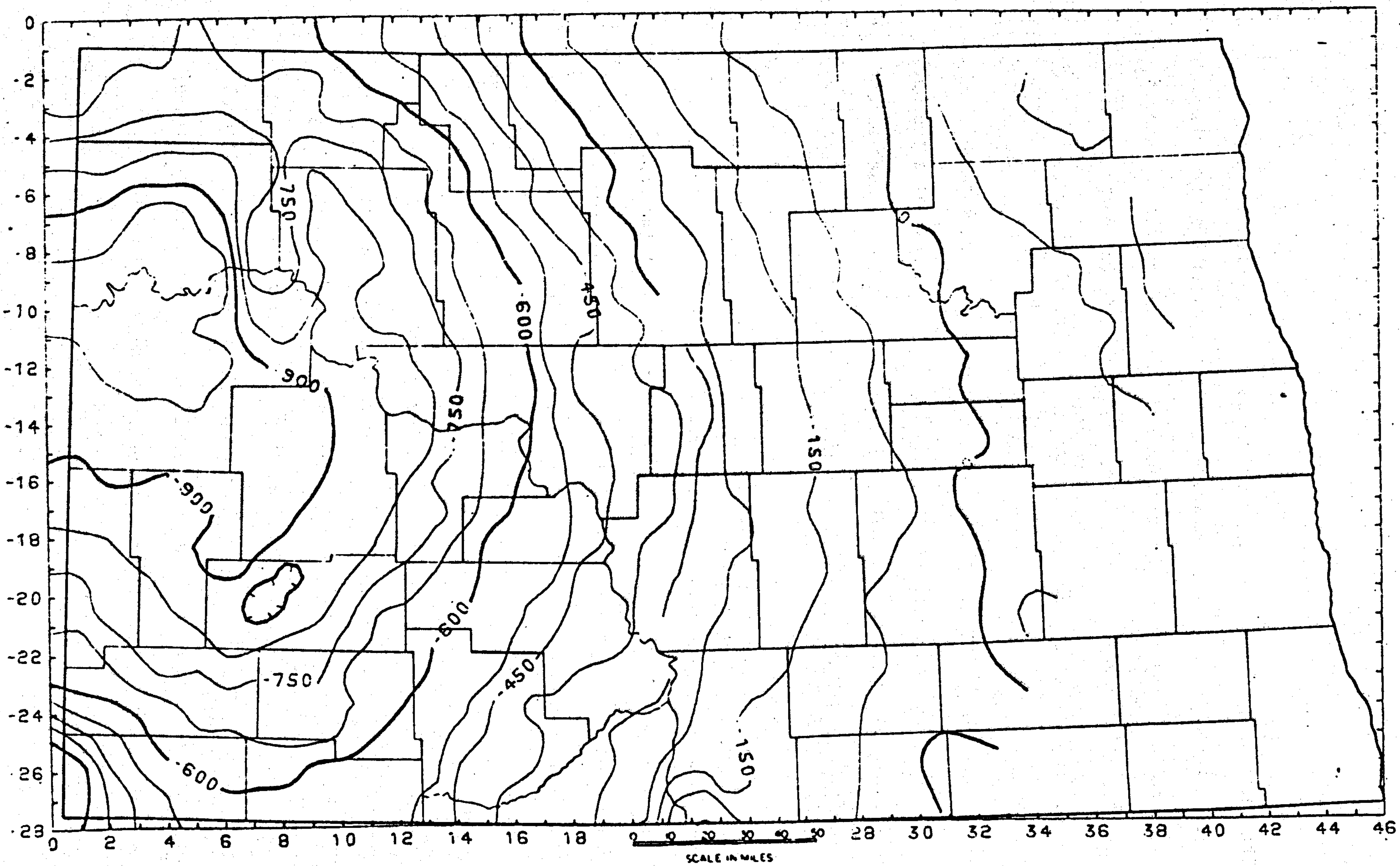


FIGURE 1 - STRUCTURE MAP ON TOP OF THE CRETACEOUS INYAN KARA FORMATION. CONTOUR INTERVAL IS 75 METRES

To date, no leasing of state or federal lands for geothermal exploration has occurred in North Dakota.

2.2 Area Development Plans

2.2.1 State Geothermal Planning Areas:

The state commercialization team has identified eight substate regions for area development analysis. These eight geographic regions coincide with the boundaries of North Dakota State Planning Regions (fig. 2).

Area development plans have been completed for two of the state's planning regions--the Roosevelt-Custer Region and the Lewis and Clark 1805 Region. Since geothermal resources occur in abundance throughout the state and their characteristics are similar, no additional area development plans are anticipated for the remainder of the contract year.

2.2.2 Specific ADPs--Completed or In Preparation:

The Lewis and Clark 1805 Region encompasses ten counties in southcentral North Dakota. Many of the groundwater resources of the region are good sources of geothermal energy. The areal extent of the potential geothermal resources varies from .5 square miles (Glencoe Channel) to 140,000 square miles (Dakota and Madison aquifers). Water temperatures in the alluvial and glacial drift aquifers range from 44° F to 51° F; temperatures in the bedrock aquifers range from 45° F to 200° F. These low to moderate temperature geothermal resources are suitable for a variety of uses, including groundwater heat pump applications, some industrial processes, and agricultural uses.

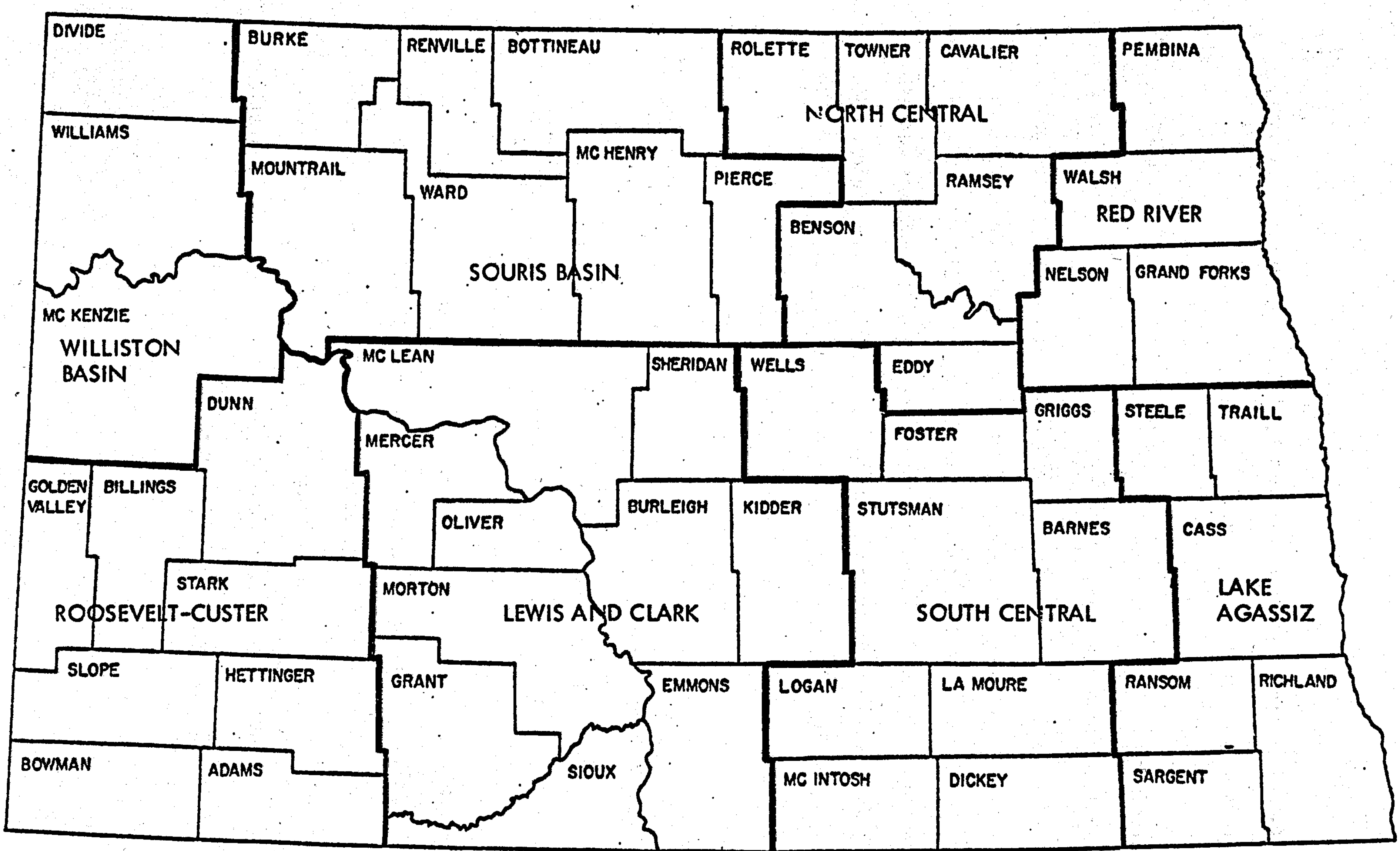


FIGURE 2 - North Dakota Geothermal Planning Areas

Since 1975 the population of the Lewis and Clark 1805 Region has increased 11.6 percent and is expected to continue to grow, in large part because of intensified energy development in western North Dakota. As the population increases, so will demands on fossil fuel sources for industrial processes and space heating and cooling. These limited fuels can in many cases be replaced by geothermal energy, resulting in considerable energy and dollar savings.

Several homeowners in the region have installed groundwater heat pumps for residential heating and cooling. A groundwater heat pump is generally more economical to operate than conventional heating systems, with the possible exception of natural gas. However, many rural areas and small communities in the region do not have natural gas service and must rely on the more expensive energy sources, such as electricity and fuel oil. The recently announced decontrol of natural gas prices may also enhance the economic outlook for converting to geothermal energy.

2.3 Site Specific Development Plans

2.3.1 Candidate Geothermal Sites/Applications:

The specific resource sites that are candidates for site specific development plans are identified in table I.

2.3.2 Site Specific Development Plans--Completed or In Preparation:

Site specific development plans are being prepared for the following projects.

LaMoure

The state commercialization team is analyzing the economic and engineering feasibility of a geothermal district heating and cooling system for downtown

TABLE I

CANDIDATES FOR SITE SPECIFIC DEVELOPMENT PLANS

	Applications		Resource Data		
Location	Current	Proposed	Representative Depth (ft.)	Representative Temp. (^oF)	Aquifer or Formation
LaMoure	None	Residential space heating; commercial district heating and cooling system		45-47 59-60	LaMoure Newcastle
Dickinson	None	Residential space heating; residential and commercial district heating system	500 1800 5225	52 70-72 160	Tongue River Fox Hills/ Hell Creek Dakota
Menoken	None	Industrial processing (concrete products)	300 2900 5400	52 97 120	Fox Hills Dakota Madison

LaMoure in southeastern North Dakota.

The system will utilize groundwater heat pumps to heat and cool the Omega City Shopping Plaza and the city's health care facility. The Plaza is a 30,000 square foot building that houses 16 businesses, and the health care facility provides space for a clinic, dental and optometric offices, and the county nursing services. Both buildings are presently heated with fuel oil.

Menoken

North Dakota Concrete Products manufactures prestressed and preformed concrete products, such as bridge beams and culverts, at its Menoken plant. It ordinarily takes 28 days for a concrete product of this type to "cure" sufficiently to withstand 5000 pounds per square inch of pressure, but North Dakota Concrete Products uses steam heat to advance the curing process and decrease the curing time from 28 days to 24 hours. Their current water supply for the steam process is obtained from a 450-foot well, which penetrates the Fox Hills Formation and provides 52^{o} F groundwater. A fuel oil-fired boiler is then used to heat the water to a usable temperature.

T.P.I., Inc., a Bismarck consulting firm, will be studying the possibility of using warmer water (estimated at 97^{o} F) from the deeper Dakota Sandstone Formation for North Dakota Concrete Products' processing requirements. If the results of this study are favorable, North Dakota Concrete Products also plans to investigate the use of geothermal energy for its Minot and Jamestown plants.

Dickinson

Preliminary reports from the North Dakota and the United States Geological Surveys indicate that the city of Dickinson may have the best potential for the direct use of geothermal energy in the state. The Dakota Group aquifer system in the Dickinson area should yield large quantities of approximately

160° F groundwater.

Dickinson provides an excellent site for a geothermal district heating project. Between 1970 and 1980 the city's population increased 28 percent, and this rapid growth is expected to continue with additional energy production in southwestern North Dakota.

The state commercialization team has initiated contact with Dickinson city officials and state officials to study the feasibility of establishing a district heating system at the "Experiment Station Addition," a 721-lot development on the west edge of the city. Plans will include secondary use of the water for domestic purposes.

2.4 Time Phased Project Plans

2.4.1 Active Demonstration/Commercialization Projects:

Heat Pump Monitoring Program

With funding from the Old West Regional Commission, the University of North Dakota, Engineering Experiment Station, has been monitoring ten heat pump installations (nine residential and one commercial) in the state since November 1980. Nine of the systems being monitored use commercially available groundwater heat pumps; the tenth is a modified air-to-air heat pump.

The following data were obtained during the first four months of the monitoring program:

Monitoring period: 11/12/80 to 3/30/81

Groundwater temperature range: 40° F to 72° F

Energy removed: 156,000 to 342,000 Btu/day

Water usage: 3,768 to 8,325 gallons/day

Electrical consumption for compressor: 3,749 to 6,057 kwh

Coefficient of performance range: 1.8 to 3.1

A few of the systems experienced minor operational problems during this period (e.g., well and plumbing difficulties), which reduced the operating efficiency. The coefficient of performance for the systems that did not experience any problems ranged between 2.6 and 3.1.

The monitoring program will continue through December 1981.

Jamestown District Heating Project

North Dakota's first district heating and cooling project went on-line in early 1981. When completed, the project will consist of nine two-bedroom townhouses. Two of the townhouses have been built, with construction of the remaining seven units scheduled for late 1981.

Each townhouse is equipped with a non-reversing groundwater heat pump system. A single 102-foot well provides 51° F groundwater to the townhouses and a discharge well returns the geothermal fluids to the production aquifer. The supply well is capable of discharging at a rate of 3300 gallons of water per minute and could easily supply geothermal energy to many additional homes in the area.

2.5 State Aggregation of Prospective Geothermal Utilization

An estimate of possible energy on-line through the year 2000 is presented in table II. These figures are based on the number of projects on-line as of June 1981 and the rate of growth apparent between June and December 1981.

TABLE II

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.

2.6 Institutional Analysis

Three bills affecting the development of geothermal energy in North Dakota were passed during the 1981 state legislative session.

