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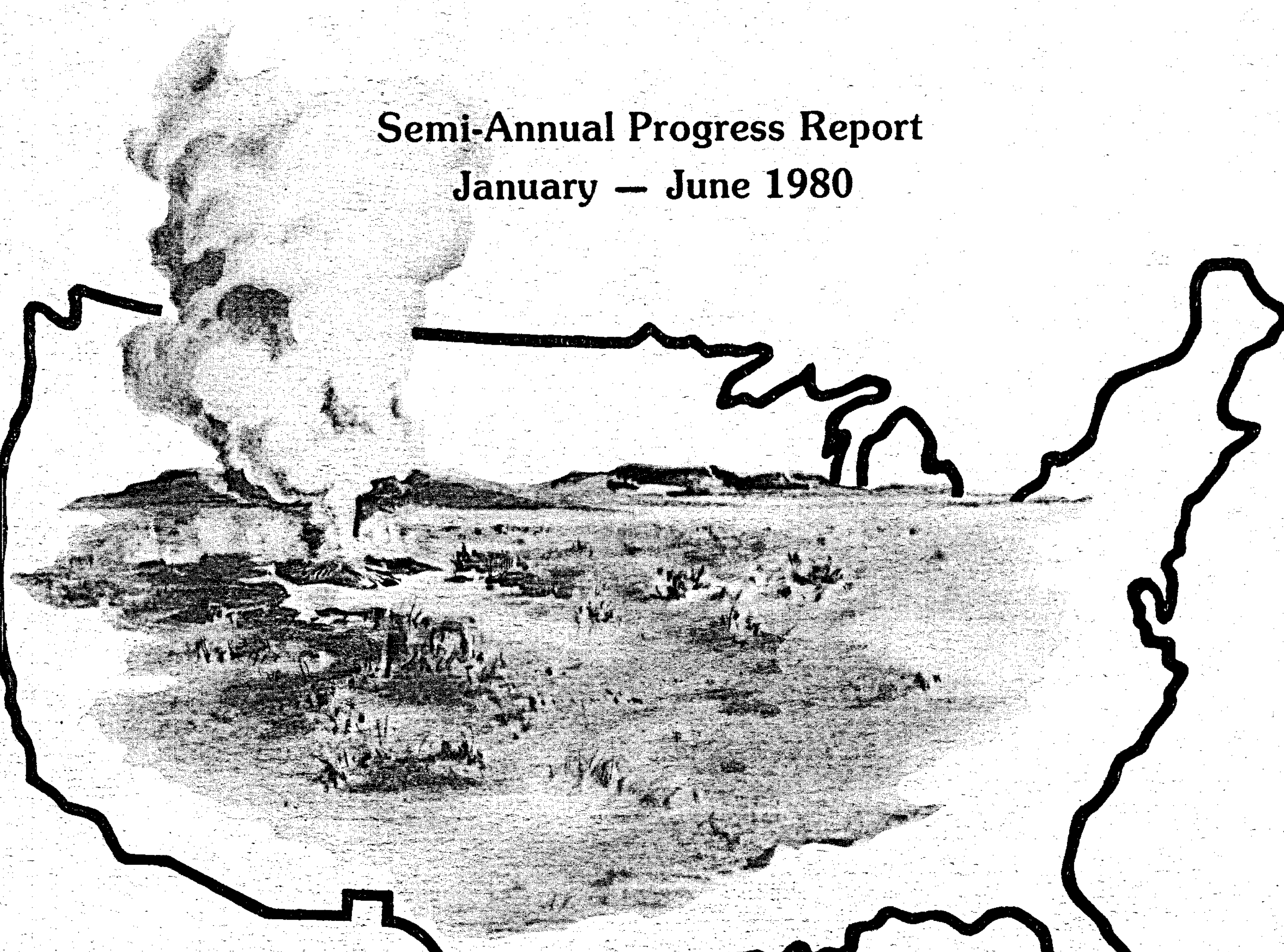
State Geothermal Commercialization Programs in Seven Rocky Mountain States

Semi-Annual Progress Report

January — June 1980



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STATE GEOTHERMAL COMMERCIALIZATION PROGRAMS

IN SEVEN ROCKY MOUNTAIN STATES

Semi-Annual Progress Report
January-June 1980

December 1980

Compiled and Edited by
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For the U.S. Department of Energy
Idaho Operations Office
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JB

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Chapter One

SUMMARY OF DOE/STATE GEOTHERMAL COMMERCIALIZATION PROJECTS IN THE RMB&R REGION

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WESTERN ENERGY PLANNERS, LTD.

December 1980

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PREFACE

Given the current scarcity of public and private funding for evaluation, exploration, and development, GEOTHERMAL ENERGY may continue to lie dormant while U.S. reliance upon imported oil continues or grows.

Continued attention to public outreach, and to the variety of possible creative technical applications, innovative institutional arrangements, and emerging social and economic forces should result in significant beneficial results.

The benefits to be gained from geothermal commercialization projects are numerous. The ultimate goal is the replacement of energy from imported oil with energy from untapped domestic resources. 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 utilization.

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 general level of consciousness within the region, has been raised to understand more of these benefits through the action of these State Geothermal Commercialization Teams and various public and private resources.

1.0 INTRODUCTION

Since the last report[1], the geographic area and direction of emphasis of the commercialization projects has been changed. This includes the individual as well as collective State Commercialization Programs in this region. Organizational change in Department of Energy geographic coverage has reduced the number of states incorporated in this document from ten to seven. Many State Commercialization Team efforts have moved from general area development plans to site specific development plans. Some states have enacted or are entertaining legislation providing for more affirmative procedures in accelerating the program. New outreach emphasis includes some exploratory ideas in organization and market penetration. Site specific development plans are delineating several potential demonstration projects. A point-by-point review follows.

1.1 Purpose of Project

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. Indeed, realistic planning and policy development requires the concurrence of federal, state and local governments.

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[1] State Geothermal Commercialization Programs in the Rocky Mountain Basin and Range Region, Semi-Annual Progress Report, July - December 1979, U. S. Department of Energy, Idaho Operations Office, August 1980, DOE/ID/12101-1.

Furthermore, greater understanding and knowledge of events and conditions bearing upon geothermal energy development in each jurisdiction have been developed within those State Commercialization Teams working most closely with each locale. Teams working in the field on geothermal projects can help expand the commercialization of geothermal energy through education, marketing and technical assistance activities.

The U. S. Department of Energy 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 appropriately using geothermal energy. Once the state commercialization programs are well-established, state and local governments will have the expertise available to continue programs on their own to provide both technical information and assistance to prospective developers and users.

During CY 1979, the Idaho Operations Office of the Department of Energy (DOE-ID) signed cooperative agreements with seven Rocky Mountain Basin and Range states to conduct state geothermal commercialization programs. The seven states discussed in this report - Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah and

Wyoming - provided a portion of the funding to cost-share with the Department of Energy.

Each state has a State Commercialization Team consisting of the Team Leader and those principal staff people that are considered by each state to incorporate the kinds of expertise essential to its unique situation. Western Energy Planners, Ltd. (WEPL), under contract to DOE-ID, provided technical and management assistance to the state teams. Although personnel of the state teams change, program cohesion is advanced by this assistance.

The states are assisted in their efforts by additional contractors who provide technical support: The University of Utah Research Institute (UURI) 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 and other support services.

This report contains four sections which describe the activities and findings of the state teams participating in the RMB&R Regional Hydrothermal Commercialization Program for the period of January through June of 1980. Section 1.0 is a summary of the state projects. Section 2.0 is a summary of findings. Section 3.0 is public outreach, and Section 4.0 provides a concise description of the major conclusions and recommendations. Unless otherwise indicated, the information presented in this summary originates with the State Commercialization Team reports that make up subsequent sections of the report. Subsequent chapters describe the commercialization activities carried out by the respective state teams using similar formats.

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 a potential market 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 participants in geothermal commercialization.
- Stimulate development of geothermal resources 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 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 the following ten tasks into their contracts with DOE. General statements of progress and emphasis for this period are also included.

- 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/or developers with information about all aspects of development including laws and regulatory processes, economic and engineering feasibility, and the geothermal resource.

  During this report period, considerable new effort has been directed in this area by all state commercialization teams.

- 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, based on definitions for those terms that were established in previous studies (Meyer and Davidson, 1978).

  During this report period, more activity has been associated with development than exploration.

- 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.

  During this report period, relevant data collection was still in evidence, but with greater application to specific site problems and not just as general reference.

- Area Development Plans (ADP's)

  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.

During this report period, several states completed additional ADPs.

- Site Specific Development Analyses (SSDA's)

  Using targets identified by ADP's 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 technology, economics, environmental, institutional, developmental and utilization. Communication with the prospective users and/or developers is established and maintained to assure realism and implementation.

  During this report period, SSDA's were prepared and used in nearly every state.

- Time-Phased Commercialization Project Plan (TPPP's)

  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.

  During this report period, several of the seven states have prepared TPPP's.

- Institutional Analyses and Handbooks

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

  As of this report period, a regulatory handbook to guide geothermal development participants has been or is being prepared by each state.

- 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.

  Until all states have completed their total prospect identification and analyses, this data will be incomplete. During this report period, however, continued progress is evident in all state teams.

- 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 action, to be taken by local, state and federal governments and by the private sector.

  Initiatives continue among all team members to address this issue.

- 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.

  During the period covered by this report the marketing activities were still in the formative period and will reflect many avenues of exploratory ideas being examined by each state team.

1.4 Benefits

The benefits to be gained from geothermal commercialization projects are numerous. The ultimate goal is the replacement of energy from imported oil with energy from untapped domestic resources. Conserving natural gas and other fossil fuels can either directly or indirectly effect 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 governments.

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 utilization.

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 within the region.

2.0 SUMMARY OF FINDINGS

In review, 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 reasonably-proximate user must be available, either already co-located with 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. The findings are reported below within the framework of those tasks.

2.1 Prospect Identification

The identification and categorization of geothermal 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. This indicates that there are presently a total of 20 geothermal sites in the region that have electrical power generation potential. Two of these sites have been classified as proven, eight as potential, ten as inferred. These numbers will continue to change as exploration and reservoir confirmation continues. Based on the 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, but federal lease applications have been submitted. As Table 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 shows that as many as 272 sites are suitable for these uses, not counting the large but undefined Dakota and Madison aquifers that underlie much of the Northern Plains.

TABLE 1

Number of Geothermal Resource Sites

State	High Temperature Electric Prospects				Low Temperature Direct Thermal Prospects				
	Proven	Potential	Inferred	Total	Proven	Potential	Inferred	Total	Grand Total
Colorado[1]	0	3	0	3	1	54	NA	55	58
Montana	0	0	0	0	4	7	62	73	73
New Mexico	1	4	10	15	7	13	12	32	47
North Dakota[2]	0	0	0	0	0	71	0	71	71
South Dakota[3]	0	0	0	0	17	18	NA	35	35
Utah	1	1	0	2	6	7	35	48	50
Wyoming	0	0	0	0	0	9	20	29	29
Totals	2	8	10	20	35	108	129	272	292

[1] This includes only those sites that have been inventoried by the Colorado Geological Survey.

[2] 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.

[3] The Madison Formation in the western part of South Dakota offers geothermal potential; this refers to those sites co-located with towns.

TABLE 2

Geothermal Leasing on Public Lands
Rocky Mountain Basin and Range Region

	Acres Leased			Number of Leases Issued			No. of Federal Lease Applications[1]
	State	Federal	Total	State	Federal	Total	
Colorado	16,728	34,926	51,654	8	25	33	48
Montana	-0-	10,687	10,687	-0-	6	6	97
New Mexico	62,974	225,710	288,684	145	123	268	508
North Dakota[2]	-0-	-0-	-0-	-0-	-0-	-0-	-0-
South Dakota[2]	-0-	-0-	-0-	-0-	-0-	-0-	-0-
Utah	234,268	459,138	693,406	238	275	513	657
Wyoming	1,150	7,448	8,598	1	4	5	92
Totals	315,120	737,909	1,053,029	392	433	825	1402

[1] Non-competitive and competitive Federal leases, as of October 1977 (Beeland, 1978), plus update report of Colorado

[2] Not yet available.

SOURCES: EG&G, 1979, and State Geothermal Commercialization Teams.

Some generalizations can be made about each state and about the region concerning these geothermal prospects.

Colorado

In Colorado, 58 geothermal areas have been inventoried, for which géo-chemical subsurface temperature estimates have been made. Three of these have been considered by the energy industry to have potential for power generation. Resevoir confirmation at the electrical power generation sites has been stymied by the inability of industry to obtain all the necessary leases.

Most of Colorado's geothermal areas are classified as "potential" resources, with only one, Pagosa Springs, considered to be "proven" for large scale district heating system. Other prime geothermal prospects are located near large resorts and other commercial facilities in recreation areas and in the San Luis Valley, a major target area for expansion of agriculture and agricultural processing activity.

In addition to these known areas, several sites have been reported but have not yet been investigated.

Montana

Montana has identified 73 geothermal resource sites. Four are considered to be proven, 7 potential and 62 inferred. The entire Madison Aquifer underlying the eastern part of the state is a possible geothermal resource. Oil test wells that were unsuccessful or that are slated for abandonment could be significant geothermal prospects, as well. Although the prospects for power generation seem doubtful, nearly 100 federal lease applications were filed and 6 were issued, leading to speculation about the reasons for those filings. The major prospects for geothermal development seem to be greenhouse heating, aquaculture, and district heating.

New Mexico

Most of New Mexico's geothermal resources are along the Rio Grande Valley and in the southwestern part of the state. Insofar as direct thermal applications are concerned, New Mexico has a fortunate coincidence of geothermal energy with the state's major population centers and economic activity. Sites are suitable for various industrial process uses and agriculture as well as space and water heating. Fifteen areas are considered to have power generation potential, while 32 are considered suitable for direct thermal applications. There were 123 federal leases issued as of December, 1979, covering 225,710 acres of land.

North Dakota

The geothermal resource prospects in North Dakota were inventoried by the North Dakota Geological Survey. The recently formed State Commercialization Team has divided the state into eight substate regions for investigation of the possible development prospects. Three of these are being analyzed now. Like South Dakota, considerable areas of this state are underlain by the Madison and Dakota formations - a confirmed and extensive geothermal heat source.

South Dakota

In this report period, South Dakota has submitted a proposal to DOE-ID and begun negotiations for a resource assessment team. The budget is still in preparation. The Madison Formation underlying western South Dakota is a confirmed geothermal reservoir, with temperatures up to 90° C. Because of these temperatures, it is not likely to have power generation potential. However, with the agricultural economic base in South Dakota, many sites seem capable of furnishing heat for agricultural processing, as well as for space and water heating.

Utah

At least two geothermal prospects in Utah continue to be directed toward electrical power generation: Roosevelt Hot Springs and Thermo. Intent of construction of a 20 MW plant at Roosevelt has been announced (May 1980) by Phillips Petroleum Company and Utah Power and Light Company. Thermo remains under study for a binary power system.

Electrical power sites are the largest of the geothermal projects in terms of both project size and energy use. More visible activity, however, has been directed toward the direct heat application of geothermal energy. The Cove Fort site is being developed for a cascaded alcohol and sulphur drying plant. Successful wells have recently been developed south of Salt Lake City for space heating and process applications with on-line application in the near future. Many other sites offer industrial, commercial and residential direct thermal prospects, with new leasing activity pursued in this period.

Wyoming

Within this reporting period, Wyoming has published a preliminary document on "Hydrothermal Resources in Wyoming" (Decker 1980). Identified are five proven resource areas, seven potential sites, and two inferred anticlinal structures. All are considered low temperature sites. Previously, ninety-two federal lease applications had been filed and 4 issued as of October, 1977, which might indicate some possibility of power generation capacity. A number of prospects seem to be useful for agricultural, industrial processing or district heating.

Region Wide

Among the RMB&R states, there are many outstanding geothermal prospects. There are electrical power generation potential sites, with prime opportunities in New Mexico and Utah, prospective sites in Colorado, and possibly some sites in Montana and Wyoming.