House Bill 1362, which will become law on July 1, 1981, gives the State Industrial Commission the authority to regulate the exploration, development, and utilization of geothermal resources in the state (see Appendix A for a copy of the law). 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 will also be subject to regulations and permit requirements related to water appropriation and discharge. The state commercialization team is presently compiling information for an institutional handbook, which will outline local, state, and federal regulations for geothermal energy development.

The other two bills amended sections of the North Dakota Century Code to provide tax incentives for the use of geothermal energy. 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.

2.7 Public Outreach Program

2.7.1 Outreach Mechanisms:

The state's outreach program is designed to inform the public of the potential and the advantages of geothermal energy in North Dakota. In addition to providing information to interested individuals and organizations upon request, the state commercialization team also actively seeks opportunities to promote the development of geothermal energy.

Existing outreach mechanisms include a monthly newsletter, formal and informal talks, and distribution of materials.

Newsletter

The newsletter now reaches approximately 1500 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.

Talks

Presentations concerning geothermal energy development potential in North Dakota were presented to civic and business organizations, including the North Dakota Association of Professional Engineers.

North Dakota's geothermal commercialization program and activities also received statewide exposure as a result of a half-hour public service television program aired in March.

Publications

The state commercialization team is actively promoting the development of geothermal-related commercial activities in the state. The number of well drillers, heat pump distributors, engineers, and other professionals who are involved with or interested in North Dakota's geothermal development has increased dramatically during the past year. A list of these firms has been compiled and is being distributed to individuals seeking advice or assistance on their geothermal project. A copy of the consultant's list is presented in Appendix B.

Two brochures explaining the operation and advantages of the geothermal groundwater heat pump have been completed. "Geothermal Groundwater Heat Pump: An Efficient Way to Heat and Cool Your Home" was published in January 1981 and has been widely distributed. The second brochure is more technically oriented and will be published in July 1981. Both brochures were written as joint ventures between the University of North Dakota, Engineering Experiment Station, and the North Dakota Energy Office, Geothermal Program.

Outreach mechanisms for the remainder of calendar year 1981 will remain the same.

2.7.2 Summary of Contacts and Results

Although individual groundwater heat pump installations for residential use continue to account for the greatest implementation of geothermal energy in North Dakota, increasing numbers of city officials and private developers have requested information or assistance with district heating and cooling projects and industrial applications.

The state commercialization team received requests from twelve communities for resource information or technical assistance with district heating projects. The initial construction phase of North Dakota's first district heating and cooling system has been completed in Jamestown, and in-depth economic and engineering analyses are being conducted for the cities of LaMoure and Dickinson.

In addition, Rolla city officials have contacted an architect to design a geothermal system for heating and cooling the city's new day care and senior citizen center. T.P.I., Inc., a Bismarck consulting firm, is proceeding with a feasibility study for geothermally curing concrete products at the North Dakota Concrete Products plant in Menoken.

A more detailed account of the state commercialization team's contacts is presented in Appendix C.

2.7.3 Overall Prospectus for Future Geothermal Commercialization

The outlook for continued geothermal energy commercialization in North Dakota is excellent.

At mid-year there were a total of 22 (19 residential, 2 commercial, and 1 agricultural) geothermal systems on-line in the state. This number is expected to quadruple by January 1982, and a comparable growth rate is anticipated during the near few years. Community-supported projects, such as those proposed for LaMoure and Rolla, will benefit other North Dakota cities by providing successful working models.

During the past year the state commercialization team has been instrumental in establishing a thriving geothermal industry in North Dakota. Groundwater heat pump distributors and installers are now located across the state, and state agencies and organizations (i.e., state plumbing board and several rural electric cooperatives) are encouraging their members to actively participate in geothermal energy commercialization in North Dakota.

3.0 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

In addition to completing several written tasks during the first half of calendar year 1981, the state commercialization team spent an increasing amount of time on project stimulation and implementation. Project stimulation activities included, but were not limited to, news releases (radio, television, and newspaper); speeches to civic, business, and educational groups; and distribution of brochures, newsletters, and lists of geothermal consultants.

The state commercialization team devoted approximately 50 percent of its time providing direct assistance to individual geothermal developers. This assistance included resource identification, technical assistance, economic analyses, identification of and assistance with government regulatory policies, and coordination of activities between project developers and consultants.

The state commercialization team's initial efforts to promote the development of geothermal energy in North Dakota began at the grassroots level and focused on individuals and small businesses. Now that the technical and economic feasibility of geothermal energy systems has been established, the state commercialization team's activities have been expanded to include community, industry, and government leaders. The value of this approach is evidenced by the number and scope of projects currently under consideration.

Problems that continue to impede the effectiveness of the commercialization effort in North Dakota include:

- Lack of funding

Individuals, small businesses, and communities often lack the front-end capital necessary to implement large-scale projects. This problem will undoubtedly be compounded by anticipated cutbacks in federal grant funds and loan guarantees available for geothermal projects.

The state commercialization team is working to overcome at least some degree of this problem on the state level by informing bankers and community leaders of the benefits of geothermal energy development. As this segment of society becomes more enlightened, they will be more willing to provide the financial and community backing necessary for large-scale geothermal projects.

. Lack of economic incentives

North Dakota is now one of four states that allow tax incentives for geothermal energy devices, including groundwater heat pump systems. Although the state's 15 percent tax credit and five-year property tax exemption provide some economic incentive, there is still a need for a concerted effort to change the federal tax laws to allow credits for systems utilizing groundwater heat pumps or geothermal resources below 50° C.

. Technical assistance

The greatest stimulation to growth and project success in North Dakota has been through the Department of Energy's technical assistance program. The changes in DOE's attitude and policy, which allow technical assistance efforts to be carried out in the state by qualified state personnel, have greatly enhanced geothermal opportunities, knowledge, and project implementation in North Dakota. Hopefully, a heightened level of technical assistance funding will be provided to the state commercialization teams.

APPENDICES

CHAPTER 377

HOUSE BILL NO. 1362
(Kloubec)

GEOTHERMAL RESOURCE DEVELOPMENT REGULATION

AN ACT providing for regulation of the exploration, development, and utilization of geothermal resources by the industrial commission; and providing penalties.

BE IT ENACTED BY THE LEGISLATIVE ASSEMBLY OF THE STATE OF NORTH DAKOTA:

SECTION 1. DECLARATION OF POLICY. It is hereby declared to be in the public interest to encourage, and promote the proper use of geothermal resources in a manner which will prevent waste; to authorize and provide for the operation of geothermal resource extraction facilities in such manner as will achieve the optimum utilization of the geothermal resource and protect the correlative rights of all owners; to prevent contamination and pollution of surface and ground water sources; and to avoid creation of secondary hazards of a geologic nature.

SECTION 2. DEFINITIONS. As used in this Act:

1. "Commission" means the industrial commission of North Dakota.
2. "Geothermal energy" means the internal energy of the earth, available to man as heat from rocks or liquids.
3. "Geothermal energy extraction facility" means and includes any drilled, bored, or excavated device or installation to provide for the extraction of geothermal energy but shall not include any device used for private residential heating or cooling purposes.
4. "Geothermal resource" means the recoverable stored heat of the earth.
5. "Producer" means the owner of a geothermal energy extraction facility or facilities, and his agents or employees.

6. "Product" means anything produced, whether usable or unusable, by means of a geothermal energy extraction facility.

7. "Waste" means and includes the locating, spacing, drilling, excavating, or operating of any geothermal energy extraction facility in a manner which causes or tends to cause reduction in the quantity or quality of geothermal energy ultimately recoverable from a geothermal resource, or which causes or tends to cause unnecessary or excessive use, or degradation, of land surface.

SECTION 3. JURISDICTION OF THE INDUSTRIAL COMMISSION. The industrial commission has jurisdiction and authority and is charged with the responsibility to enforce the provisions of this Act. This Act shall not apply to any activity regulated under chapters 38-08, 38-12, 38-12.1, 38-14.1, and 61-28. The jurisdiction granted to the commission by this Act shall not be exclusive and shall not affect the jurisdiction of other governmental entities. The industrial commission acting through the office of the state geologist has the authority:

1. To require:

   a. Identification of ownership of all facilities, installations, and equipment used in the extraction of geothermal energy.

   b. The making and filing of all logs and reports on facility location, drilling, boring, excavating, and construction and the filing, free of charge, of samples, core chips, and complete cores, when requested, in the office of the state geologist.

   c. The drilling, boring, casing, excavating, plugging, and construction of facilities in a manner to prevent contamination and pollution of surface and ground water sources and unnecessary environmental degradation.

   d. The furnishing of a reasonable bond with good and sufficient surety, conditioned upon the full compliance with the rules of the commission relating to the extraction of geothermal energy.

   e. Metering or measuring all products extracted from or by means of a facility regulated by this Act.

   f. That every person who operates a geothermal energy extraction facility in this state shall keep and maintain complete and accurate records of the quantities and nature of products extracted from or by means of any facility, and the ultimate disposition of such products, which records shall be available to the commission or its agents at all times, and that every such person file with the commission such reports as it may prescribe.

g. That upon termination of the operation of any facility or activity regulated by this Act, the operator of the facility shall restore the surface as nearly as possible to its original condition and productivity.

2. To regulate:

a. The drilling, boring, excavating, and construction of all geothermal energy extraction facilities.

b. Operations to assure the optimum performance of all facilities regulated under this Act.

3. To limit and prescribe the nature, quantity, and source of geothermal energy to be extracted from any facility regulated by this Act.

4. To adopt rules and issue orders to effectuate the purposes of this Act.

SECTION 4. PERMIT REQUIRED. It shall be unlawful to commence any operations for the drilling, boring, excavating, or construction of a geothermal energy extraction facility without first securing a permit from the state geologist, under such rules as may be adopted by the commission and after paying to the commission a fee for each such facility in an amount to be prescribed by the commission by rule. The fee set shall be related to the cost or regulation and inspection under this Act.

SECTION 5. COMMISSION MAY EMPLOY EXAMINERS. The industrial commission may use hearing examiners under such rules as the commission may adopt.

SECTION 6. ACTION TO RESTRAIN VIOLATION OR THREATENED VIOLATION. Whenever it appears that any person is violating or threatening to violate any provision of this Act, or any rule or order of the commission, the commission may bring action against that person, in the district court of the county where the violation occurs or is threatened, to restrain that person from continuing the violation or from carrying out the threat of violation. In any such action, the court shall have jurisdiction to issue, without the filing of a bond or other undertaking by the commission, such prohibitory and mandatory injunctions as are necessary, including temporary restraining orders, preliminary injunctions, temporary, preliminary, or final orders restraining the person from continuing the violation or from carrying out the threat of violation.

SECTION 7. PENALTIES.

1. Any person who violates any provision of this Act, or any rule or order of the commission adopted or issued under this Act, shall be subject to a civil penalty of not more than twelve thousand five hundred dollars for each act of violation and for each day the violation continues.

2. It is a class C felony for any person, for the purpose of evading this Act, or any rule or order of the commission, to make or cause to be made any false entry or statement in a report required by this Act or by any rule or order adopted or issued or promulgated by the commission, or to make or cause to be made any false entry in any record, account, or memorandum required by this Act, or by any rule or order of the commission, or to omit, or cause to be omitted, from any such record, account, or memorandum, full, true, and correct entries as required by this Act or by any rule or order of the commission, or to remove from this state or destroy, mutilate, alter, or falsify any record, account, or memorandum.

3. The civil penalties provided in subsection 1 shall be recoverable by suit filed by the attorney general in the name and on behalf of the commission, in the district court of the county in which the defendant resides, or in which any defendant resides, if there is more than one defendant, or in the district court of any county in which the violation occurred. The payment of the penalty shall not operate to relieve a person on whom the penalty is imposed from liability to any other person for damages arising out of such violation.

SECTION 8. ADMINISTRATIVE PROCEDURE AND JUDICIAL REVIEW. Any proceedings under this Act for the adoption or modification of rules or orders, including emergency orders relating to extraction of geothermal energy and determining compliance with rules of the commission, shall be conducted in accordance with sections 38-08-11, 38-08-12, 38-08-13, and 38-08-14; and chapter 28-32 shall govern administrative practice where consistent with the provisions of this Act and the above-referenced sections.

SECTION 9. DISPOSITION OF UNUSABLE PRODUCTS. Products for which there is no beneficial use and which the commission determines to be hazardous, must be disposed of in accordance with the provisions of chapter 23-20.2 of the North Dakota Century Code and other state laws and regulations regarding the management of hazardous waste.

Approved March 11, 1981

APPENDIX B

CONSULTANTS LIST

Bauer Plumbing and Heating Bismarck, ND	Heat pump installation; plumbing/heating contractor
Bell Geophysics Bismarck, ND	Geological and geophysical testing
Bismarck Heating and Air Conditioning Bismarck, ND	Heat pump installation and sales
Camp Brothers Sheet Metal Bismarck, ND	Plumbing/heating contractor
Kohl and Schwartz Engineering, Inc. Bismarck, ND	Engineer
T.P.I., Inc. Bismarck, ND	Consultant
Sherman Plumbing and Heating Carrington, ND	Heat pump installation and sales; plumbing/heating contractor
Western Mechanical, Inc. Dickinson, ND	Heat pump installation and sales; plumbing/heating contractor
Schall Plumbing and Heating Enderlin, ND	Heat pump installation; plumbing/heating contractor
Baker Wholesale, Inc. Fargo, ND	Heat pump sales (wholesale)
Dean's Refrigeration and Heating Fargo, ND	Heat pump installation and sales; plumbing/heating contractor
Richard Burns Associates Fargo, ND	Architect
Simek Refrigeration Fullerton, ND	Heat pump installation; plumbing/heating contractor
Border States Electric Grand Forks, ND	Heat pump sales

Neppel Engineering Grand Forks, ND	Engineer
Falk Brothers Well Drilling Hankinson, ND	Heat pump installation and sales; well driller
Russell Drilling Co. Harvey, ND	Well driller
Smith Refrigeration and Heating Jamestown, ND	Heat pump installation and sales; plumbing/heating contractor
Traut Wells Jamestown, ND	Heat pump installation and sales; well driller
Jay Tee Electric LaMoure, ND	Heat pump installation and sales; electrical contractor
Toman Engineering Co. Mandan, ND	Engineer
Willenbring Wells Mandan, ND	Well driller
Baker Wholesale, Inc. Minot, ND	Heat pump sales (wholesale)
Lindsay Brothers Co. Minot, ND	Heat pump sales (wholesale)
Solar Dakota, Inc. Minot, ND	Heat pump sales
Earth Energy Systems Northwood, ND	Heat pump installation and sales; plumbing/heating contractor; well driller
Oakes Electric Inc. Oakes, ND	Heat pump installation and sales; electrical contractor
John T. O'Rourke & Associates Mountain View, CA	Engineer
Western Energy Planners Aurora, CO	Planning and economic analyst
Lee Hurry Associates, Inc. Minnetonka, MN	Heat pump sales