Some especially noteworthy direct application prospects are apparent. In New Mexico and Utah, the co-location of geothermal resources near major cities offers opportunities for a wide array of industrial as well as residential and commercial uses. In some cases, processing of agricultural products and natural resources near the production sites may be the most economical approach. New Mexico's chili, cotton and cattle industries and Colorado's San Luis Valley agriculture are prime candidates for geothermal process heat applications. Mining and mineral processing activities in Montana, New Mexico and Wyoming offer select opportunities for geothermal applications. Developments in district heating are being pursued throughout the region. Undoubtedly, many more such opportunities will reveal themselves as the State Commercialization Teams continue to investigate and stimulate such uses.

2.2 Area Development Plans

Most of the states have compiled Area Development Plans (ADPs) to assess the prospects for geothermal commercialization, as shown in Table 3.

Colorado

Since the last report, two Area Development Plans have been documented, assembled and forwarded to the Department of Energy with a third in preparation. The San Luis Valley, including six south central Colorado counties, could develop geothermal energy for agricultural processing and space heating estimated to be as much as 450×10^{10} BTU's (Coe, 1980).

TABLE 3

Summary

Area Development Plans

Completed or In Preparation

Location	Possible Uses
Colorado	
San Luis Valley	Agricultural processing, space heating
Chaffee County	Electric power and direct heat applications
Steamboat Springs	Town and district space heating
Montana	
Area 1 - Lewis & Clark, Broadwater & Jefferson Counties	Industrial processing, space heating
Area 2 - Madison County	Animal feed, space heat, aquaculture, greenhouses
Area 3 - Treasure, Rosebud, Big Horn, Custer, Powder River, Fallon and Carter Counties	Not indicated
Area 4 - Gallatin Park, Meagher Counties	Greenhouses, aquaculture, space heating
New Mexico	
Dona Ana County	Agricultural processing
Greater Albuquerque	Industrial processing, space heating
North Dakota	
Roosevelt-Custer Region	Various direct heat applications
Lewis and Clark Region	Space heating
South Central Region	Space heating

TABLE 3 (Continued)

Summary

Area Development Plans

Completed or In Preparation

Location	Possible Uses
Utah	
1. Jordan Valley	Space heating & Industry
2. Southwest Utah	Space heating & Industry
3. Southwest Utah	Space heating & Industry
4. Sevier Valley	Space heating & Industry
5. Northern Wasatch Front	Space heating & Industry
6. Utah Valley	Space heating & Industry
7. West Central Valley	Space heating & Industry
8. Northern Utah	Space heating & Industry
9. Great Salt Lake Desert	Space heating & Industry
Wyoming	
1. Big Horn Basin	Ethanol plant
2. Fremont County	Agribusiness, oil & gas extraction, drying process lumber
3. Natrona-Converse	Space heating, energy impact area

Assessment of Chaffee County indicates present resort uses could be expanded to include electric generation and heat applications to reach 52.7×10^{10} BTU's by the year 2020 (Healy 1980). In the proposed Area Development Plan for Steamboat Springs, direct geothermal heating of the town could possibly be supplied at potential savings over currently priced natural gas.

Montana

Four Montana ADP's have been developed and were described in previous reports. Major emphasis is shifting to site specific plans. In the fourth and most recent ADP, an agrarian area, the primary applications for geothermal energy seem to be greenhouses, aquaculture and space heating, with an estimated potential of about 34.0×10^{10} Btu's by the year 2020. In the town of White Sulphur Springs interest is especially high since development has taken place, and it is expected that a geothermal heating district will be developed in the near future.

New Mexico

Data are still evolving on the Dona Ana County Area Development Plan, and the greater Albuquerque area.

North Dakota

The Roosevelt-Custer Region of eight counties has an ADP prepared which, as of this report, is currently being published. Considerable potential for residential, commercial and industrial space heating from the Madison, Dakota, Fox Hills, Hell Creek, and other less extensive aquifers, which underlie the region is defined. Subsurface temperatures from the Madison Formation vary from 155° F to 270° F with fluid under Arterian pressure.

Two other ADP's are planned: one for Lewis and Clark 1805 Region and the other on the South Central Region.

Five other regions have been blocked out to complete the state coverage.

South Dakota

Area Development Plans have not progressed as well as expected, with data on units smaller than counties difficult to obtain. The ADP effort will continue in future reporting periods.

Utah

General energy demand data have been projected for nine ADP's during this period. A number of factors, including the IPP project in Millard County, and the potential MX missile system could drastically affect population and industry projections in several regions of this state.

Wyoming

Three ADP's show considerable potential. The Big Horn Basin Area Development Plan includes an economic evaluation of district heating in Cody and Thermopolis. The evaluation indicates that geothermal energy would be competitive with other energy sources, if some interest-free grant funds were available to offset a portion of the initial system cost.

The Area Development Plan for Fremont County indicated that geothermal space heating could be competitive with alternatives. Uses identified for existing geothermal energy in this area include space heating, low-temperature processing, agriculture and greenhouse heating.

The Natrona-Converse Counties Plan is currently being published and indicates that geothermal space heating could greatly assist energy "boomtowns" in this area.

2.3 Site Specific Development Analyses

2.3.1 Completed Site Specific Development Analyses

Several States have prepared Site Specific Development Analyses for one or more sites. They are summarized in Table 4.

TABLE 4

Summary

Completed Site Specific Development Analyses

	Potential Uses	Constraints	Incentives
Colorado			
Idaho Springs	Commercial & residential space and water heating	Lack of feasibility study and financing	Economically competitive
Glenwood Springs	Commercial & residential space and water heating	Lack of front-end financing	Economically competitive
Ouray	Commercial & residential space and water heating	Lack of feasibility study and financing	Economically competitive
Durango	Commercial & residential space and water heating	Lack of front-end financing	Economically competitive
Montana			
Baker	District-wide space and process heating (+irrigation)	Definition of potential and cost	Feasibility study, grants program, acquisition of well for testing
Boulder	Aquaculture	Threatened law suit by spring owner	Commitment of funds for drilling, need and interest of town
East of Avon	Solar-geothermal greenhouse	Grant approval	Technical assistance of State, materials purchased by town and school
White Sulphur Springs	Public Buildings — space heating	Further investigations	State technical assistance

TABLE 4 (Continued)

Summary

Completed Site Specific Development Analyses

	Potential Uses	Constraints	Incentives
North Dakota			
Patterson Hotel Bismark	Space heating and electricity	Lack of front-end financing	Economically feasible
Maryvale Convent Valley City	Space heat	Lack of front-end financing	Under study
St. Marys School New England	Space heat	Lack of front-end financing	Under study
Wyoming			
Cody	Ethanol	Resource limitations	Developer/user financing
Thermopolis	Residential & Commercial	Front end funds	Community support

Colorado

Four Site Specific Development Analyses are in final stages of publication for Glenwood Springs, Ouray, Idaho Springs and Durango. All four sites have active tourism and recreation industries with a high ratio of commercial to residential energy consumption. The first three communities are actively seeking funds for development of district heating systems. Without outside assistance, Ouray has already installed geothermal heat in a municipal garage. A boarding school north of Durango has obtained a DOE Region VIII Appropriate Technology Grant to install geothermal heat. Preliminary economic analyses show numerous uses to be competitive economically. Opportunities for energy savings by private owners of major restaurants, lodging and resort facilities could spur private investment in geothermal development.

Wyoming

A Site Specific Development Analysis was completed for the town of Cody in the Big Horn Basin. Interest among people in the area was high regarding a possible ethanol plant and it was hoped that geothermal fluid could fuel the plant. However, it appears now that the resource is inadequate for that use.

2.3.2 Candidates for Site Specific Development Analyses

Several sites are candidates or have been selected for Site Specific Development Analyses; as shown in Table 5.

Montana

Several candidate areas were identified for Montana's Site Specific Development Analyses. Ennis in Madison County has a large but unproven subsurface resource for residential space heat and ethanol production.

TABLE 5

Summary

Candidate Site Specific Development Analyses

Sites	Potential Uses
Montana	
Ennis, Madison Co.	Residential space
Camp Aqua, Saunders Co.	Ethanol plant
Silver Star, Madison	Ethanol plant
New Mexico	
Animas/Lighting Dock	Soil warming
Los Alturas	Industrial processing
Truth or Consequences	Space heat
Albuquerque	Space heat-heat pump
Jemez Springs	District heat
North Dakota	
Linton	District Heat
Badlands	Residential space
Harvey	Residential & Commercial space
Mandan	Commercial & Residential space
South Dakota	
Lemmon	Agribusiness, space heating
Philip	Space heating
Midland	Space heating
Utah	
Crystal Springs	Space heating
Crystal Springs	Space heating
Uddy Hot Springs	District heating
Cove Fort	Alcohol plant

TABLE 5 (Continued)

Summary

Candidate Site Specific Development Analyses

Sites	Potential Uses
Utah - continued	
Newcastle	Greenhouses
Abraham Hot Springs	Recreation & Aquaculture
Wyoming	
Thermopolis	Residential and Commercial
East Thermopolis	Residential and Commercial
Midwest/Edgerton	Residential and Commercial
Fort Washakie	Residential and Commercial
Countyman Ranch	Residential and Commercial
Saratoga	Residential and Commercial
Astoria	Residential and Commercial
Demaris	Agriluminess & Industrial
Auburn	Residential and Commercial

Camp Agua in Sanders County is being considered for an ethanol plant. The owner of a hot springs in Silverstar in Madison County is interested in developing ethanol.

New Mexico

Several sites are candidates for Site Specific Development Analyses. Animas/Lighting Dock currently has two geothermally-heated greenhouses. The operators would like to use geothermal energy for an outdoor soil warming system. Proposed uses in the Los Alturas area include process heat at the Hanes L'eggs hosiery plant, heating of New Mexico State University buildings and other heating and processing. Truth or Consequences is developing the geothermal energy for heating the Senior Citizens Center and the Carrie Tingley Hospital. Proponents would like to use it in additional buildings. The rapid growth of Albuquerque provides an excellent opportunity to use the warm water in heat-pump assisted heating systems, especially for large facilities.

North Dakota

In this report period, North Dakota has begun preparation for a Site Specific Development Analysis of a downtown Bismarck heating district, including renovation of housing for the elderly. Two other sites for a school and slaughter house at New England, and a convent at Valley City were identified during this reporting period. All show considerable promise.

South Dakota

Three sites in South Dakota were chosen for preparation of Site Specific Development Analyses. Lemmon is planning to use geothermal energy for agriculture and agricultural processing, as well as for space heating. Data collection is proceeding well. Philip has a DOE cost-sharing contract to heat three school buildings with geothermal energy. St. Mary's Hospital in Pierre recently completed a DOE cost-sharing project to provide space heating for the hospital and a new annex building utilizing direct geothermal heating and a heat pump system. Midland is also a good candidate for space heating projects.

Utah

Six areas have definitely been identified during this report period as candidates for SSDA's. Also being considered are eight other promising sites that appear to be good prospects but for which no specific plans have been announced. BTHERM models have been designed in four locations, and a cooperative study undertaken on the use of heat pumps for a large redevelopment project, Block 53, in downtown Salt Lake City.

Wyoming

A site specific analysis for the towns of Thermopolis and Cody, in the Big Horn Basin, has been completed and the Midwest/Edgerton analysis is in preparation as is one for East Thermopolis.

2.4 Time Phased Project Plans

2.4.1 Completed Plans

Time-Phased Project Plans were prepared for selected sites that have geothermal development well underway. These are listed in Table 6.

Colorado

A plan for Pagosa Springs, Colorado, described the initial activities leading to a PON-funded heating district. It discussed possible subsequent development including a proposed city-wide heating district, a suburban heating district, and a timber kiln, greenhouse and agriculture.

Montana

For Montana, two Time-Phased Project Plans were prepared. The plan for White Sulphur Springs describes in detail the development of a well and heating system for a bank building, with the aid of State financial assistance of $43,500. The Warm Spring State Hospital is a retrofit project, with at least two buildings planned for conversion to geothermal heat. The White Sulphur Springs project was completed in slightly more than two years.

Utah

A Time-Phased Project Plan for Roosevelt Hot Springs was completed by the Utah Geothermal Commercialization Team in July 1979. Development plans include a 20 MWe pilot plant, probably on-line about 1983. Proposals are going forward with potential plant operators and power customers at this time.

TABLE 6

Completed Time-Phased Project Plans

Location	Potential Uses
Colorado	
Pagosa Springs	District heating
Montana	
White Sulphur Springs	Space heating
Warm Springs State Hospital	Space heating and hot water heating
Utah	
Roosevelt Hot Springs	Power generation

2.5 Aggregation of Prospective Geothermal Use

Although much is still unknown about the geothermal reservoirs in the RMB&R Region, as well as about the demand for the energy, the prospective use of geothermal energy has been estimated for the states by New Mexico Energy Institute. Table 8 shows the preliminary estimates of direct heat applications; about 467 x 10^{12} Btu's could be on line by year 2000, and 1371 x 10^{12} Btu's could be on line by 2020.

2.6 Institutional Analysis

All seven states are at various stages of progress in their contracted institutional analyses and publication of Institutional Handbooks. Legislative achievements were summarized in our Semi-Annual Progress Report of July-December, 1979, and will be summarized again, following the 1981 state legislative sessions. Handbooks, designed for step by step guidelines for prospective geothermal developers, have been issued by Colorado, Montana, New Mexico, South Dakota and Wyoming. North Dakota and Utah are expected to have theirs completed in the second half of CY 1980.

TABLE 8

REGIONAL AGGREGATION OF

PROSPECTIVE GEOTHERMAL DIRECT HEAT USE (10^{12} Btu's)*

STATE	YEAR 2000	YEAR 2020
COLORADO	157.7	961.4
MONTANA	43.4	51.1
NEW MEXICO	66.5	90.8
NORTH DAKOTA	40.7	51.0
SOUTH DAKOTA	13.2	15.5
UTAH	111.2	145.1
WYOMING	34.2	55.7
Totals	466.9	1370.6

* Economically feasible (high range).

Source: New Mexico Energy Institute, 1979, modified by current State Team reports.

3.0 PUBLIC OUTREACH

3.1 New Emphasis

Public outreach activities received considerably more attention from the State Commercialization Teams during this period than in the past. Armed with experience and materials derived from intensive area and site planning through project development, plus knowledge and direct access to various levels of public and private operations, the State Teams report of exploring many and various approaches to geothermal development. Consequently, both expressions of interest and proposals to develop geothermal energy have increased.

3.2 Mechanisms

In analyzing the current reports of the State Teams, some suggested activity groupings have emerged. These groupings can be useful for an organized presentation of this report segment as well as providing a possible frame for accelerating and evaluating future marketing efforts.

For the present, these outreach activities can be grouped as follows:

3.2.1 Effective Response to Specific Requests.

3.2.2 Targeted Marketing to Prospective Users.

3.2.3 Technical Assistance for Prospective Users and Specialists.

3.2.4 Public Education.

3.2.5 Institutional System Development.

Under each of these headings, the current activities reported by the State Teams have been summarized with whatever Team assessment of effect seems germane.

3.2.1 Effective Response to Specific Requests.

Personal meetings and prompt response to geothermal energy inquiries are acknowledged by all teams as a highly effective outreach activity. Telephone interviews and conversations on a regular basis are also recommended.

Indeed, the Wyoming State Team has acquired a toll-free (Energy Hot-Line) telephone number for access by the general public from the entire state. This is a specific technique other State Teams might want to consider.

3.2.2 Targeted Marketing to Prospective Users.

In the process of data collection for Area Development Plans and Site Specific Analyses, most State Teams have made significant personal contacts and evolved useful ideas about particular needs and operating procedures of different types of energy users in various communities.

Marketing techniques are being created for directly dealing with, or in cooperation with other agencies, for effectively meeting the needs of generalized energy user prospects. For instance, some Teams have begun to focus on home builders and small commercial developers as their most lucrative user clientele. Others, with the help of Chambers of Commerce, State and local Industrial Promotion Agencies, have concentrated on industry and commercial needs.

Public school, county, state and city officials are emerging in other states as leaders in promoting geothermal and other energy alternatives in attempting to set examples for community study and standards. Agricultural users in nearly all states are examining geothermal energy in home space heating, farm buildings, agriculture, greenhouses, alcohol production, and for soil warming for outdoor extension of growing environment and reduced frost damage in the northern states.