Vigesaa Engineers Moorhead, MN	Engineer
Schwab Vollhaber, Inc. St. Paul, MN	Heat pump sales

APPENDIX C

SUMMARY OF MAJOR CONTACTS AND RESULTS

Federal Government:

Ray Butler U.S. Geological Survey Bismarck	Geothermal resource information

State Government:

Don Mathsen Engineering Experiment Station University of North Dakota	Groundwater heat pump brochure
Roger Koski Dist. 32 State Representative Bismarck	Sponsoring geothermal tax credit legislation
Francis Schwindt State Health Department	Water discharge regulations
Rick Nelson State Health Department	Underground Injection Control Program
Mike Dwyer State Water Commission	Water appropriation regulations
Erling Brostuen N.D. Geological Survey	Geothermal regulations
Wallace Owen Public Service Commission	Natural gas information
Otto Bervik Land Department	State prospecting and leasing regulations
Bill Delmore State Health Department	Water discharge regulations
Ken Harris N.D. Geological Survey	Geothermal resource information

Barry Zibelman State Water Commission	Requested resource information for city of Gackel--proposed district heating system
Randy Jorgenson Tax Department	Geothermal tax credit information
Lewis Lubka N.D. State University	Requested resource information for Sioux County
Joe Ziegler Dept. of Natural Resources and Conservation Helena, MT	Requested groundwater heat pump information

Local Government:

John O'Leary Lewis and Clark 1805 Regional Council Mandan	Lewis and Clark 1805 Area Development Plan
John Lee Mayor City of Colfax	Requested resource information for city of Colfax--proposed district heating/cooling system
Chris Troseth Southcentral Regional Council Jamestown	Requested funding source information for proposed district heating/cooling system in LaMoure
Lynn Fundingsland Lake Agassiz Regional Council Fargo	Requested resource information for Sioux County
Bill Bryant Rural Development Corporation Grand Forks	Requested groundwater heat pump and resource information for East Fairfield
Kim Nesvig North Dakota Central Resource Center Devils Lake	Requested resource information for North Central Region
Art Baumgartner Mayor City of Dickinson	Dickinson district heating system project

Commercial/Industrial

Richard Burns Associates Fargo	Architectural firm involved in Jamestown district heating/ cooling project and Rolla community center project. Requested resource information for Osnabrock--proposed nursing home
Montana-Dakota Utilities Bismarck	Natural gas rates and regulations
Tom Trousdale Capital Rural Electric Coop. Bismarck	Requested groundwater heat pump information and brochures for distribution to customers
Sparb Collins T.P.I., Inc. Bismarck	Consultant for proposed Cherry Street (Grand Forks) district heating/cooling system
Jerry Kainz Refrigeration Service Jamestown	Requested information on geothermal tax incentives; installed heat pump system for Jamestown district heating/cooling project
Don Anderson Capital Realty Bismarck	Requested resource information for Bismarck--proposed 48-unit condominium development
Tom Kambeitz Bismarck Plumbing and Heating Bismarck	Lewis and Clark 1805 Area Development Plan
Willy Williamson Leichty Mobile Homes Jamestown	Requested information on geothermal development potential in Jamestown
Reuben Meland Earth Energy Systems Northwood	Geothermal developers in northeast North Dakota; requested slide presentation and brochures for distribution at Valley City Winter Fair
Jim Haines and John Jennings North Dakota Concrete Products Bismarck	Requested feasibility study for N.D. Concrete Products

Vern Zink T.P.I., Inc. Bismarck	Conducting feasibility study for N.D. Concrete Products
Dale Rogers First State Bank Lemmon, SD	Lemmon, SD, district heating project
Roger Russell Russell Well Drilling Harvey	Has installed geothermal slab-floor heating system in his shop
Mike Robb Globe Development Bismarck	Has installed groundwater cooling system in commercial building, Bismarck
Roys Willenbring Mandan	Drilling shallow groundwater wells for cooling purposes in Bismarck/Mandan area
Bill Davis T.P.I., Inc. Bismarck	Requested information on HUD district heating program for Mayor, City of Lincoln
Terry Moore Oil and gas broker	General
Dave Schaaf Amoco Oil Refinery Mandan	Requested groundwater heat pump information
Dave Buckmiller Solar Dakota Minot	Requested geothermal tax credit information
Rod Bohr and Jim Lindstrom Team Builders Fargo	Beginning heat pump distributorship
Les Nesvig First State Bank LaMoure	LaMoure district heating/cooling system
Bob McLeod KFYR Television Bismarck	Television and radio interview

Harvey Schneider Toman Engineering Mandan	Requested information for city of Medora--proposed district heating system
Hunter Grobe Architects Fargo	Requested engineering assistance for West Fargo school district
Darrell Pierson LPC Systems, Inc. Boulder, MT	Requested groundwater heat pump information
Envirogenics Systems El Monte, CA	Reverse osmosis system for Dickinson
Bill Shamouri Basin Oil Williston	General
Loren Kopseng Carlson Homes Bismarck	Requested information on geothermal potential in Dickinson
Larry Whitcomb Western Mechanical, Inc. Dickinson	Groundwater heat pump distributor

Civic or Business Groups

Bismarck Exchange Club	Speech
Bismarck Lions Club	Speech
Bismarck Rotary Club	Speech
Bismarck Junior College	Speech
N.D. Association of Professional Engineers	Speech (annual meeting)
Robinson Lions Club	Speech
Fessenden Kiwanis Club	Speech

Individuals

Keith Osberg South Dakota	Requested groundwater heat pump information
Dave Poppke Grand Forks	Requested groundwater heat pump and federal loan information
Ben Schaaf Mandan	Proposed heat pump installation south of Mandan
Larry Hoge Bismarck	Requested geothermal tax incentive information
David Salisbury Beulah	Requested groundwater heat pump information
Dan Mars Bismarck	Requested groundwater heat pump information
Glen Schuelke	Proposed residential heat pump installation
Other individuals	General information

SOUTH DAKOTA GEOTHERMAL COMMERCIALIZATION PROJECT

SEMI-ANNUAL PROGRESS REPORT

JANUARY - JUNE, 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

CONTENTS

1.0 INTRODUCTION

1.1 Scope of Project

The top priority of the state geothermal team is to replace conventional fuels with geothermal energy wherever possible in South Dakota. Outreach and technical assistance have been the main vehicles used to achieve this priority. The physical aspects of the resource restricts the use of geothermal energy in South Dakota. The low temperature and regional aspect of the Madison Formation limits its use to space heating and agricultural purposes in an area that has little industry. The other shallower aquifers that underlie eastern South Dakota have to be groundwater heat pump assisted.

There are numerous existing artesian wells in South Dakota whose only use is for livestock watering. Other wells in small communities are not being used for any purpose. The past 6 months the state team has been trying to make the owners of these wells aware of the benefits of geothermal energy. Dupree, Wessington, Faulkton, Eureka, and Vermillion are interested in various forms of space heating and have applied for technical assistance. Numerous individual land owners have also asked for assistance in space heating their buildings. A data needs sheet for geothermal and heat pump applications was prepared by NMEI and the state team (Appendix A). This data sheet was filled out by the requestor and returned to the state team. Data from resources that had temperatures lower than 38°C were sent to NMEI to run on their groundwater heat pump model study. Data from resources with temperatures over 38°C were sent to EG&G for evaluation in their 100 hour technical assistance program. A list of requestors is included in Appendix A.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

There still is no resource assessment team in South Dakota. The South Dakota Department of Water and Natural Resources and the Department of Energy are still negotiating a contract. The latest inventory of existing geothermal resources was Del Jensen's study of central South Dakota that was included in the last semi-annual report.

2.2 Area Development Plans

Data collection for ADP's 5 and 6 are continuing and will be published in the final report.

2.3 Site Specific Development Plans

2.3.1 Candidate Geothermal Sites/Applications

Lemmon, South Dakota remains as one of the prime candidates. The latest TA Report (May 30, 1981) prepared for the city by Dunham Associates, Inc. has scaled the project down to a minimum Phase I construction effort. Phase I comprises one well located at the central city park site and enough basic distribution piping to utilize a significant fraction of the energy available from the well. The utility district will provide all the heating energy for a downtown area of 9 blocks consisting of 62 buildings. The project could later be expanded to a district heating concept for the surrounding residential area. Lemmon is going to submit a UDAG application for district heating. The engineering and geological estimates for the project are listed below.

Lemmon Geothermal Construction Estimate

Material	Quantity	Unit Price	Per	Amount Including Labor
6" pipe	2,300	$40.00	Ft	$101,200
4" pipe	1,040	38.00	Ft	39,520
3" pipe	2,600	26.00	Ft	67,600
2" pipe	5,240	24.00	Ft	125,760
6" taps	2	800.00	Tap	1,600
4" taps	25	700.00	Tap	17,500
3" Taps	53	600.00	Tap	31,800
2" Taps	40	600.00	Tap	24,000
		Subtotal		$408,980
		Mobilizing	LS	25,000
		Contingency	LS	50,000
		Total Cost		$483,980

Aquifer Data
Depth 2073 Meters
Temperature 72°C
Flow Rate/Well 400 GPM (pumped)
Supply Wells 1
Disposal Wells 1
TDS 7500 ppm
Static Level - 100 feet
Estimated Cost for Supply & Disposal Wells $1,400,000

Energy Data
BTU x 10^6/yr

	Existing	Proposed	Save
Propane	6,630	0	6,630
Fuel Oil	8,340	0	8,340
Coal	5,810	0	5,810
Electric	595	0	595
Electric (pump dist.)	0	102	(102)
Electric (well pump)	0	370	(370)
Total	21,375	472	20,903

Annual Fuel Cost (1000's)

	Existing	Proposed	Save
Propane @ $.59/gal.	44.05	0	44.05
Fuel oil @ $1.10/gal.	70.60	0	70.60
Coal @ $30/ton	10.50	0	10.50
Electric @ $.035/KWH	6.10	4.84	1.26
Total	131.25	4.84	126.41

Midland and Philip are other prime candidates for SSDA; Midland's data have been published in prior reports. Philip has been selected to receive community assistance from Eliot Allen and Associates so that data will probably be updated.

2.4 Time Phased Project Plans

The three demonstration projects in South Dakota have been operational since the fall of 1980. A brief description of the projects follows:

- Diamond Ring Ranch, Hayes, South Dakota

  This direct use demonstration satisfies the space heating demands of two mobile homes, two permanent residences, a shop building, a bunkhouse, a hospital barn, and dries all grain harvested on the ranch. The 68°C water is also used to irrigate lawns, gardens, and trees without affecting the soil. A garage is heated with a series of pipes embedded in a concrete floor. All other heating is accomplished via water-to-air heat exchangers. The grain dryer is used to dry small grains such as wheat, oats, and barley in the summer and corn in the fall. Approximately 100 gallons of geothermal fluid per minute flow to the grain dryer. Total energy used is 7.87×10^9 BTU/yr replacing 185,288 Kwh of electricity and 49,415 gallons of propane. There have been some maintenance problems with degassing and with some of the lines freezing. Total cost of the project was $403,000 with a 62-38% DOE-owner split.

- St. Mary's Hospital, Pierre, South Dakota

  A 663 meter well drilled in the Madison aquifer supplies 42°C geothermal water at a rate of 375 gallons per minute for hospital space heating. This application satisfies 100 percent of the space heating needs of a new 65,000 square foot wing, and partial heating of the original 83,000 square foot hospital complex. Geothermal energy heats the high volume of outside air required to flow into the hospital for ventilation. The well also provides energy to preheat domestic hot water from 13°C to 38°C before going to a conventional oil-fired unit. The geothermal energy replaces 115,000 gallons of fuel oil annually for a savings of $140,000. The discharged geothermal fluid is pumped into the Missouri River.

Project costs were $118,000 with a 75-25% DOE-participant split.

- Haakon County School District, Philip, South Dakota

A 1300 meter well with a flow rate of 300 gpm and a temperature of 69°C is used to provide heat and domestic hot water for the 5 building school complex. The geothermal water flows through the space and domestic hot water heat exchanger and then is discharged into the downtown business area. Eight business places obtain approximately half of their heating requirements from the geothermal energy. The presence of Radium 226 in the geothermal water requires a 10% aqueous solution of barium chloride be added resulting in a chemical reaction that removes the radium in a settling pond. The chemical reaction creates a scaling problem that requires some maintenance. Total amount of conventional energy replaced is electricity - 122,989 Kwh, fuel oil - 54,729 gallons, and propane - 23,858 gallons. Cost of the project was 1.2 million dollars with a 78-22% DOE-participant split.

2.5 State Aggregation of Prospective Geothermal Utilization

The demonstration projects described in the previous section and the TA projects described in Appendix A are the majority of the prospective geothermal users that are known at this time. The Missouri Basin Municipal Power Agency has a new office building under construction in Sioux Falls that is going to be space heated by a Westinghouse groundwater heat pump. No estimate of energy savings has been made at this time. Numerous individuals have installed groundwater heat pumps in their residences, however, energy data are still incomplete.

2.6 Institutional Analysis

The South Dakota Department of Water and Natural Resources is the permitting agency for geothermal wells in the state. They have generally been in favor of geothermal development the past two years. The Department of Water and Natural Resources is extremely conscious of protecting prior water rights and of prohibiting the discharge from an aquifer to become greater than the recharge. There are two cases that vividly illustrate this regard: the Indian school at Chamberlain was issued a water permit for the Dakota Formation only after agreeing to plug the same flow rate existing in wild wells as the school wants to use at the site. Lemmon has been issued water permits for the Madison Formation; the city has been told by the Department of Water and Natural Resources personnel That permits for the Fox Hills and Dakota will be refused.

2.7 Public Outreach Program

The state teams's outreach program is designed with two goals in mind. The first goal is to provide the people of South Dakota with all the available information about geothermal energy. The second goal is to match the user with the resource and provide the necessary technical assistance and information about funding sources to put projects on-line.

The past six months the 100 hour Technical Assistance Program has been stressed in the outreach program. The Energy Newsletter and all the South Dakota daily newspapers have run feature articles on the TA Program. The response to the program was moderate. Numerous requests were received; however, the majority of them were from individuals that had a resource with a temperature of 38°C or less. Data sheets from low temperature resources were forwarded to NMEI to be run in their computer model of groundwater heat pump heating systems. Requestors that did not provide sufficient data for the computer model were sent heat pump information by the state team. Data from resources with temperatures above 38°C was forwarded to EG&G for acceptance in their Technical Assistance Program.

A geothermal energy user's conference was held in Pierre February 26. The program consisted of speakers from the private and government sectors addressing all aspects of the geothermal field. Bill Toth from EG&G talked about DOE's role in promoting the use of geothermal energy. Dan Carda of the South Dakota School of Mines and Technology talked of the active South Dakota geothermal projects and the engineering problems encountered during construction. Keith Osberg of the Huron Drilling Company talked about drilling water wells in South Dakota. Reuben Pastians of the Midwestern Energy Company explained the role of groundwater heat pumps in the state, and John Hatch of the South Dakota Department of Water and Natural Resources explained the state laws and regulations pertaining to the use of geothermal water.

The South Dakota Extension Service conducted a series of "Energy Expo's" throughout central South Dakota February 10-19. Slide shows explaining the use of groundwater heat pumps and the potential of geothermal energy in South Dakota were featured. The public broadcasting system showed a half hour program on alternative energy May 28 and 31. Dr. Stan Howard explained the geothermal system at the Diamond Ring Ranch.

The state team presented a talk on geothermal energy at the Alternative Energy short course on the South Dakota State University campus in June.

The future of geothermal commercialization in South Dakota is primarily in the space heating and agriculture sectors. There are many deep artesian wells in western South Dakota that either are not being used or are used for stock watering only. Ranchers are now showing an interest in using this resource for energy.

District heating may be a possibility in the state but population density will be a problem. There are several small communities that would like to utilize existing wells for space heating of public buildings and private homes. The towns, however, consist of single family dwellings and don't have the tax base to support a district heating system.

Groundwater heat pumps have a great potential for space heating in eastern South Dakota. Groundwater temperatures range from 8-12°C north to south across the glaciated portion of the state. The outwash plains and the river valleys have the resource to sustain space heating by groundwater heat pumps.

3.0 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

The state team activities have been directed towards outreach and technical assistance. The sparse population, extreme weather, and lack of industry in South Dakota dictates that the most efficient use of geothermal energy is in the space heating and agricultural fields. The low to moderate resource temperatures, (less than 84°C) is also best suited for space heating and agriculture.

With these limitations in mind, the state team embarked on an educational and informational program designed for the best utilization of the resource available.

TV, newspapers, and radio were used to familiarize South Dakotans with the potential of geothermal energy. Informational workshops featuring local speakers knowledgable in all aspects of geothermal development are being held throughout the state.

EG&G's 100 hour Technical Assistance Program and NMEI's Groundwater Heat Pump Model Study have received statewide publicity and have created a lot of interest.

The goal of getting BTU's on line will be accomplished if:

- The general public is convinced geothermal energy is economically feasible: this is being accomplished by publishing data from existing geothermal projects that show a savings when compared to conventional fuel.
- Funding is available at a rate people can afford; the high interest rates are discouraging small communities from developing existing resources. Most municipalities are bonded to the limit and do not have the tax base to pay off high interest loans.

The solution to the financial problem is very complex and beyond the scope of this report. The problem could be alleviated if there were low interest loans available either through federal or state programs.

APPENDIX A

Wessington, South Dakota

Resource

Depth: 385 M

Temperature: 27°C

Flow Rate: 50 GPM

Tyoe of Discharge: Storm sewer

User

Degree Days Heating: 7,660

Winter Design Temperature: -17°C

Type: Space heating and hot water for fire hall and gymnasium

Building Area: 11,800 ft^2

Heat Demand: 8.89 X 10^8BTU

Payback Period: 9 years

Status: Project suspended due to lack of funds

Faulkton, South Dakota

Resource

Depth: 366 M

Temperature: 22°C

Flow Rate: 225 GPM

Type of Discharge: Storm sewer

User

Degree Days Heating: 8,200

Winter Design Temperature: -18°C

Type: Space heating, with aid of heat pump, elementary, high school and gymnasium

Building Area: 74,000 ft^2

Type of Energy: #2 oil

Price of Conventional Fuel $/MM/BTU's: $9.06

Annual Heat Demand: 5.897 X 10^9 BTU

Payback Period: 4 years

Status: No action has been taken

Eureka, South Dakota

Resource

Depth: 636 M

Temperature: 23°C

Flow Rate: 348 GPM

Type of Discharge: Into lake

User

Degree Days heating: 8,720

Winter Design Temperature: -19°C

Type: Space heating and hot water, assisted by heat pumps, for gymnasium, elementary, and high school

Building Area: 64,000 ft^2

Type of Conventional Fuel: Oil

Price of Convention Fuel MM/BTU's: $9.06

Annual Heat Demand: 5.369 X 10^9 BTU

Payback Period: 5 years

Status: Data sent to city, no action taken

Dupree, South Dakota

Resource

Depth: 1,372 M

Temperature: 59°C

Flow Rate: 66 GPM

Type of Discharge: Storm sewer

User

Degree Days Heating: 7,890

Winter Design Temperature: -17°C

Type: Direct use for space heating and hot water for school, courthouse, fire hall, and municipal bar.

Building Area: 85,931 ft^2

Type of Energy: Fuel oil

Price of Conventional Fuel MM/BTU's: $9.06

Annual Heat Demand: 6.79×10^9 BTU's

Payback Period: 9 years

Status: EG&G may provide technical assistance

Vermillion, South Dakota

Resource

Vermillion proposes to use potable water stored in a 1.5 million gallon ground storage reservoir to assist in the heating and/or cooling of the Vermillion Public Library. Rather than discharge the water, it is proposed that the water be returned to the reservoir. Temperature of the water is 17°C.

User

Degree Days Heating: 7,700

Winter Design Temperature: -24°C

Building Area: 11,000 ft^2

Type of Conventional Fuel: Natural gas

Price of Conventional Fuel MM/BTU's: $5.61

Payback Period: 3 years

Status: No action taken.

Hot Springs Veteran's Administration

Resource

The resource is a spring that has a flow rate of 1600 GPM and a temperature of 29°C.

Type of Discharge: Into sewer or river

User

Degree Days Heating: 8,000

Winter Design Temperature: -12°C

Type: Use water to water heat pumps to produce 60°C hot water for both space heating and hot water. Conventional boiler can be used as the back-up system to heat hospital and four plex apartments.

Building Area: 603,000 ft^2

Type of Conventional Fuel: #2 & #6 fuel oil

Price of Conventional Fuel MM/BTU's: $9.06

Annual Heat Demand: 75 X 10^9 BTU

Payback Period: 2

Status: No action as yet

In addition several other projects are in the planning stage and could result in viable geothermal energy use. EG&G is negotiating with two ranchers who have applied for the Technical Assistance Program. Ed Brunner of Nisland, South Dakota has a 1,340 meter well that has a flow rate of 1,400 gpm and a temperature of 52°C. The water is presently being used for stock watering and then is discharged into a drainage ditch. Mr. Brunner has two houses, one has electric heat and the other is heated with LPG, that he would like to heat with the water.

Ray Herman of Presho, South Dakota has a 530 meter well that has a flow rate of 1435 gpm and a temperature of 48°C. It is presently being used for domestic water, stock water and irrigaiton. Mr. Herman would like to heat three ranch houses, machine shed, shop and calving barn with the water.

A third project that looks very promising is the St. Joseph's Indian School at Chamberlain, South Dakota. The school proposes to heat seven buildings, with a combined floor space of 153,000 ft^2, with a three well two centrifugal groundwater heat pump system. All financing will be private. Roby, Quintal, & Everson of Mitchell, South Dakota is the consulting engineer; the groundwater heat pumps will be installed by Westinghouse. The system will replace a fuel oil system at a savings of $175,000 a year.

UTAH GEOTHERMAL COMMERCIALIZATION PROJECT

SEMIANNUAL PROGRESS REPORT

January -June 1981

Prepared by

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UTAH DIVISION OF WATER RIGHTS

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U.S. Department of Energy

Idaho Operations Office

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UTAH GEOTHERMAL COMMERCIALIZATION PROJECT

SEMIANNUAL PROGRESS REPORT, JANUARY-JUNE 1981

1.0 Introduction

The Utah Geothermal Commercialization Project is part of a regional program funded primarily by the U.S. Department of Energy. 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 for the commercialization program; L. Ward Wagstaff, planning and technical analysis; and Connie Walker, who replaced Douglas Nielsen in January as the information and marketing specialist.

The primary benefit of the geothermal commercialization project in Utah has 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 January to June 1981, there were no new deep exploratory wells drilled for electrical exploration; there were also no successful new wells drilled for direct use. A number of reservoir tests were conducted, however, including tests at Roosevelt Hot Springs and Crystal Hot Springs.

At Roosevelt Hot Springs, the major high-temperature prospect in Utah, work is progressing into the development phase. A contract has been signed by Phillips Petroleum Company, the major developer and Unit operator, and Utah Power and Light, the major utility in Utah. The contract provides that Phillips will drill the production and injection wells and construct the wellhead facilities, and that Utah Power and Light will buy the steam, operate the generating plants, and distribute the power.

Phillips and Utah Power and Light have announced plans to initiate power production at Roosevelt with a 20 MWe pilot plant. The operation of this plant will enable the developers to study the reservoir during the time that the larger capacity plants are being designed, permitted, and constructed. The pilot plant will use mostly existing wells for production and injection. Several additional wells will be drilled for the initial plant, including at least two production wells which will probably be drilled in late 1981 or early 1982.

At Crystal Hot Springs, near Bluffdale in Salt Lake County, a flow test was conducted in February in a 1000 ft well drilled for the Utah State Prison space heating project. The well was allowed to flow under artesian pressure at 600 gpm for 15 hours, then was cut back to 400 gpm for 11 hours. The well was then shut-in and the pressure recovery was measured; ninety percent of the 4 psig initial pressure was recovered within 24 hours after the flow had ceased.

In May 1981, L. D. Haddock, a private landowner, drilled an exploratory well in Midway, Wasatch County, to determine the potential for space heating. Haddock intended to use heat from the well to heat one and possibly two homes. The well was drilled to a total depth of about 260 feet, and encountered temperatures of about 75^{0} F (24^{0} C). The well had an artesian flow of a few gallons per minute of fairly good quality water. Unfortunately, the temperature was inadequate for the planned uses, but the owner may reenter and deepen the well at a later date.

Phillips Petroleum Company formed the Drum Mountains Geothermal Unit in a remote area about 30 miles west of Delta. The Unit has been approved by the USGS and by the Utah Division of State Lands. It contains 64,523.50 acres, including 8,502.36 acres of state lands and 56,021.14 acres of federal lands. Although there are no surface manifestations of geothermal resources in the area, unofficial reports have indicated that favorable temperature gradients have been encountered. Phillips intends to drill a deep exploratory well in the Unit, but has not yet specified when or where the drilling will occur.

Several companies conducted temperature gradient surveys during the first half of 1981. Most of this exploration was in fairly remote areas of western Utah. Companies for which temperature gradient drilling permits were issued included Phillips Petroleum Company, Union Oil company, and Hunt Energy Corporation.

A field inspection for a geothermal well within the Roosevelt Hot Springs Unit was held during March 1981. Geothermal Power Corporation applied to the USGS to drill an exploratory well on a 40-acre federal lease held by A. L. McDonald. The tract nearly straddles the Dome Fault, which is one of the major controlling structural features in the resource area. Extensive opaline deposits lie along the fault and extend into the tract. Geothermal Power planned eventually to drill up to three wells including two production wells (on the south side of the fault) and an injection well (north of the fault). Although the purpose of the field inspection was to discuss potential environmental impacts, the primary concerns revolved around safety considerations involved with drilling close to the fault. An issue which was raised later was whether a well drilled in that area should be considered an exploration well or a development well.

A number of new geothermal leases were issued by the Utah Division of State Lands. These are listed in Table I.

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

TABLE I NEW STATE GEOTHERMAL LEASES, JANUARY - JUNE 1981

County/ Leaseholder	Size (acres)	No. of Leases	Location	Date Issued
Juab				
Phillips Petroleum Co.	2559	3	T14S, R11, 12, 13W	2/17/81
Beaver and Millard				
Hunt Oil Co.	2919	3	T30S, R11W T20, 21S, R9W	4/20/81

energy for the area with the estimated energy potential of geothermal resources within the area. This information could be used to target likely sites for 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 Semi-annual 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 economical feasibility of the project; and a fairly detailed analysis of the institutional and other factors which might hinder or prevent the successful completion of the project. Site specific development analyses 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 is available, e.g., temperature gradients, stratigraphic drilling results, etc.

Candidate sites for site specific analyses are listed in Table II. 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.

TABLE II CANDIDATE SITES FOR SITE-SPECIFIC DEVELOPMENT ANALYSIS

Sites Where Development is in Progress

Crystal Hot Springs (Salt Lake County)	Space Heating - State Prison
Crystal Hot Springs (Salt Lake County)	Greenhouses - Utah Roses
Belmont Hot Springs (Box Elder County)	District Heating
Newcastle (Iron County)	Greenhouses
Midway (Wasatch County)	Space Heating

Other Promising Sites

Wasatch Hot Springs (Salt Lake County)

Beck's Hot Springs (Salt Lake County)

Utah Hot Springs (Weber County)

Hooper Hot Springs (Davis County)

Monroe Hot Springs (Sevier County)

Cove Fort (Beaver County)

Thermo (Beaver County)

Escalante Desert (Iron County)

Abraham (Baker) Hot Springs (Juab County)

Drum Mountains (Millard County)

2.3.2 Site Specific Development Plans Completed or in Preparation

During the period of January-June 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.

Block 53 in downtown Salt Lake was purchased for redevelopment by the Salt Lake City Redevelopment Agency. The proposed redevelopment involves the clearing of most of the existing structures on the block and the construction of office buildings, with space planned for state, city, and private offices. A set of high rise condiminiums is also planned as a possible later addition to the project.

The site specific analysis which was performed by the Geothermal Team examined the economic feasibility of a heat pump district heating system which would service the buildings on the block. It was performed in cooperation with the Redevelopment Agency using available technical information and project plans.

The analysis compared the present value of initial and future costs and benefits of the heat pump system as opposed to a conventional natural gas system. The results showed that the heat pump system would require a higher capital investment, but savings in operating costs over the life of the equipment would more than offset the high initial cost. The details and the results of the analysis are found in earlier reports, particularly the Progress Report for the period of July-December 1980.

Unfortunately, the project had capital restrictions which precluded the consideration of the heat pump system. The Redevelopment Agency applied for a HUD district heating grant in an attempt to obtain the extra capital, but the proposal was not approved by HUD. The first of the office buildings scheduled for the block, a state office building, is now nearly complete and construction of the city offices has begun.