3.2.3 Technical Assistance for Prospective Users and Specialists.

Many State Teams have become involved with direct engineering and technical assistance to geothermal developers, feeling this to be one of the most effective means of getting geothermal energy on-line. Site specific analyses, assistance with design criteria, and facility construction hints are often provided.

Additionally, locating funding sources, contacting and coordinating multiple loan-grant agencies, filling out application forms, and providing letters of support for applications have been activities recorded by different State Teams for various users. Certainly the Department of Energy's Appropriate

Technology Small Grants Program, User-Coupled Reservoir Confirmation Drilling Program, Geothermal Loan Guaranty Program, resource, engineering and economic feasibility studies (PRDA's) and the cost-shared demonstration projects (PON's) provide incentives that should enhance the pace of geothermal development. The DOE programs have been much enhanced with state geothermal demonstration programs and energy grant programs in certain states. Knowledge of these sources, forms and procedures should be updated from time to time.

Technical assistance has also been called for by a few State Teams to help organize and fine-tune some of their own internal operations.

3.2.4 Public Education.

The public is becoming more aware of the potential for geothermal energy in these seven Rocky Mountain Basin and Range States. This is not only through the actions of the State Commercialization Teams, but also in consort with various formal and informal services, public news media, and recently, churches and social action groups as well.

Initiatives of the State Teams are paying off in various ways. In New Mexico, a series of geothermal market research discussion meetings in several communities produced considerable interest among potential users and, according to the New Mexico Team, generated more requests from them for technical assistance than all the other mechanisms they had tried to date. Publications such as: Information Sheets on heat pumps, geothermal uses, etc.; Pamphlets on various geothermal subjects; the issuance of Institutional Handbooks that are emerging; and Monthly Newsletters to interested parties, covering legislative concerns, funding sources, applications, etc. are becoming more popular among all reports. Billboards are being used in North Dakota. Semi-Permanent Booth Displays are reported by Utah, with variations of slide-show presentations and free-standing information racks also by various other teams in connection with such scheduled State Fair or Energy Fair events as are appropriate. Organized Public Service Announcements and prepared Press Releases to public television, commercial radio and general newspapers are useful in South Dakota and elsewhere, and provide more frequent and mutually reinforcing information to the general public. Articles to professional journals and business news publications are also effective aids in selected areas.

Input to Extension Services, Adult, Community and Continuing Education Programs should also be cultivated. Indeed, these educational entities are currently expanding their roles and offerings to meet more public needs for organized information.

Talks, professional presentations, conferences and workshops are most valuable for dissemination of information. Universities and high schools have engineering, earth science, political science, current affairs classes, etc., found by some teams to be vitally interested in having talks on relevant state activities.

Professional societies as the American Public Works Association, Civil Engineers, etc., look for current input relevant to their field. A statewide geothermal conference, discussing exploration, development and laws (as held in May in Montana), can include major opinion leaders from all fields, receive major news media coverage, and obtain strong public attention to current issues. Workshops (as being planned in South Dakota) can target specific markets like business leaders of a local area, and provide intensive exchanges and closer opportunities for accelerated cooperative ventures.

Also, publicized special events as October Energy Month and Open House and ribbon-cutting ceremonies can bring significant public and media attention to successful operations and new directions. See South Dakota report for details.

Community and regional OEDP planning councils, Community Action Program Agencies, VISTA workers, many church groups, and Consumer Advocacy Programs are now rapidly emerging as institutional and social forces seeking knowledge about the planning and development of alternative energy sources for the poor, elderly, handicapped and general public welfare interests.

3.2.5 Institutional System Development.

Although Institutional Analyses have long been a part of the early efforts in orderly geothermal development, continued attention is reported by all State Teams as part of accelerating development and in outreach programs. Appropriate linkages with public officials, with private developers, and new ad hoc or permanent institutions remain a vital growth pattern in current affairs with geothermal commercialization.

Regular contacts with State and Federal lawmakers, agency heads, county planners and officials, city administrators are ongoing processes in all state reports. Membership in, access to, or promotion of Renewable Energy Advisory Councils and State Energy Development Committees are emerging in some areas. Attention to financial problems and the lack of geothermal awareness among money lenders and other financial institutions are driving at least one state team, Montana, into replacing staff with expertise to cover this area. Where useful projects cannot be made feasible for one participant, joint ventures (as with state, city and school combinations) are emerging. Considered also are joint developments of solar/wind and geothermal to get a more comprehensive alternative energy cost reduction.

Preparation of proposed legislation is still required not only in properly defining and utilizing geothermal energy but also in continuing to eliminate the constraints for full public access to this viable source of energy.

Further, assessment of building codes, contractor training, licensing and other regulatory activities (not particularly defined in the laws but part of the fabric of daily construction and technical utilization practices) should be the subject of analysis, State Team input, and improvement.

3.3 Geothermal Projects Stimulated/Assisted by State Commercialization Teams.

The State Geothermal Commercialization Teams have been a vigorous and stimulating force in both initiating and assisting the development of geothermal projects in their states. The sheer number of projects that can be attributed to some measure of support from the State Teams has increased each year since 1977. Table 9 is a fairly comprehensive compilation of geothermal projects that currently are in various stages of conceptual planning, preliminary design, feasibility study, design, demonstration or construction within each of the seven states. The compilation is confined to direct heat applications since the electric projects are few and have been documented elsewhere in this report.

These projects are physical developments and do not reflect the equally important results of the State Teams in other areas, such as legislative reform, policy development, and informational services.

TABLE 9

COLORADO

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Alamosa	Owner of store being redeveloped into shopping center	Geothermal space heating for small shopping center.	Construction was predicted to be completed by 10/1/80.	Water will also be used as domestic water by a 75-unit mobile home park, and for irrigation.
Alamosa	City	Bailey malting plant and industrial plant	Recently awarded a User Coupled Drilling Program Contract	
Alamosa	Baca Grande Corp.	Space heating for residential and commercial.		
Boulder County - Haystack Butte	George Vranesh	Geothermal heating of 20 acre greenhouse complex.	A geothermal loan guaranty application is being prepared.	In early summer of 1980 commercial water source heat pump costs were investigated for heating greenhouse.

COLORADO (CONT'D)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Canon City	State of Colorado	Space, water and process heating for penitentiary and prison industries.	Being evaluated	New Mexico Energy Institute evaluated feasibility. Colorado Geological Survey aided in resource assessment.
Chaffee County	Chaffee Geothermal	Possible use for potato processing, barley malting, and mushroom growing.	In 1980, leases on national forest lands in the Chalk Creek area were awarded to Amax Exploration. U.S. DOE awarded cost-share contract for $73,000 to Chaffee Geothermal which will study feasibility of geothermal processing of zinc and other uses in Poncha Springs area.	In May 1980, State Commercialization Team prepared an Area Development Plan on Chaffee County. It has several thermal hot springs, wells and a KGRA.

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Durango	Timberline Academy	Geothermal space heating for school.	Geothermal heating system planned.	They received technical assistance from State Team, EG&G, NMEI, and CGS. A small grant was received from DOE.
Eldorado Hot Springs	Resort owner	Water heating for health spa.		Purchased for health spa development.
Glenwood Springs	City of Glenwood Springs	Space heating of municipal building and sewage treatment	Denver Research Institute was to have completed feasibility study by end of September 1980.	PRDA awarded in November 1979.
Glenwood Springs	Colorado Department of Highways	Geothermal heating of ammonia with 68°F water to melt snow and ice on bridge.	CDH is trying to acquire rights to adequate geothermal resources to support	Colorado Highway Department has a bridge model in Glenwood. They are interested in snow and

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
			this type of project	ice melting on structure to be constructed as part of I-70 through Glenwood Canyon.
Glenwood Springs	U.S. Water & Power Resources Service.	Desalinization		
Gunnison County (Waunita Hot Springs)	Gunnison County	Space heating of new town; cascaded energy applications.		Planning is being done by local planners. A $44,000 grant proposal has been submitted for planning for a new town to be heated with geothermal energy.
Idaho Springs and Indian Springs Resort	City of Idaho Springs	Space heating.	Considering submittal of a grant proposal.	City Council voted to seek funds for detailed evaluation of economics. In July 1980, State Team met with city officials

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				to tell them about User-Coupled Drilling Program.
Ouray	City of Ouray	Space heating.		A geothermal heating system has been installed in a municipal garage. Grant proposal for $72,000 for a feasibility study was submitted to DOE.
Pagosa Springs	City of Pagosa Springs.	Space heating.	As of 9/80, data being analyzed by Hydro-Triad Resource appears sufficient. Final design for heating system completed and being reviewed by DOE.	A $1 million DOE P.O.N. contract was awarded.