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 III 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. Permitting, planning, and design of the project are in progress. Phillips submitted

TABLE III ACTIVE GEOTHERMAL PROJECTS

Sites (Developer)	Application	Resource Characteristics	Geothermal Energy Requirements	Status of Project
Crystal Hot Springs (Utah Roses)	Greenhouses	Reported Artesian flow at 90°C in 125 m well.	Development as supported by resource, up to about 234 x 10^9 Btu's/yr.	The initial set of greenhouses, 70,000 ft^2, was heated geothermally; an additional 65,000 ft^2 has been constructed.
Crystal Hot Springs (State of Utah)	Space Heating	Probably similar to Utah Roses well.	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.	An existing 288 ft. well was deepened to 500 ft. and a 1,000 ft. exploratory well was drilled. Both had artesian flow at temperatures close to 90°C.
Sandy City (Utah Roses)	Greenhouses	1,527 m well with slight flow; bottom hole temp. at surface around 50°C.	Greenhouse conversion from natural gas, about 70.0 x 10^9 Btu's/yr.	The well has not produced flows or temperatures hoped for. Utah Roses was granted a permit to discharge to the Jordan River.
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.
Monroe Hot Springs (Monroe City)	Space Heating	Slight flow from 457 m well at about 74°C.	Initial phase, South Sevier High School, 4.5 x 10^9 Btu's/yr.	Flow and temperatures were much lower than expected; project has been suspended.

TABLE III ACTIVE GEOTHERMAL PROJECTS (CONTINUED)

Site (Developer)	Application	Resource Characteristics	Geothermal Energy Requirements	Status of Project
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 a shallow well, has been in operation for about 5 years.
Cove Fort (R & R Energy)	Alcohol	Well drilled by Union - about 173°C.	Planned initial development of 7×10^6 gal alcohol production.	A well test was reported to yeild flow and temperture results which were better than expected. Project has been suspended.

the Plan of Operations for Development, Injection, and Utilization to the USGS August 1980, and those permits are now in the process of review and approval.

As part of the field development program, Phillips plans to conduct tests on several wells during August and September 1981 to determine chemical and production characteristics. At least two production wells will later be drilled for the 20 MWe initial power plant.

The Utah Roses greenhouses at Bluffdale were heated with hydrothermal resources during the 1980-1981 heating season. The second set of greenhouses were constructed in the spring of 1981, which brought the total area under cultivation to about 130,000 square feet. Hot geothermal water from the 410 ft production well is pumped through finned radiator pipes laid along the edges of the greenhouses and through smaller polyethylene pipes laid adjacent to the rows of plants. Although the water flows from the well under artesian pressure, a booster pump is used to push the water through the piping system. The single well and pump apparently provide adequate heat for both sets of greenhouses. Spent water has been discharged to drainage ditch because of problems with the injection well.

The Utah State Prison space heating project, also associated with the Crystal Hot Springs hydrothermal system, is now in the design stage. As mentioned earlier in this report, the Utah Geological and Mineral Survey and Terra Tek, Inc., conducted an artesian flow test of a 1000 ft exploratory well drilled on prison property. Although the results of the test were not conclusive with regard to reservoir capacity, the test did provide data for design of the project. At present, the consultants for the project, which include Terra Tek and CH2M Hill, are working with the Utah Energy Office to evaluate design alternatives, particularly for the fluid disposal system.

The Christensen Brothers Ranch at Newcastle operated a set of small greenhouses using geothermal heat for the second year. Christensen Brothers originally had two shallow wells (about 500 feet deep) which produced hot water at boiling temperatures with no artesian pressure. One of the wells was sold to a major greenhouse company headquartered in Florida, and construction on those greenhouses will probably begin during 1981.

At Cove Fort-Sulphurdale, developers had planned to use an existing geothermal well to provide energy for an ethanol plant. The well, which was drilled by Union Oil Company during its exploratory activities in the Cove Fort area, was tested late in 1981. The results of the flow test were not made public, but unofficial and unconfirmed reports indicated that the well was more productive than previously believed. However, in late 1980 and early 1981 the developers of the project had some internal disagreements and the project has apparently become the subject of litigation.

The Crystal Hot Springs resort at Honeyville has completed the initial renovation of its facilities. The resort has replaced the previous swimming and soaking pool, and several smaller jacuzzi-type pools. The resort owners plan additional improvements.

2.4.2 Time-Phased Project Plans

A time-phased project plan for the development of the Roosevelt Hot Springs geothermal prospect was completed in the summer of 1979. The plan outlined development 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 had been completed, Phillips announced that they planned to initiate development with a 20 MWe pilot plant which would be followed after several years by full-sized 55 MWe plants. The smaller plant will provide operating experience, reservoir data, and revenue during the time in which the larger plants were permitted and constructed.

The results of the original time-phased project plan for Roosevelt Hot Springs can be found in the Utah Geothermal Progress Report for January-June 1979 and will not be repeated in this report. However, a brief update of the development will be included here.

In the interval since 1979 when the plans for the 20 MWe plant were announced, a number of important milestones have been achieved. After several years of negotiations, a unit agreement was signed between Phillips Petroleum Company and the ATO Consortium (AMAX Exploration, Inc., Thermal Power Company, and O'Brien Resources Corporation). This agreement cleared the way for orderly development of the resource. In September 1980 Phillips Petroleum Company, acting as operator for the unit, signed a marketing agreement with Utah Power and Light. Under the agreement, Phillips will drill the wells, supply steam to Utah Power and Light, and dispose of the spent fluids. Utah Power and Light will construct, operate, and own the plant.

Subsequent to these events, the major permit applications were submitted to the appropriate regulatory agencies. Phillips Petroleum Company has submitted the plans for Development, Injection, and Utilization to the USGS. Utah Power and Light is in the process of obtaining siting permits from the BLM.

Other major steps in the development of the resource which are planned for the near future are the testing of several wells (fall 1981), commencement of construction on the 20 MWe plant (late 1981 or early 1982), and the drilling of additional productin wells (late 1981 or early 1982).

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 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

One of the deepest needs of geothermal development in Utah has been a clear and effective law regulating geothermal development. The original law dealing with geothermal development in Utah was a brief section attached to the Utah Water Law which assigned regulatory for geothermal development to the Division of Water Rights. The powers of the State Engineer, as administrator of the law, were not stated and regulatory guidelines were not given.

With the advent of the geothermal commercialization program the state team became involved in the effort to draft effective geothermal legislation. In 1978, after making presentations to a legislative committee, an advisory group was established to formulate geothermal legislation for proposal to the 1980 session of the legislature. Members of the advisory group included Stanley Green of the State Commercialization Team, representatives from the Legislative Analyst's Office legal advisors from the National Conference of State Legislatures, and representatives of the major companies involved in geothermal development in Utah, including Phillips Petroleum Company, AMAX, Thermal Power, O'Brien Resources, and Utah Power and Light.

The bill which was subsequently proposed to the 1980 legislature was supported by all of the advisory committee except Utah Power and Light, who apparently opposed any legislation which had any potential at all for affecting the administration of water rights. The bill was introduced to the legislature late in the session. It passed the House, but was amended before passing the Senate; the amendment, proposed by Utah Power and Light, would have thwarted the intent of the bill. Because the session was very near to its close, it was too late late at that point to re-amend and introduce the bill, and it died at the end of the session.

Throughout 1979 work on the proposed legislation continued. The advisory group modified the legislation, but Utah Power and Light still opposed it on principle. The bill which was introduced to the 1980 legislature was essentially the same as was introduced the previous year, with the exception of certain modifications made primarily in an attempt to gain the support of Utah Power and Light. However, when the bill was introduced to the legislature, Utah Power and Light actively opposed it. The bill was eventually tabled because of the controversy and confusion surrounding it.

During 1980, work on the legislation continued. After Utah Power and Light had signed the Roosevelt Hot Springs marketing contract with Phillips Petroleum Company, they agreed to drop their opposition to the legislation. The bill which was subsequently introduced to the 1981 legislature was essentially the same as the 1980 bill, but it passed with no opposition.

The major provisions of the bill are as follows:

--A geothermal resource is defined as the natural heat of the earth at temperatures above 120^{o} C and the energy, in whatever form, which may be extracted from that natural heat. Geothermal resources do not include geothermal fluids, which are defined as water or steam at temperatures in excess of 120^{o} C which may be naturally present in a geothermal system.

--Correlative rights are defined as the rights of each geothermal owner to produce his just and equitable share of the geothermal resource which underlies the geothermal area. Ownership of a geothermal resource derives from an interest in land and not from an appropriative right to geothermal fluids.

--Because of the potential relationship between geothermal fluids and groundwater resources, an approved application to appropriate geothermal fluids is required prior to the production of geothermal fluids from a well. The appropriation, however, does not guarantee ownership of the resource.

--The law assigns regulatory authority to the State Engineer (Division of Water Rights) and outlines his powers and responsibilities. Among other things, the State Engineer is authorized to hold hearings, to enforce unitization, and to regulate exploratory and development activities. The law is very specific about some of the regulatory and unitization provisiions.

The entire geothermal law has been included in the appendix to this report.

A number of issues related to geothermal development still should be addressed by legislation, but to date no such legislation has been proposed or suggested. Among the issues remaining to be resolved are tax incentives for geothermal developers, particularly for direct use; exemption of small district heating systems from public utility regulation; and the authorization for municipalities and other governmental or quasi-governmental entities to form district heating or energy systems.

A recurring problem for geothermal developers and regulators is the disposal of spent geothermal fluids. Reinjection may not be an attractive method of disposal for economic, hydrologic, technical, or environmental reasons. So far, cases involving reinjection and alternatives to reinjection have been considered by regulatory agencies on an individual basis.

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 January 1981 Douglas Nielsen left the project to take other employment and was replaced by Connie Walker, who directed and coordinated the outreach program for Utah.

The outreach activities for Utah for 1981 included the following:

—Legislation: Stanley Green, the State Team Leader, worked with the legislative and advisory committees to coordinate and advise in the preparation of the geothermal bill which was passed in February.

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

—Energy Fairs: The State Team exhibited the Utah Geothermal Display and distributed information at several energy fairs throughout the state. The State Team participated in energy fairs at Hill Air Force Base, Orem, Mount Pleasant, and several in Salt Lake City.

—Presentations: Presentations on geothermal energy in Utah were made to the Utah Water Users' Association in February. Stanley Green spoke to two workshop sessions about the recently passed geothermal legislation, and Ward Wagstaff gave an overview of geothermal resources and their utilization in Utah. In April, Stanley Green, along with several other state officials, participated in a workshop in Denver, Colorado, entitled "Energy Development in the 1980's: A Partnership between Government and Industry". At the workshop, Mr. Green served on a panel which discussed geothermal development.

Plans for upcoming outreach activities include the following:

—County Fairs: The state team has plans to exhibit the Utah Geothermal Display at several county Fairs during the late part of the summer. At this time, firm plans for the display include Washington, Utah, and Sanpete Counties. In addition to the display, slide presentations will be shown and geothermal information will be distributed.

—Geothermal/Industrial Packet: Current plans include the preparation of a Utah Geothermal Information Packet, which would be made available for use by industrial commissions or multi-county agencies to inform new industry about the potential for geothermal utilization in the state.

—Utah Geothermal Pamphlet: The state team plans to put together a pamphlet dealing with the use of geothermal energy in Utah. The pamphlet is intended for general distribution to the public.

—Technical Assistance: The state team plans to use technical assistance to the public to assist in the development of new projects and to demonstrate the feasibility of geothermal utilization in Utah.

2.7.1 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.

2.7.2 Overall Prospectus for Future Geothermal Commercialization

Although few new projects have been seriously proposed for Utah, there has been significant progress in projects already underway.

The largest project in Utah continues to be the Phillips/ATO/Utah Power and Light venture at Roosevelt Hot Springs.. Activity in the project during the first part of 1981 was primarily related to permitting, developer negotiations, planning, and design. Phillips has submitted permit applications for the additional production wells, which will probably be drilled in late 1981 or early 1982. There is little doubt that the resource at Roosevelt will be developed, although the extent and timing of that development is somewhat uncertain.

The Utah Roses greenhouses at Crystal Hot Springs are now in full operation and are an impressive demonstration of geothermal utilization. One drawback to the success at Crystal has been an excess of interest in that particular resource by other developers, a situation which has led to competition for the resource at that site. Since the resource capacity does not appear to be sufficient to supply all the needs of the would-be users, some regulatory restrictions on development are inevitable.

Other projects have not progressed so readily. This situation is probably due to several factors, including the general slowing of the economy, high interest rates, and the withdrawal of federal support of geothermal projects. This slowdown is generally expected to continue for some time, probably until the economy improves, and will probably affect smaller projects such as small direct utilization projects more than large electrical projects.

3.0 Summary of Major Findings and Recommendations

A short summary of the more important conclusions are included here.

—The potential for geothermal development in Utah is substantial, but barriers to development still exist. Often a resource is owned by someone who doesn't have the financial backing or interest to develop it. Along the Wasatch Front, for example, geothermal occurences are evidently related to deep circulation through fault systems, and only a few of them are high temperature/high quality resources. Development so far has clustered around the best resource sites, while lower quality resources are not well developed. These factors result in limitations of development at the better resource areas and slow development at others.

—Some legislation is still needed, as mentioned earlier. Geothermal development, particularly direct utilization, would be greatly encouraged by tax incentives, exemption of small district heating systems from regulation as public utilities, and authorization for municipalities to form district heating systems.

GEOTHERMAL RESOURCE CONSERVATION ACT

1981

GENERAL SESSION

Enrolled Copy

S. B. No. 43 By Fred W. Finlinson

Glade M. Sowards

AN ACT RELATING TO THE DEVELOPMENT OF GEOTHERMAL RESOURCES IN THE STATE; DECLARING THE PUBLIC INTEREST IN THIS DEVELOPMENT AND ASSIGNING REGULATORY AUTHORITY REGARDING THIS TO THE DIVISION OF WATER RIGHTS; DEFINING THE RESOURCE AND ITS RELATIONSHIP TO WATER; PROVIDING FOR THE PROTECTION OF CORRELATIVE RIGHTS AND THE PREVENTION OF WASTE; AUTHORIZING AND ESTABLISHING PROCEDURES FOR UNITIZING OF GEOTHERMAL AREAS; AND PROVIDING FOR PROCEDURES TO GOVERN REGULATION BY THIS DIVISION.

THIS ACT ENACTS THE UTAH GEOTHERMAL RESOURCE CONSERVATION ACT BY ENACTING SECTIONS 73-21-1 THROUGH 73-21-10, UTAH CODE ANNOTATED 1953; AND REPEALS SECTION 73-1-20, UTAH CODE ANNOTATED 1953, AS ENACTED BY CHAPTER 189, LAWS OF UTAH 1973.

Be it enacted by the Legislature of the State of Utah:

Section 1. Section 73-21-1, Utah Code Annotated 1953, is enacted to read:

73-21-1. This chapter shall be known and may be cited as the "Utah Geothermal Resource Conservation Act."

Section 2. Section 73-21-2, Utah Code Annotated 1953, is enacted to read:

73-21-2. It is declared to be in the public interest to foster, encourage, and promote the discovery, development, production, utilization, and disposal of geothermal resources in the State of Utah in such manner as will prevent waste, protect correlative rights, and safeguard the natural environment and the public welfare; to authorize, encourage, and provide for the development and operation of geothermal resource properties in such manner that the maximum ultimate economic recovery of geothermal resources may be obtained through, among other things, agreements for cooperative development, production, injection, and pressure maintenance operations.