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Penny Hot Springs	Owners	Space heating for home and clinic.		Funding is private. Willard Owen Co. is conducting geothermal investigations in area.
Pueblo	Larry Houser	Direct geothermal application for alcohol production plant.	Project is not actively being pursued.	An alcohol production plant using geothermal energy is being considered.
San Luis Valley (Northeast of Alamosa)	Alamosa Mushroom Farms, Inc.	Direct geothermal application for mushroom plant.	A 2000' well will be drilled. FCRC will supply about $40,000 of total drilling cost of $127,000.	A study of San Luis Valley is being done for South Central Economic Development District.
State Buildings around Colorado	State	Space heating.	Western Energy Planners, Ltd. is studying feasibility of geothermal space	

COLORADO (CONT'D)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENT
			heating in selected state buildings.	
Telluride		Space heating.	The town has asked the State Team for help in locating and developing a geothermal resource.	
Trimble Hot Springs	Rudy Baer	Space and water heating for resort.	Design of resort underway.	
Routt Hot Springs		Space heating for school.		Resource data is being evaluated.
Sand Dunes	Charles Underwood	Space heating for greenhouse.	Refining loan guaranty application	Leases have been acquired; preliminary assessment has been done; a loan guaranty application has been prepared.

MONTANA

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Avon	Earth Energy Institute	Space heating for a community greenhouse.	Completion is expected by July, 1981.	The townspeople will be promoting self-reliance in this demonstration project. Gravity flow from four 90° F hot springs will provide 400,000 BTU/hr. Montana Department of Natural Resources and Conservation is providing user assistance and hopes to help with funding.
Baker	Town of Baker	Direct geothermal applications such as space and water heating for a town of 3,000 population.	A feasibility study is being undertaken by Hengel, Berg Associates.	Natural gas and oil fields are plentiful now but are expected to be exhausted in 10 years. Baker needs an alternative energy supply. Perhaps 1000

MONTANA (CONT'D)

LOCATION	PROPONENT OF DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				buildings could be heated geothermally.
Barkell's Hot Springs	Dr. John Miller, owner	Geothermal energy for ethanol production; greenhousing and aquaculture.	Funds from the User-Coupled Drilling Program have been sought.	A temperature of 250° F is estimated to exist at depths of 100-300 feet.
Boulder	Town of Boulder	Space heating for a proposed light industrial park; greenhouse, aquaculture.	A greenhouse is in operation and an aquaculture facility is in advanced planning stages.	The springs have a surface temperature of more than 160° F and a flow of 500 gpm.
Broadwater Hot Springs	Frank Gruber, owner	Space and water heating for a large health spa.	Operational	The industrial park project has been cancelled. The hot springs owner threatened a lawsuit if

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				the springs were damaged, although the targeted site was not on his land. The owner has since proposed a geothermally heated community for commuters to Helena & Butte.
Chico Hot Springs	Mike Art	Space and water heating using a hydroelectric water-to-water heat pump.	Funding is thus far inadequate.	The state has approved a $10,000 grant. Estimated energy use would be 400,000 BTU/hr.
Deer Lodge County	Montana Energy Research & Development Institute	Space and water heating for Warm Springs Hospital.	The well is not performing as anticipated. The project is stalled.	A PON for $685,000 has provided the primary funding. EG&G and MERDI have worked on system design.

MONTANA (CONT'D)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Fort Peck Reservation	Fort Peck Tribe	Space heating of greenhouses and homes; ethanol production.	Feasibility studies are being conducted and institutional barriers are being analyzed.	A PRDA of $124,995 has been awarded. Part of a $24 million CERT grant will be available.
Helena Valley	State of Montana; City of Helena	Assessment of the geothermal resource in area; identification of production drill sites.	Gravity data are currently being analyzed.	The Department of Natural Resources and Conservation is cost-sharing the project.
Hot Springs	Energy Engineering	Process heat for an ethanol plant.	Advanced design stage. Test drilling is underway.	The geothermal resources appear to be excellent. The town has expressed interest in a district heating system. A high school has drilled a test well.
Hunters Hot Springs	Private developer	Space heating for a greenhouse		The developer has private funding and has contacted

MONTANA (CONT'D)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				DOE-SAN about loan guar. ty program.
Lost Trail Hot Springs		Space and water heating for recreational-spa complex.		A meeting was held in tl spring of '80 with reso owners and prospective developers.
Norris Hot Springs	Private developer	Space heating for a greenhouse.		The owners are investig ing bedding plant produ
Spring Creek (new town)		Heat pump system for space and water heating for a new town.		Preliminary indication that ground water heat pump systems can compet with comparable space c ditioning systems when tricity costs 2¢/Kwh or

MONTANA (CONT'D)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
White Sulphur Springs	Town of White Sulphur Springs	Space heating for a bank building; waste water will be cascaded to a motel for swimming pool and space heating.	Operational	The system is expected to meet 80% of bank's heating demand. Technical assistance has been provided by EG&G. A State Renewable Energy Grant for $43,500 was received.
White Sulphur Springs	Town of White Sulphur Springs	Space heating for Mt. View Hospital, Court House, grade school, and high school.	Initial feasibility stage.	Funds for feasibility studies were awarded in March 1980. A new test well was drilled for the hospital, although an existing well may be used.

NEW MEXICO

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Columbus	State of New Mexico	Direct geothermal applications for an industrial park.	As of Oct. '80 the test well had reached a depth of 1500', and seemed to have usable resource for an industrial park.	A ceremony was held in Columbus in August '80 inaugurating New Mexico's geothermal exploration program. This is part of an effort to develop the International Industrial Park which hopefully will aid the economic development of northern Mexico and southern New Mexico. State Funding: $75,000.
Dona Ana County	American Drilling and Grouting, Inc.	Direct geothermal application for ethanol plant.	Preliminary feasibility criteria for establishing a 100,000 gal/day ethanol plant was investigated during the	

NEW MEXICO

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
			summer of '80 by a private firm.	
Dona Ana County	Dona Ana County Geothermal Task Force	Comprehensive planning for geothermal energy development.	The final report was completed in Oct. '80. Recommendations from the geothermal task force are included. The report has been approved by Las Cruces City Council and Dona Ana County Commission.	In November '79 the EMD authorized funding for a comprehensive planning study for geothermal development in Las Cruces and Dona Ana County. The state appropriated $10,000 for the study. Initiated by Dona Co., local gov't entities.
Dona Ana County	NMSU, Las Cruces, New Mexico	Space and water heating for 12 New Mexico State University campus buildings.	Heating and cooling feasibility studies were to have been completed in September,	The project envisions heating a major portion of the University campus. A retrofit plan has been

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
			1980. Bid openings for drilling a second geothermal production well on campus were scheduled for October 30, 1980. Second production well will be drilled before end of year and testing will begin. Drilling activity completed for observation well and two temp gradient wells.	under review. Natural gas displacement will be about 400 x 10^9 Btu annually.
Gila Hot Springs	Doc Campbell	Space and water heating for 15 buildings and two greenhouses.	Operational	Doc Campbell has discussed expansion plans with the Energy & Minerals Department. Funding is

NEW MEXICO (CONT'D)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				being sought. Two new wells have been dug.
Gila Hot Springs	Doc Campbell	Low temperature electrical generation utilizing a Rankine cycle engine.	A $32,000 grant has been received through the Appropriate Technology Small Grants Program. Additional research and environmental assessment funds are being sought.	
Jemez Springs	Municipality	Space and water heating for municipal facilities, including police & fire departments.	An R & D study is being undertaken by an engineer from New Mexico State University.	Funding for this project is from the State of New Mexico.