Section 3. Section 73-21-3, Utah Code Annotated 1953, is enacted to read:

73-21-3. As used in this chapter:

(1) "Correlative rights" mean the rights of each geothermal owner in a geothermal area to produce without waste his just and equitable share of the geothermal resource underlying the geothermal area.

(2) "Division" means the division of water rights, department of natural resources.

(3) "Geothermal area" means the general land area which is underlain or reasonably appears to be underlain by geothermal resources.

(4) "Geothermal fluid" means water and steam at temperatures greater than 120 degrees centigrade naturally present in a geothermal system.

(5) "Geothermal resource" means: (a) the natural heat of the earth at temperatures greater than 120 degrees centigrade; and (b) the energy, in whatever form, including pressure, present in, resulting from, created by, or which may be extracted from that natural heat, directly or through a material medium. Geothermal resource does not include geothermal fluids.

(6) "Geothermal system" means any strata, pool, reservoir, or other geologic formation containing geothermal resources.

(7) "Material medium" means geothermal fluids, or water and other substances artificially introduced into a geothermal system to serve as a heat transfer medium.

(8) "Operator" means any person drilling, maintaining, operating, producing, or in control of any well.

(9) "Owner" means a person who has the right to drill into, produce, and make use of the geothermal resource.

(10) "Person" means any individual, business entity (corporate or otherwise), or political subdivision of this or any other state.

(11) "Waste" means any inefficient, excessive, or improper production, use, or dissipation of geothermal resources. Wasteful practices include, but are not limited to: (a) transporting or storage methods that cause or tend to cause unnecessary surface loss of geothermal resources; or (b) locating, spacing, constructing, equipping, operating, producing, or venting of any well in a manner that results or tends to result in unnecessary surface loss or in reducing the ultimate economic recovery of geothermal resources.

(12) "Well" means any well drilled, converted, or reactivated for the discovery, testing, production, or subsurface injection of geothermal resources.

Section 4. Section 73-21-4, Utah Code Annotated 1953, is enacted to read:

73-21-4. (1) Ownership of a geothermal resource derives from an interest in land and not from an appropriative right to geothermal fluids.

(2) This chapter shall apply to all lands in the State of Utah, including federal and Indian lands to the extent allowed by law. When these lands are committed to a unit agreement involving lands subject to federal or Indian jurisdiction, the division may, with respect to the unit agreement, deem this chapter complied with if the unit operations are regulated by

the United States and the division finds that conservation of geothermal resources and prevention of waste are accomplished under the unit agreement.

Section 5. Section 73-21-5, Utah Code Annotated 1953, is enacted to read:

73-21-5. (1) The division is granted jurisdiction and authority over all persons and property, public and private, necessary to enforce the provisions of this chapter and shall have the power and authority to adopt and enforce rules, regulations, and orders and do whatever may reasonably be necessary to carry out this chapter.

(2) Any affected person may apply for a hearing before the division, or the division may initiate proceedings upon any question relating to the administration of this chapter, and jurisdiction is conferred upon the division to hear and determine the same and enter its rule, regulation, or order with respect to the matter.

(3) The division shall have the power to summon witnesses, to administer oaths, and to require the production of records, books, and documents for examination at any hearing or investigation conducted by it.

(4) In case of failure or refusal on the part of any person to comply with a subpoena issued by the division, or in case of refusal of any witness to testify as to any matter regarding which he may be interrogated, any district court in the state, upon the application of the division, may issue an order compelling the person to comply with the subpoena and to attend before the division and produce any records, books, and documents covered by the subpoena or to give testimony or both. The court shall have the power to punish for contempt as in the case of disobedience to a like subpoena issued by the court, or for refusal to testify in the court.

(5) Whenever it appears that any person is violating or threatening to violate any provision of this chapter or any rule, regulation, or order made under this chapter, the division may bring suit in the name of the state against that person in the district court in the county of that person's residence, in the county of the residence of any defendant if there be more than one defendant, or in the county where the violation is alleged to have occurred, to restrain that person from continuing the violation or from carrying out the threat of violation. In the suit the court may grant injunctions.

(6) Nothing in this chapter, no suit by or against the division, and no violation charged or asserted against any person under this chapter, or any rule, regulation, or order issued under it, shall impair or abridge or delay any cause of action for damages which any person may have or assert against any person violating this chapter, or any rule, regulation, or order issued under it. Any person so damaged by the violation may sue for and recover such damages as he otherwise may be entitled to receive.

Section 6. Section 73-21-6, Utah Code Annotated 1953, is enacted to read:

73-21-6. (1) The division shall have authority to require:

(a) Identification of the location and ownership of all wells and producing geothermal leases.

(b) Filing with the division of a notice of intent to drill, redrill, deepen, permanently alter the casing of, or abandon any well. Approval of the notice of intent must be obtained from the division prior to commencement of operations.

(c) Keeping of well logs and filing true and correct copies with the division. These records are public records when filed with the division, unless the owner or operator requests, in writing, that the records be held confidential.

The period of confidentiality shall be established by the division, not to exceed five years from the date of production or injection for other than testing purposes or five years from the date of abandonment, whichever occurs first, as determined by the division. Well records held confidential by the division are open to inspection by those persons authorized in writing by the owner or operator. Confidential status shall not restrict inspection by state officers charged with regulating well operations or by authorized officials of the Utah state tax commission for purposes of tax assessment.

(d) The spacing, drilling, casing, testing, operating, producing, and abandonment of wells so as to prevent: (i) geothermal resources, water, gases, or other fluids from escaping into strata other than the strata in which they are found (unless in accordance with a subsurface injection program approved by the division); (ii) pollution of surface and groundwater; (iii) premature cooling of any geothermal system by water encroachment or otherwise which tends to reduce the ultimate economic recovery of the geothermal resources; (iv) blowouts, cavings, and seepage; and (v) unreasonable disturbance or injury to neighboring properties, prior water rights, human life, health, and the environment.

(e) The operator to file cash or individual surety bonds with the division for each new well drilled and each abandoned well redrilled. The amount of surety required shall be determined by the division. In lieu of bonds for separate wells, the operator may file a blanket cash or individual surety bond in an amount set by the division to cover all the operator's drilling, redrilling, deepening, maintenance, or abandonment activities for wells in the state. Bonds filed with the division shall be executed by the operator, as principal, conditioned on compliance with division regulations in drilling, redrilling, deepening, maintaining, or abandoning any well or wells covered by the bond and shall secure the state against all losses, charges, and expenses incurred by it to obtain such compliance by the principal named in the bond.

(f) The geothermal owner or operator to measure geothermal production according to standards set by the division and maintain complete and accurate production records. The records, or certified copies of them, shall be preserved on file by the owner or operator for a period of five years and shall be available for examination by the division at all reasonable times.

(g) Filing with the division any other reasonable reports which it prescibes regarding geothermal operations within the state.

(2) Any bond filed with the division in conformance with this chapter may, with the consent of the division, be terminated and canceled and the surety be relieved of all obligations under it when the well or wells covered by the bond have been properly abandoned or another valid bond has been substituted for it.

(3) The division may enter onto private or public land at any time to inspect any well or geothermal resource development project to determine if the well or project is being constructed, operated, or maintained according to any applicable permits or to determine if the construction, operation, or maintenance of the well or project may involve an unreasonable risk to life, health, property, the environment or subsurface, surface, or atmospheric resources.

Section 7. Section 73-21-7, Utah Code Annotated 1953, is enacted to read:

73-21-7. (1) The division upon its own motion may hold, and upon the application of any affected person shall hold, a hearing to consider the need for cooperative or unit operation of a geothermal area.

(2) The division shall make an order providing for the cooperative or unit operation of part or all of a geothermal area if the division finds that a developable resource exists and that this operation is reasonably necessary to prevent waste, to protect correlative rights, or to prevent the drilling of unnecessary wells and will not reduce the ultimate economic recovery of geothermal resources.

(3) An order for cooperative or unit operations shall be upon terms and conditions that are just and reasonable and satisfy the requirements of subsection (2).

(4) An order by the division for unit operations shall prescribe a plan, including:

(a) A description of the geothermal area to be so operated, termed the unit area.

(b) A statement of the nature of the operations contemplated, the time they will commence, and the manner and circumstances under which unit operations shall terminate.

(c) An allocation to the separately-owned tracts in the unit area of the geothermal resources produced and of the costs incurred in unit operations. The allocations shall be in accord with the agreement, if any, of the affected parties. If there is no such agreement, the division shall determine the allocations from evidence introduced at a hearing before the division. Production shall be allocated in proportion to the relative value that each tract bears to the value of all tracts in the unit area. The acreage of each tract in proportion to the total unit acreage shall be the measure of relative value, unless the division finds after public hearing that another method is likely to result in a more equitable allocation and protection of correlative rights. Resource temperature, pressure, fluid quality, geological conditions, distance to place of use, and productivity are among the factors that may be considered in evaluating other methods. The method for allocating production in unit operations shall be revised if after a hearing the division finds that the revised method is likely to result in a more equitable allocation and protection of correlative rights. The division shall hold a hearing to consider adoption of a revised allocation method upon the application of any affected person, but the application may not be made until three years after the initial order by the division or at less than two-year intervals after that.

(d) A provision for adjustment among the owners of the unit area (not including royalty owners) of their respective investment in wells, tanks, pumps, machinery, materials, equipment, and other things and services of value attributable to the unit operations. The amount to be charged unit operations for each item shall be determined by the owners of the unit area (not including royalty owners), but if the owners of the unit area are unable to agree upon the amount of the charges or to agree upon the correctness of same, the division shall determine them after due notice and hearing, upon the application of any affected party. The net amount charged against the owner of a separately-owned tract shall be considered an expense of unit operation chargeable against that tract. The adjustments provided for in this subsection may be treated separately and handled by agreements separate from the unitization agreement.

(e) A provision providing how the costs of unit operations, including capital investments, shall be determined and charged to the separately-owned tracts and how these costs shall be paid, including a provision providing when, how, and by whom the unit production allocated to an owner who does not pay the share of the cost of unit operation charged to that owner, or the interest of that owner, may be sold and the proceeds applied to the payment of the costs. The operator of the unit shall have a first and prior lien for costs incurred pursuant to the plan of unitization upon each owner's geothermal rights and his share of unitized production to secure the payment of the owner's proportionate part of the cost of developing and operating the unit area. This lien may be established and enforced in the same manner as provided by sections 38-1-8 through 38-1-26. For these purposes any nonconsenting owner shall be deemed to have contracted with the unit operator for his proportionate part of the cost of developing and operating the unit area. A transfer or conversion of any owner's interest or any portion of it, however accomplished, after the effective date of the order creating the unit, shall not relieve the transferred interest of the operator's lien on the interest for the cost and expense of unit operations.

(f) A provision, if necessary, for carrying or otherwise financing any person who elects to be carried or otherwise financed, allowing a reasonable interest charge for this service payable out of that person's share of the production.

(g) A provision for the supervision and conduct of the unit operations, in respect to which each person shall have a vote with a value corresponding to the percentage of the costs of unit operations chargeable against the interest of that person.

(h) Such additional provisions that are found to be appropriate for carrying on the unit operations.

(5) No order of the division providing for unit operations shall become effective unless and until the plan for operations prescribed by the division has been approved in writing by those persons, who under the division's order, will be required to pay 66% of the costs of the unit operation, and also by the owners of 66% of the production or proceeds of same that are free of costs, such as royalties, overriding royalties, and production payments; and the division has made a

finding that the plan for unit operations has been so approved. If the persons owning the required percentage of interest in the unit area do not approve the plan within six months from the date on which the order is made, the order shall be ineffective and shall be revoked by the division unless for good cause shown the division extends this time.

(6) An order providing for unit operations may be amended by an order of the division in the same manner and subject to the same conditions as an original order for unit operations; but if this amendment affects only the rights and interests of the owners, the approval of the amendment by the owners of royalty, overriding royalty, production payments, and other interests which are free of costs shall not be required. Production allocation may be amended only according to subsection 73-21-7 (4) (c).

(7) All operations, including, but not limited to, the commencement, drilling, or operation of a well upon any portion of the unit area shall be deemed for all purposes the conduct of such operations upon each separately-owned tract in the unit by the several owners of tracts in the unit. The portions of the unit production allocated to a separately-owned tract in a unit area shall, when produced, be deemed for all purposes to have been actually produced from that tract by a well drilled on it. Good faith operations conducted pursuant to an order of the division providing for unit operations shall constitute a complete defense to any suit alleging breach of lease or of contractual obligations covering lands in the unit area to the extent that compliance with these obligations cannot be had because of the order of the division.

(8) The portion of the unit production allocated to any tract, and the proceeds from the sale of this production, shall be the property and income of the several persons to whom, or

to whose credit, the same are allocated or payable under the order providing for unit operations.

(9) Except to the extent that the parties affected so agree and as provided in subsection 73-21-7 (4) (e), no order providing for unit operations shall be construed to result in a transfer of all or any part of the title of any person to the geothermal resource rights in any tract in the unit area. All property, whether real or personal, that may be acquired in the conduct of unit operations shall be acquired for the account of the owners within the unit area and shall be the property of these owners in the proportion that the expenses of unit operations are charged.

Section 8. Section 73-21-8, Utah Code Annotated 1953, is enacted to read:

73-21-8. (1) Geothermal fluids are deemed to be a special kind of underground water resource, related to and potentially affecting other water resources of the state. The utilization or distribution for their thermal content and subsurface injection or disposal of same shall constitute a beneficial use of the water resources of the state.

(2) (a) Geothermal owners shall, prior to the commencement of, or increase in, production from a well or group of wells to be operated in concert, file an application with the division to appropriate such geothermal fluids as will be extracted from the well or group of wells. Publication of applications shall be made as provided in section 73-3-6, and protests may be filed as provided in section 73-3-7. The division shall approve an application if it finds that the applicant is a geothermal owner and that the proposed extraction of geothermal fluids will not impair existing rights to the waters of the state.

(b) The division may grant the quantity of an application on a provisional basis, to be finalized upon stabilization of well production. Flow testing of a discovery well shall not require an application to appropriate geothermal fluids.

(3) The date of an application to appropriate geothermal fluids, when approved by the division, shall be the priority date as between the geothermal owner and the owners of rights to water other than geothermal fluids. No priorities shall be created among geothermal owners by the approval of an application to appropriate geothermal fluids.

Section 9. Section 73-21-9, Utah Code Annotated 1953, is enacted to read:

73-21-9. Rights to geothermal resources and to geothermal fluids to be extracted in the course of production of geothermal resources acquired under section 73-21-8 shall be based on the principle of correlative rights.