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Las Cruces	AMDEC Corp.	Space and water heating for 1500 homes in the Candlelight Shadows subdivision	Funding is being sought. Approximately $1.2 million will be required. The project appears to be technically feasible, and the necessary zoning permits are being acquired.	A site specific analysis was completed in early summer 1980 by the State Team and the NMSU Physical Science Lab. The subdivision site seems to overlie a geothermal resource
Las Cruces	L'eggs Products Inc.	Direct geothermal applications at L'eggs hosiery plant.	Energetics Corp. completed their study of the L'eggs plant and concluded that the project is not economically feasible.	Funding: DOE PRDA contract. The final phase of the study, which began in July '80, involved the N.M.S.U. well, 4.25 miles of piping from the well to L'eggs, and the retrofitting of the plant to utilize geothermal water.

NEW MEXICO (CONT'D)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Mesilla Park	Sandyland, Inc.	Space and water heating for a major greenhouse at Sandyland Nursery	Well drilling has begun.	Nursery owners have met with the EMD to discuss funding and technical assistance. Annual fossil fuel savings will approximate 30 x 10^9 Btu. Sandyland, Inc. is the world's largest chrysanthemum grower. The geothermal fluid also serves as a hydroponic medium for tomato crops.
Taos (Ponce de Leon Hot Springs)	Solar America, Inc.	Space heating for a 7500 sq. ft. thermal/solar greenhouse project.	Ribbon cutting ceremony for this project was on Oct. 31, 1980.	This project is part of the State Demonstration Program. Funding is half state, half federal. A water rights problem was

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				negotiated in the spring of '80.
		Space heating for a proposed 80-unit condominium complex.	Planning Stage	Natural gas displacement will be approximately 12 x 10^9 BTU/yr.
Truth or Consequences	Carrie Tingley Hospital	Space and water heating of crippled children's hospital.	The hospital's geothermal hot water pre-heat system is now operational. A dedication ceremony was held on Sept. 18, 1980.	This project is part of the State Demonstration Program.
Truth or Consequences		Space and water heating of Senior Citizen's Complex.	Drilling was to begin the last week of Oct. '80 on a 250' production well.	This project is part of the State Demonstration Program. Some funding also comes from the FCRC.

NEW MEXICO (CONT'D)

LOCATION	PROPONENT OF DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Truth of Consequences		Space and water heating for a 29-unit condominium complex.	Construction is underway.	2 x 10^9 BTU/yr. of natural gas would be displaced.
University of New Mexico	University of New Mexico Interdisciplinary team.	Space and water heating on University of New Mexico campus.	Engineering and geological studies have been completed by a team at the University of New Mexico. The report will be presented to University of New Mexico administrators, regents, and legislators, who will decide the future of geothermal energy at the University. UNM may try to get DOE assistance if the project is cleared for construction.	DOE awarded a $125,000 PRDA contract for the initial study. A huge water reservoir of 180° to 200° F may be approximately 8500 feet below the university. If this resource could be tapped, 90% of the buildings at UNM could be heat-geothermally. Given the cost of natural gas and backup fuel oil supplies relative to inflation, geothermal energy is competitive right now.

NORTH DAKOTA

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Bismarck	Town of Bismarck Downtown Merchants Association	Space heating of CBD buildings.		The Downtown Merchants Association investigated the potential for a central business district geothermal heating system, either with or without a heat pump.
Bismarck	Carlson Homes, Inc.	One year demonstration and analysis of ground water heat pumps used in connection with a shallow aquifer system.	Demonstration project is planned for 1980 and early 1981.	Carlson Homes planned to install and demonstrate ground water heat pumps in two of four models homes with reports and technical assistance from UND Experiment Station. They will supply $353,424. An amount of $9,650 has been requested from Old West Regional Commission. The geothermal portion of project was pending action by them.

NORTH DAKOTA (CONT'D.)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Clinic	Private developer.	Space cooling by an experimental geothermal air conditioning system operating in a clinic.		A large energy savings is anticipated from the experimental system.
Dickenson	Carlson Homes, Inc.	Potential space heating using heat pumps in private homes.		Carlson Homes, who are building 200 homes per year in Dickenson, have been considered a prospect for geothermal energy utilization. Favorable bottom hole temperatures have been indicated by oil wells.
Harvey	Roger Russel	Space heating using heat pumps for a warehouse, office space; and possibly a residence.		Mr. Russel, who initiated this commercial heat pump project, said in the summer of 1980 that he would drill a well to obtain 85-90°F water to use in conjunction with a heat pump.

NORTH DAKOTA (CONT'D.)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Jamestown	Trout Wells	Geothermal heat pump demonstration project in commercial building.		This demonstration project opened in early 1980.
New England	St. Mary's School	Space heating.		An engineer was hired in summer of 1980 to conduct an energy audit to qualify them for the Schools and Hospitals program. Because the school has been given a geothermal well by the State Water Commission, school officials and supporters are expecially interested in a geothermal heating system for both the school and a slaughter house.
Patterson Hotel		Space and water heating using heat pumps for a	In October 1980, developers were assured of	The engineering feasibility study was completed in

NORTH DAKOTA (CONT'D.)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
		hotel which is being renovated as housing for the elderly; project may ultimately expand to include nearby commercial and professional buildings.	funding for renovation from HUD's rent subsidy program.	August 1980. A permit has been granted to allow discharge into the Missouri River. Fossil fuel displacement from use of heat pump system and shallow wells will amount to about 12 x 10^9 BTU annually.
Private Residence	Private developer.	Space and water heating of private residence, including hot tub (water to air heat pumps).		The geothermal heat pump replaces a propane system.
Twilight Hills Ski Bowl	Group of business people from Bismarck	Space heating with heat pump assistance; water may then be used for snow-making.		In the fall of 1979, a group of business people planned to re-open and expand this ski area.

NORTH DAKOTA (CONT'D.)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Valley City	Maryvale Convent and School	Space heating using ground water heat pumps for a convent and school.		Conversion of the convent to a geothermal heating system will result in annual savings of 40,000 gallons of fuel oil. The system will be constructed without DOE assistance. Design work is finished but an injection well needs to be developed. If the system is not operational by winter 1980-1981, fuel oil will cost about $60,000. Capital cost is expected to be about $80,000, with a payback period of about 4-5 years for total system.

SOUTH DAKOTA

LOCATION	PROPONENET OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Edgemont	Town of Edgemont	Space and water heating for school, etc.	Preliminary design and planning is underway.	There are seven geothern wells in the area. The State Team held a publi meeting there in July 1 to discuss geothermal e and specific project in mation. Technical assi was requested from EG&G A proposal to DOE for f is being prepared.
Haakon County - Diamond Ring Ranch	Ranch owners	Space heating, grain drying, stock water warming, irrigation on Diamond Ring Ranch.	Construction of geothermal system is complete. Operational monitoring is in progress until June 1981.	The well being used is years old and has a wat temperature of 158°F. Private consultants ass with economic and engin analyses. A DOE-PON pı 62 percent of the total $403,098 expenditure.

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Haakon County - Philip	Town of Philip	Space heating for several schools and businesses	Retrofit of the schools for geothermal heating has been completed. An open house was scheduled for October 1980. Construction of the business district system is in progress.	The project has a DOE cost-share contract. NMEI prepared an economic analysis for Philip. Developers experimented with barium chloride to eliminate radium from the water. Total project cost is \$1.14 million.
Lemmon	City of Lemmon	Space and water heating for homes, businesses, greenhouses and aquaculture; industrial process heat for grain drying and ethanol production.	Community leaders are preparing a proposal for DOE for funding. Exploration wells were drilled. A proposal for demonstration was completed in August 1980 by Dunham and Associates.	Energy yield of 1×10^{12} BTU/yr. was anticipated. The system cost was estimated to be \$6,204,000 with \$4,844,000 DOE funding and \$1,360,000 city funding. Anticipated geothermal cost was estimated at \$5.50/6.00 per MMBTU, with savings of \$3.00-6.00 per MMBTU.