Section 10. Section 73-21-10, Utah Code Annotated 1953, is enacted to read:

73-21-10. (1) Any person adversely affected by any rule, regulation, or order issued under this chapter may within 60 days after the effective date of the rule or regulation or entry of the order bring a civil suit against the division in the district court of Salt Lake County or in the district court of the county in which the complaining person resides to test the validity of the rule, regulation, or order, or to secure an injunction or to obtain other appropriate relief, including all rights of appeal.

(2) An action or appeal involving any provision of this chapter, or a rule, regulation, or order issued under it shall be determined as expeditiously as feasible. The trial court shall determine the issues on both questions of law and fact and shall affirm or set aside the rule, regulation, or order, or remand the cause to the division for further proceedings. The court is authorized to enjoin permanently the enforcement by the division of this chapter, or any act done or threatened

under it, if the plaintiff shall show that as to him the act or conduct complained of is unreasonable, unjust, arbitrary, or capricious, or violates any constitutional right of the plaintiff or if the plaintiff shows that the act complained of constitutes or results in waste or does not in a reasonable manner accomplish an end that is the purpose of this chapter.

(3) Any person who, for the purpose of evading this chapter or any rule, regulation, or order of the division issued under it, shall make or cause to be made any false entry in any report, record, account, or memorandum required by this chapter, or by any rule, regulation, or order issued under it, or shall omit or cause to be omitted from the report, record, account, or memorandum, full, true and correct entries as required by this chapter, or by the rule, regulation, or order, or shall remove from this state or destroy, mutilate, alter, or falsify the record, account, or memorandum, is guilty of a class A misdemeanor.

(4) No suit, action, or other proceeding based upon a violation of this chapter or any rule, regulation, or order of the division issued under it shall be commenced or maintained unless same shall have been commenced within two years from the date of the alleged violation.

Section 11. If any provision of this act, or the application of any provision to any person or circumstance, is held invalid, the remainder of this act shall not be affected thereby.

Section 12. Section 73-1-20, Utah Code Annotated 1953, as enacted by Chapter 189, Laws of Utah 1973, is repealed.

WYOMING GEOTHERMAL COMMERCIALIZATION PROJECT
SEMI-ANNUAL PROGRESS REPORT

January - June , 1981

Prepared by

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U.S. Department of Energy
Idaho Operations Office

CONTENTS

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 resource assessment data.

1.2 Objectives

The objectives of the WGCO are: (1) To bring about a general understanding and use of geothermal energy in Wyoming, (2) To create a working relationship and exchange of information with other state or federal agencies involved in geothermal development, (3) To contribute to the accomplishment of national geothermal energy goals of the U.S. Department of Energy, (4) To develop usable plans that will help to predict and encourage geothermal development in Wyoming, (5) To maintain regional ties with other states, and (6) 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	Co-Principal Investigator
Rick James	Program Director
Karen Marcotte	Research Associate
Patti Burgess-Lyon	Graduate Research Assistant
Ruth Tebbutt	Senior Secretary
Keith Bray	Work-Study Student

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 THERMAL PROSPECTS

Resource	Temperature (°C)	Depth (meters)
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 THERMAL PROSPECTS

Resource	Temperature (°C)	Depth (meters)
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: Breckenridge, R. and B. Hinckley, Thermal Springs of Wyoming, Bulletin 60, Wyoming Geological Survey, 1978.)

TABLE 3
INFERRED DIRECT THERMAL PROSPECTS

Resource	Temperature (^{o}C)	Depth (km)
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 the 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 Limesone, 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

2.21 State Geothermal Planning Areas

See Figure 1.

2.22 Specific ADP's - Completed or in Preparation

See Fig. 2 (shaded area has been completed).

a. Big Horn Basin ADP
b. Fremont County ADP
c. Converse/Natrona ADP

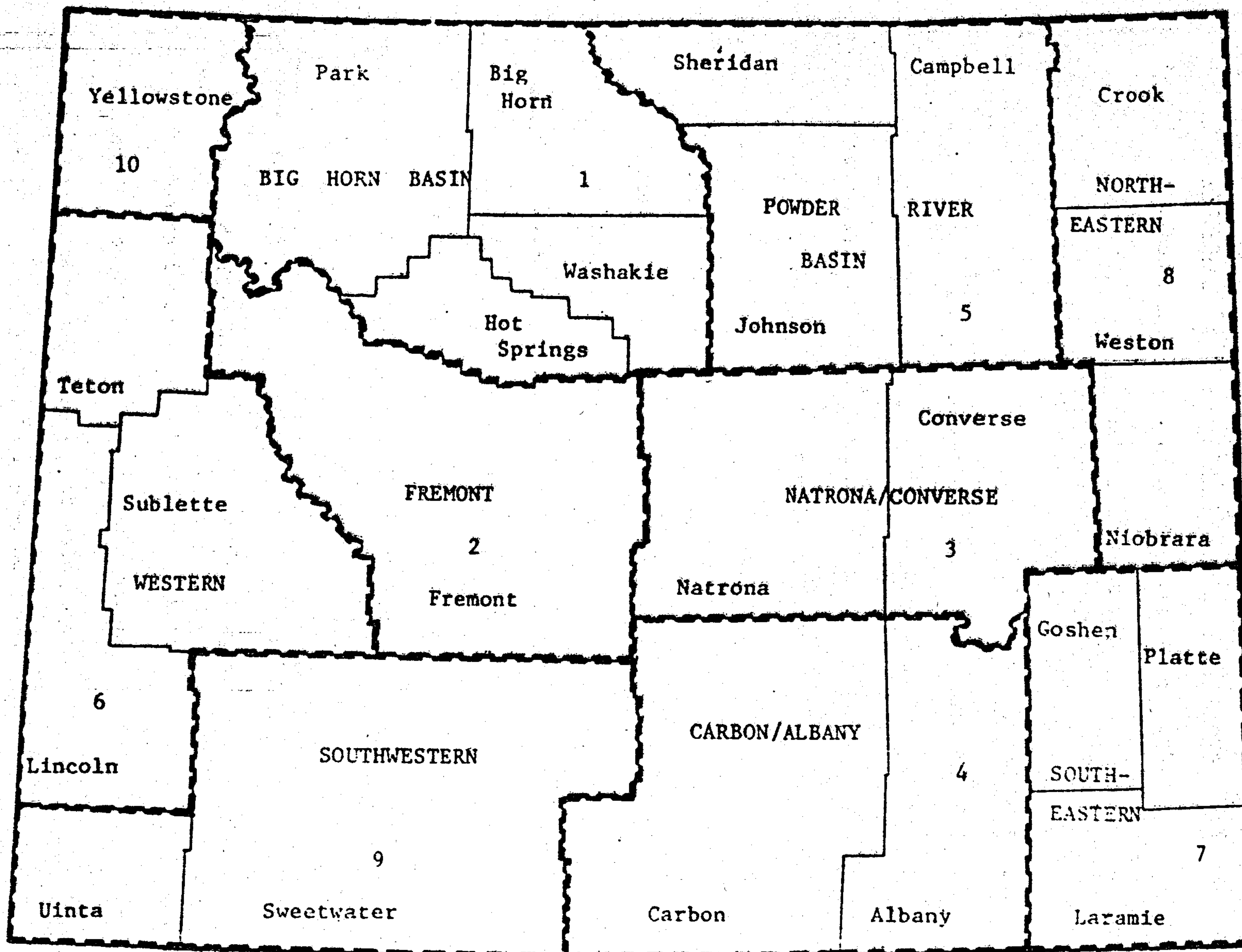
2.3 Site Specific Development Plans

2.31 Candidate Geothermal Sites/Applications

a. Midwest/Edgerton

(i) Resource data for Midwest/Edgerton area is summarized as follows: "It is clearly shown that the Salt Creek Oil Field is a conspicuous thermal anomaly. Within this 10 - 12^2 mile field, bottom hole temperatures between 1,000 and 4,500 feet (.3 - 1.4 km) are in the range 120 - 170°F (49 - 77°C), and maximum calculated gradients are between 40 and 100°F/1,000 feet (72 - 182°C/km). Additionally, water injection wells that penetrate the Madison Formation produce 160 - 175°F (71 - 79°C) waters that flow to the surface at rates exceeding 7,000 gallons/min. There can be little doubt, therefore, that the Salt Creek Field could be used to produce hydrothermal fluids for direct-heat applications in the vicinity of Midwest. The major impedences to resource development could be the relative values of hydrocarbon and geothermal resources, the high concentrations of solids in the

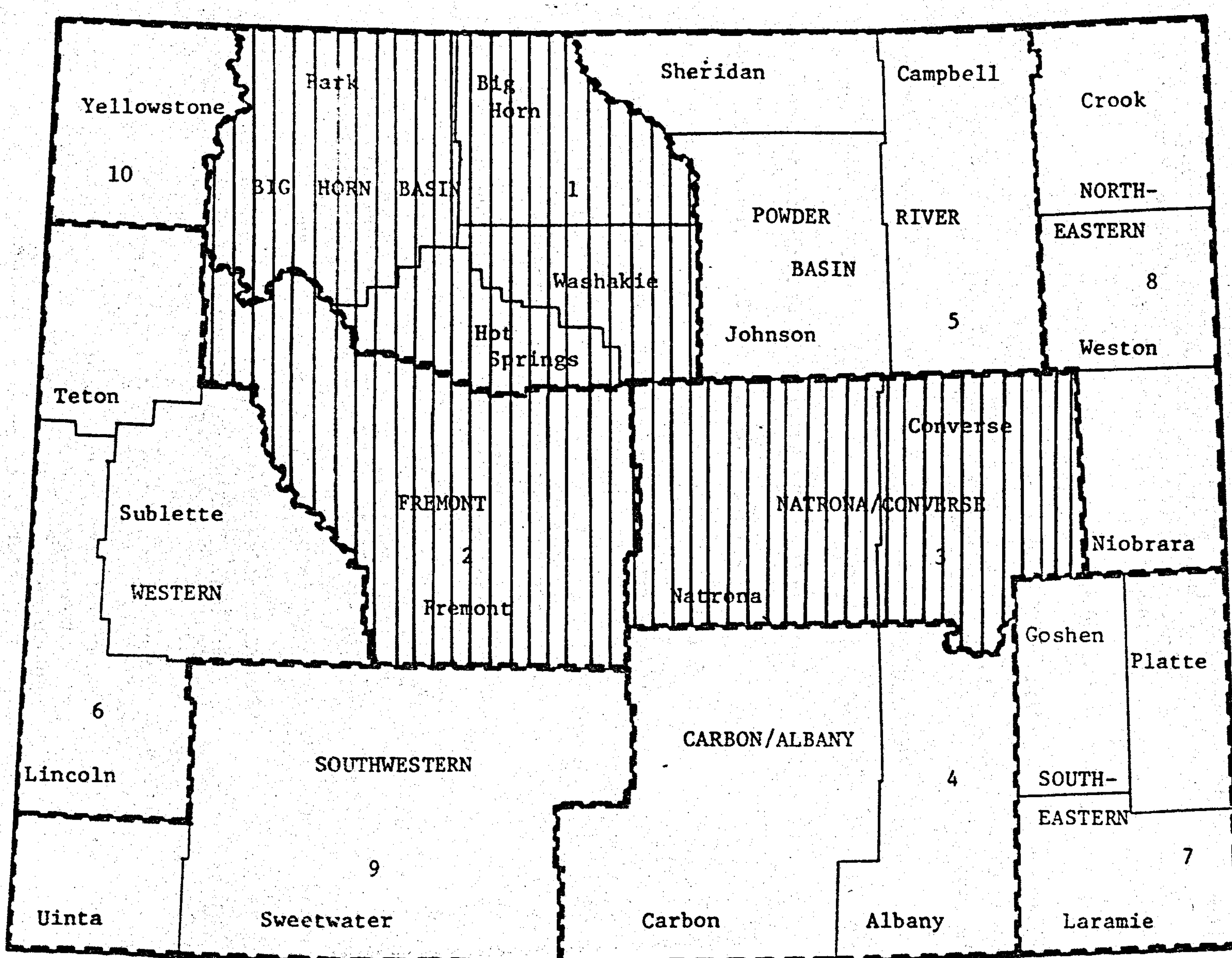
Figure 1. WYOMING GEOTHERMAL PLANNING REGIONS



Scale: 1 in. = 50 mi.
1 cm. = 31.69 km.

Note: Numbers in regions indicate ADP priorities.

Figure 2. WYOMING GEOTHERMAL PLANNING REGIONS



Scale: 1 in. = 50 mi.
1 cm. = 31.69 km.

Note: Numbers in regions indicate ADP priorities.

nonpotable waters, and the question of whether AMOCO Production Co., Wyoming, or the federal government owns the geothermal resource."

(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.)

(ii) Proposed uses for Midwest/Edgerton area:

--greenhousing
--aquaculture
--district heating for part or all of these small, adjacent communities

b. Auburn/Afton

(i) Resource data for Auburn/Afton area: "Auburn Hot Springs, 62°C. The Auburn Hot Springs cover approximately three acres around a private residence. Included in the area are over 100 separate vents which form mud pots, tiny terraces, large terraces, weak geysers, cones, sulfur veins, and two large pools. Flow is accompanied by profuse bubbling, a strong hydrogen sulfide smell, and a lush growth of multicolored algae."

NOTE: Additional resource assessment work on the Auburn/Afton area is presently underway by the Wyoming Resource Assessment Team and the Earth Sciences Laboratory of UURI.

(Source: Breckenridge, R. and B. Hinckley, Thermal Springs of Wyoming, Bulletin 60, Wyoming Geological Survey, 1978.)

(ii) Proposed uses for the Auburn/Afton area:

--dairy industry process heat
--greenhousing
--aquaculture
--district heating of one or both of these small towns
--space heating of any private and commercial

buildings that may be located near the Auburn Hot Springs.

2.32 Site Specific Development Plans - Completed or in Preparation

a. Thermopolis/East Thermopolis Site Specific Development Analysis (completed and available in final form from the Wyoming Geothermal Commercialization Office.

(i) Population: 4,000 (1979 figure)

The population of Thermopolis increased about 30% between 1970 and 1979. The majority of this increase occurred between 1975 and 1979. Approximately 30% of the total population consists of senior citizens. Thermopolis has become a popular retirement spot in recent years and that trend is expected to continue.

(ii) Geothermal Resource Information

Temperatures, gradients and regional geology have been compiled for a 1,800 - 1,900 mi^2 area that is roughly centered on the Thermopolis Hot Springs. The results demonstrate that the thermal anomaly occurs all along the central part of the Thermopolis anticline, occupying a 20-mi long by 3-mi wide area that strikes west-northwest between the southwestern part of T. 43 N., R. 93 W. and the southeastern part of T. 44 N., R. 96 W. Within this zone, calculated gradients are in the range 43 - 300°F/1,000 ft (78 - 547°C/km) and tabulated bottom hole temperatures range from 90°F (32°C) to 160°F (70°C) at depths less than 2,000 ft (≈.6 km). Inasmuch as downward continuation of the lower gradients predicts 60+°C temperatures at depths between 3,500 and 4,000 ft (1.1 - 1.2 km), we consider all of the region to be a "viable" low temperature, hydrothermal resource area.

The Red Springs Anticline area in T. 43 N., R. 93 W. may be a "marginal" resource area. Here the calculated gradients are in the range 24 - 59°F/1,000 ft (43 - 107°C/km). Consequently, 45°C waters might be encountered at 3,900 - 4,500 ft depth (1.2 - 1.3).

A tightly folded syncline is located immediately south of the Thermopolis anticline. It is believed that waters from the Owl Creek Mountains are heated at the bottom of this syncline. Subsequent upward movement of these waters along the northern flanks of the syncline could explain the high gradients in the anticline. The thermal waters are most likely to be in the Tensleep and/or Madison Formation—two formations with porosities and permeabilities sufficient to yield the flow rates (≈2,800 gpm; Breckenridge and Hinckley, 1978) of the spring system in Hot Springs State Park. Within the central part of the anticline, the "tops" of the Tensleep and Madison range from 200 - 2,800 ft (.06 - .85 km) and 800 - 3,450 ft (.24 - 1.08 km), respectively. It is possible, therefore, that these aquifers could be reached with economical drilling in some parts of the structure.

Referring to "practical" aspects of resource development, one question that must be answered is whether drilling and large scale development would change temperatures and flow rates of the Thermopolis Hot Springs. Lack of data on porosities and permeabilities of the regional subsurface units also could impede development, as could the data for the springs which suggest that regional thermal waters would contain large amounts of total dissolved solids. Finally, minor structures along the crest of the anticline should be carefully considered during drill site selection; for example, numerous faults cross-cut the northwest-southeast trend of the anticline, and a heretofore unmapped fault is evident on air photos of the structure.

(Source: King, J.K., H.P. Heasler, and E.R. Decker, 1980. The Thermopolis Hydrothermal System, Rough Draft, Department of Geology, University of Wyoming, 47 pp.)

(iii) Proposed Process/Applications of Thermopolis Resource

Greenhousing - A case study was conducted for a one-acre greenhouse utilizing geothermal energy as the heat source. This greenhouse has a heating requirement of 10.598 MBTU annually. Cost comparisons between greenhouses using natural gas, fuel oil, coal and geothermal as heat sources were made using figures from: Task Force Report on Klamath Falls Greenhouse Production Potential, 1977.

Ethanol Production - A small scale ethanol production plant has been proposed by one of the private well owners in Thermopolis. The ethanol plant was included in the SSDP as an example of possible uses. Because temperatures of about 300°F are needed for ethanol production, (and the well's water temperature is 129°F, 54°C), the geothermal heat source would have to be supplemented. The owner of this well is considering the use of heat pumps and solar energy as supplemental heat sources to the existing geothermal well.

District Heating - Three case studies of district heating systems for Thermopolis were included in the SSDP. Two of the case studies were completed by NMEI and the third by WEPL, Ltd. The entire cost estimate schedule and notes on assumptions were included in the SSDP. Initial investment costs ranged from $2.5 million to $10 million dependent upon assumptions made. An annual heat demand of 55,000 MMBTU/yr. was assumed in all cases.

(iv) Community Interest and Recent Developments

A great deal of community interest presently exists in the town in regard to a district heating system. The large number of persons living on fixed incomes and a recent 40% increase in local natural gas rates contributes significantly to this interest.

The town of Thermopolis recently applied for and received a feasibility study grant through the cooperatively funded DOE/HUD District Heating System Project. Thermopolis' grant is for a total of $50,600. Much of the work for this feasibility study will consist of labor provided by interested citizen groups and local expertise. A private consultant will be hired to assess the economic and engineering feasibility of this project. The consultant will be selected by the Town Manager, County Planner and the City Council, with guidance and assistance from an Advisory Work Group. Consultant selection has not been completed at the time of this writing but should be forthcoming during the month of June.

If the feasibility of this project looks good after the completion of the study, the Town of Thermopolis could use additional assistance to bring this project on line. Identification of public and private sources of funding, and the method for application of such funds would be extremely helpful on this promising project.

b. Cody Site Specific Development Analysis (completed in rough draft form and available from the Wyoming Geothermal Commercialization Office.)

(i) Population:

The Census Retrieval and Information Service (CRIS) released the final 1980 census count for Cody as 6,790 persons. This is a 3.6% increase since 1970 when the census counted 5,161 persons in Cody. At the time of this writing, age distribution of the population had not been released for 1980.

(ii) Geothermal Resource Information:

This potential resource area is bounded by the DeMaris Hot Springs (27 - 39°C (80 - 96°F) 1,700 gpm) just west of Cody and the Horse Center anticline about 7 miles to the south. The first evidence for a low-temperature resource was provided by the 49 - 205°C/km (27 - 112°F/1,000 ft) gradients calculated using bottom hole temperatures in eleven dry oil wells in the anticline. Down hole measurements by Wyoming personnel agree with the oil well data. For example, least-squares gradients and maximum temperatures based on measurements in five shallow oil wells are in the ranges 96 - 190°C/km (52 - 104°F/1,000 ft) and 38.4 - 47.5°C (101 - 117°F), respectively, at subsurface depths in the range 185 - 500m (607 - 1,640 ft).

Data from six shallow temperature gradient wells drilled by the Department of Geology in early 1980 suggest that the area of greatest potential use is in T. 52 N., R. 102 W., S½ of section 2, and W½ of section 11. In this area, warm waters (34°C (93°F)) can be reached at shallow depths (51 to 300 meters (168 to 1,000 ft)). The maximum temperature of this system may approach 55 to 65°C (131 - 149°F) at depths of 260 to 500m (853 to 1,640 ft). Warm waters will be found at the shallower depths in the more western portions of this potential use area.

The main aquifers for the Cody-Horse Center hydrothermal system are the Tensleep Sandstone, Madison Limestone, and Bighorn Dolomite. These formations are reported to have good porosities and permeabilities with flows in the Madison Limestone and the Bighorn Dolomite sometimes exceeding 1,000 gallons per minute. However, the water flow of wells drilled into these aquifers may vary greatly between wells due to secondary fracture permeability, secondary silica cementation of the Tensleep Sandstone, and the cavernous nature of the Madison Limestone and Bighorn Dolomite.

The Rattlesnake anticline is between Cody and the Horse Center anticline. As seems to be the case elsewhere in the area, the Chugwater Formation in this anticline appears to be an impermeable cap rock that overlies porous, permeable and perhaps water-bearing units in the Tensleep and Madison Formations. It is believed that waters are heated at depth in a syncline that is to the southwest of the Rattlesnake anticline. Subsequent upward movement of the water along the northeastern flank of the syncline through the Tensleep and Madison Formations results in the warm temperatures at shallow depths.

(Source: Heasler, H.P. and E.R. Decker, 1980. Preliminary Data from Six Temperature Gradient Holes near Cody, Wyoming, Department of Geology, University of Wyoming, 35 pp.)

(iii) Proposed Process/Applications of Cody Resource: Three hypothetical district heating systems for Cody were developed. One is for the central portion of the city of Cody, and the other two are for residential subdivisions outside the city limits.

Case I - Cody Heating District

The Cody Heating District is a 15 square block area of central Cody. This area includes the hospital, Buffalo Bill Historical Center, high school complex, 75 homes, and 210 businesses including city and county buildings.

This heating district is not now cost effective due to the unusually low price ($1.90/MMBTU) of natural gas in Cody. The expected cost of the geothermal fuel for this heating district is $3.34/MMBTU, with an estimated annual energy demand of 29.4×10^9 BTU/year.

Cody has an agreement for a guaranteed supply of natural gas at a guaranteed price. When this agreement expires, the price of natural gas in Cody will increase dramatically due to deregulation and inflation. At that point in time, geothermal energy will be cost competitive.

Case II - Large South Fork Subdivision Heating District

The Large South Fork Subdivision Heating District is presently cost competitive. The geothermal fuel is compared to electricity and propane ($9.00 - $10.00/MMBTU) which are currently used for fuel in this subdivision

Homes	Annual Demand	Annual Geothermal Cost per Home	% Savings
100	9.47×10^9 BTU/yr	$586	52%
200	18.94×10^9 BTU/yr	$387	68%
300	28.41×10^9 BTU/yr	$368	69%
400	39.77×10^9 BTU/yr	$353	70%

The cost to the homeowner for geothermal ranges from $353 to $586 per year depending on the number of homes on line. This cost is very attractive compared to $943 per year for electrical heat.

Case III - Small South Fork Subdivision Heating District

20 homes, 2,000 ft^2 each

1 greenhouse, 3,750 ft^2

1 barn, 500 ft^2

Total annual energy demand = $2,545 \times 10^6$ BTU/yr

This heating district is also compared to electricity and propane as fuels. The estimated cost savings for a goethermal system over 20 years is

73%. In the first year alone, geothermal energy would cost $484 compared to $1,062 for conventional fuel. Payback calculations for this system show a five year breakeven period.

(iv) Community Interest and Recent Developments:

There are two types of energy consumers in Cody: those served by inexpensive natural gas, and those who consume higher priced electricity and propane due to the unavailability of natural gas. The gas supply network of the Cody Gas Company is not viewed as being expandable at this time. Therefore, many of the new residential subdivisions (especially those south of town) are served only by propane or electricity.

Understandably, those consumers paying the high price for energy are very interested in utilizing the comparitively less expensive geothermal energy source. Several private developers are interested in finding funding sources for subdivision district heating projects of up to 200 homes each.

Attendance at WGCO sponsored meetings in Cody has been high, with inquiries directed towards this office from Cody residents steadily increasing over time.

2.4 Time Phased Project Plans

None.

2.5 State Aggregation of Prospective Geothermal Utilization

ADP's	1981 MMBTU/yr	1985 MMBTU/yr	2000 MMBTU/yr	2020 MMBTU/yr
Big Horn Basin	10,000	50,000	125,000	170,000
Fremont County	20	40	45	50
Converse/Natrona	10	25,000	50,000	50,000
Carbon/Albany	15	15	30	30
Powder River Basin	15	25	45	60
Western	15	25	150	275
Southeastern	0	10	10	10
Northeastern	0	10	10	10
Southwestern	0	0	5	10
Total from ADP's	10,075	75,125	175,295	220,445

SSDP's	1981 MMBTU/yr	1985 MMBTU/yr	2000 MMBTU/yr	2020 MMBTU/yr
Thermopolis	5,000	55,000	100,000	125,000
Cody	5,000	45,255	60,000	85,000
Midwest	0	75	100	150
Afton/Auburn	0	125	1,000	1,750
Total SSDP's	10,000	100,455	161,100	211,900

2.6 Institutional Analysis

The WGCO, in cooperation with the National Conference of State Legislatures, worked for nearly one year with the Joint Mines, Minerals and Industrial Development Interim Committee of the Wyoming state legislature to develop and enact clarifying geothermal legislation. The outcome of this work was the introduction of two bills, House Bill 282 and 283, both sponsored by the Joint Interim Committee.

House Bills 282 and 283 were described in detail in the July - December, 1980 Semi-Annual Progress Report prepared by this office. A brief description of the two bills is as follows:

HB282 - gives the State Board of Land Commissioners the authority to lease state lands or school lands for geothermal development.

HB283 - specifies that the extraction of heat is a beneficial use of water.

House Bill 283 passed both the state house and senate and was signed into law by Governor Herschler on February 26, 1981. House Bill 282 died in committee in the senate at the termination of the regular legislative session. It will probably be reintroduced during the next regular session.

In addition to legislative analysis and monitoring, the WGCO is currently 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 potential geothermal developers in the state.

2.7 Public Outreach Program

2.71 Outreach Mechanisms

1. Distribution of published information produced by the WGCO and the Wyoming Resource Assessment Team.
2. Responses to informational requests that come into the WGCO by mail and telephone.
3. "The Geothermal News," a monthly WGCO newsletter with a circulation of 600.
4. Toll-free in-state telephone number.
5. Public presentations to professional, public, civic,

and academic organizations.

6. Radio interviews and newspaper releases.

7. Expanded use of informational workshops.

2.72 Summary of Contacts and Results

1. 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 this 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.

2. Presentations on the geothermal potential of Cody were given to: the Cody City Council, the County Planning and Zoning Commission, the Park County planner and two private developers interested in building geothermally heated subdivisions.

3. An all day state wide informational workshop on geothermal energy was held on April 14, 1981. This workshop was well attended and provided a great deal of information on topics such as: application technologies, economics of direct use, Wyoming geothermal resources, institutional overview, water rights and state regulations, heat pumps, corrosion, environmental factors, and federal leasing and regulation.

   The speakers at the workshop were: Wyoming Senator Diemer True; Ed DiBello of EG&G of Idaho, Inc.; Chuck Higbee of the Oregon Institute of Technology;

Henry Heasler of the University of Wyoming Department of Geology; Richard T. Meyer of Western Energy Planners, Ltd.; Richard Stockdale, State Groundwater Geologist; Richard Deery, Bureau of Land Management; and Steven Goering of Glenn Coury and Associates.

4. A presentation was made on geothermal energy to the University of Wyoming student body on April 17, 1981. This presentation was part of a week long Appropriate Technology conference sponsored by the University Women's Center and Student Activities Council.

2.73 Overall Prospectus for Future Geothermal Commercialization

Additional geothermal development is likely to occur in the Thermopolis region in the near future. The WGCO has submitted a community profile of Thermopolis to the DOE in an attempt to acquire financing advice to the town through the Community Assistance Contractor: Elliot Allen and Associates of Salem, Oregon. The WGCO will remain closely involved with Thermopolis as a member of the Work Assessment Group for the HUD/DOE District Heating Program Grant.

The Cody area also shows a great deal of promise. Geothermal energy utilization will most likely occur after deregulation of their natural gas prices go into effect. There are two private developers in Cody that are beginning the developmental process by filing for water rights and studying financing options for the geothermal subdivisions they have planned.

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 aquacultural industries of these areas.

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. Some state support is continuing from the Mineral Division of the Department of Economic Planning and Development.

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

1. Increase financing opportunities for district heating projects (i.e. continue existing programs into fiscal year 1982 and initiate other community assistance programs aimed at locating funding sources for geothermal development).
2. 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.
3. Increase state support of geothermal energy development.
4. Streamline state and federal leasing requirements and legislatively create a uniform definition of a geothermal resource.
5. Create a simpler method for potential geothermal developers to utilize abandoned mineral exploration wells without the

capital-intensive "in perpetuity" bonding regulations.

6. Continue providing federal funds for state planning and resource teams. Without data, there is no sure awareness of an alternative to fossil fuels. Without the public awareness of the alternative energy choices available, changes cannot be made.