SOUTH DAKOTA (CONT'D)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Lyman County	State of South Dakota	Space heating of Vivian highway rest area/visitor's center.	The final design is due April 1, 1981.	The South Dakota Dept. of Energy and the U.S. Dept. of Energy have participated.
Pierre	State of South Dakota	Space heating for Capitol Mall.	An economic analysis indicated a 16-year payback period. The project has been deferred until state funds are available.	A well in the capitol grounds would be used. An estimated 145,000 gallons of fuel oil would be saved annually. NMEI provided technical assistance.
Pierre	Ray Shields, housing developer	Space and water heating for 200 homes.	A funding source has not yet been found.	
Pierre	St. Mary's Hospital	Space and water heating for a new wing of St. Mary's Hospital.	Operational	A $718,000 DOE-PON provided 75% of the project funds. A nine-year payback period is anticipated

SOUTH DAKOTA (CONT'D)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Polo	John Biegler, Polo School District	Space and water heating assisted by heat pump for a high school.	Sources of funding are being investigated, and an economic analysis is being performed.	School district official hope to heat the school a 78°F artesian well abo 200 yards from the build
Sioux Falls		Groundwater heat pump at the Missouri Basin Power building.	Early planning stage.	

UTAH

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Cove Fort	Forminco, Inc. R&R Energies	Industrial applications: ethanol production and sulfur drying; cascading possible for greenhousing and aquaculture	R&R Energies has begun permitting processes with the USFS and the USGS. A revised schedule indicates a May 1981 production start up at the earliest.	This will be the first alcohol production unit in the state, and is expected to produce 7 million gallons of alcohol per year. The well has been pump tested and system design has been completed. The developers hope to use the Geothermal Loan Guaranty Program. Some technical assistance has been provided by UURI, as well as the State RA Team and the State Commercialization Team.

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Draper (Crystal Hot Springs)	State of Utah	Space and water heating of Utah State Prison.	Two xploratory wells have been drilled. Tests are planned for late 1980. Indications are that the geothermal reservoir is adequate for the project and is accessible on prison property. Flows of up to 1000 gpm at 180 + ^{o}F were encountered in the 1000 ft. exploratory hole.	This is a DOE-PON project, but the State has also provided some funding. The original proposal called for $159,457 of State funds and $379,150 of DOE funds. TERRA-TEK and EG&G are providing technical assistance. Initial heating design demand is estimated to be 3.68×10^6 Btu/hr.
Plymouth (Belmont Hot Springs)	Belmont Hot Springs Corp.	Space and water heating for a resort and a housing development.	The resort is operational. The housing development is in the initial stages of negotiation and construction.	This project for a small district system (35 houses) is in the planning and development stages. Plans are to utilize a 140^{o} F resource. Funding is pri-

UTAH (CONT'D.)

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				vate. Resource has been investigated, the State RA team at the UGMS.
Crystal Hot Springs (Honeyville)	Crystal Hot Springs	Space and water heating for spa facility including a lodge; greenhouse heating also evaluated.	The resort is in operation after extensive renovation.	This geothermal project was evaluated early in 1980 by EG&G Idaho. The resource was investigated by the State RA team. Funding is private.
Logan	Dallas Elder	Space and water heating, for housing, possibly cascaded to aquaculture.	Still in planning stage.	Early in 1980 the State Engineer's Office approved the drilling of two shallow direct use geothermal wells in the northern part of the town of Logan.
	City of Logan	Site specific analysis for potential direct geothermal applications.	Under consideration.	The state team performed the site specific analysis early in 1980.

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Monroe City	City of Monroe	Space and water heating.	Project is being rescoped. Reinjection restrictions could have major impact on the economics of the project.	This is a DOE-PON project. Monroe City is also providing funding. Several wells have been drilled and the engineering and technical design phase is still underway. TERRA-TEK, EG&G, and UURI have provided technical assistance.
Newcastle	Stephen Christensen	Space heating for greenhouses.	A production well drilled in 1979 supplies heat to a set of greenhouses.	200°F water from the well has replaced a propane heating system and ended a $2,500 monthly heating bill. The project is privately funded.
Hill Air Force Base	U.S. Air Force	Space and water heating.	In planning stage. Disappointing exploration results.	The USAF indicated an interest in geothermal heating at Hill AFB as a result of UURI resource

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
				assessment work on the base and a preliminary economic analysis by EG&G, which showed payback times of 4 to 6 years.
Newcastle	Hygroponics Pensacola, Florida	Space heating for hydroponic greenhouses.	The Florida-based greenhouse company has purchased a hot well and a parcel of land from Christensen Bros.	The well purchased by Hygroponics is one of two drilled by Christensen Bros. Plans call for a large greenhouse project which would raise tomatoes and cucumbers for distribution in the Southwest. Funding will be private.
Salt Lake City	Salt Lake City Corporation.	Ground water heat pumps for heating and cooling.	The 28-story LDS Church Office building and a number of schools and other buildings along the	The State Team's preliminary economic assessment of the use of ground water heat pumps for the downtown redevelopment

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
			Wasatch Front are currently heated & cooled by means of ground water heat pumps. The State Team conducted a preliminary analysis of a heat pump system for a large State & Municipal redevelopment project; Western Energy Planners of Denver has suggested more detailed engineering and economic feasibility studies to determine the advantages and disadvantages of heat pump systems. Phase I of the redevelopment project is	project indicated that heat pumps were marginally competitive with natural gas systems. This is due to low natural gas costs and high electricity costs in Utah. A low temperature geothermal resource is common in heavily populated north central Utah. Ground water heat pumps have the potential of allowing utilization of this resource. Funding would be through municipal bonds.

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
			too far along to redesign for heat pumps, but subsequent phases may be designed to include heat pumps.	
Sandy	Utah Roses, Inc.	Space heating for Utah Roses greenhouse operation.	Well drilling has been completed to 5009 ft; flow testing and design are in progress.	DOE-PON Project; DOE share (proposed) \$495,000, Utah Roses share \$416,700. The geothermal energy could replace as much as $75x10^9$ Btu/yr.
Bluffdale (Crystal Hot Springs)	Utah Roses, Inc.	Space heating for Utah Roses greenhouse	The production well is operational and the reinjection well is completed. The injection well does produce geothermal fluids, but no problems are anticipated in using it for re-	This project is privately funded, and is adjacent to Utah State Prison where geothermal space conditioning is being investigated. A 70,000 sq. ft. building has already been planted with roses, and the geo-

LOCATION	PROPONENT OR DEVELOPER(S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
			injection.	thermal system is operational, supplying up to an estimated 16.25 x 10^9 Btu/yr Eventually as much as 700,000 sq. ft. of greenhouse may be heated geothermally, replacing natural gas and propane.

WYOMING

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Casper		Space heating of new homes.		During the falls of 1979, the transport of geothermal water 40 miles, from the Salt Creek oil fields to Casper, was examined. If this project materializes, the Wyo. Dept. of Economic Planning and Development expects that Amoco and Marathon Oil will build a pipeline to transport hot water.
Cody	Martin Nielson Bob See	Industrial application of geothermal heat for $50 million gasohol plant.		A preliminary engineering feasibility study has been conducted, and a site specific development analysis was completed. Field data for the Cody geothermal resource indicates water temperatures of 170-200°F.

WYOMING (CONT'D.)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Big Horn Basin in Clark Co.		Geothermal energy to work in conjunction with solar for ethanol production.		The developers, who are already utilizing solar energy in their ethanol production, have requested technical assistance to incorporate the use of geothermal energy into their solar still operation.
I-80 Laramie		Geothermal energy for melting snow and ice on bridges.	Heat pipes were installed in a bridge on I-80 in Laramie. Sixty pipes, 100' in depth, will use freon as a heat transfer fluid.	This demonstration project was funded by the Wyoming Highway Department and by a grant received by the University of Wyoming. The consultant who built this bridge also has worked for the Colo. Highway Dept. on the Glenwood Canyon roadway structures.

WYOMING (CONT'D)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Midwest-Edgerton (Salt Creek oil fields)	Town fo Midwest and Edgerton Private developers	Space and water heating for homes, greenhouses, and in aquaculture facility; space heating and industrial process heat for an industrial park.	These projects are still in the planning and development stages.	The State Team has worked with Amoco and Arco to evaluate potential use of hot water wells for district heating in Midwest and Edgerton. In the spring of '80 the two towns exercised a Joint Powers Act Agreement to develop a district heating system to include an industrial park. The industrial park will utilize an existing city-owned well (160^{o}F, 500 GPM)
Powell	- -	Space heating of 3 greenhouses.		This project, which is past the initial feasibility state, will utilize geofluids from the nearby Texaco oil field for heating three large greenhouses.

WYOMING (CONT'D)

LOCATION	PROPONENT OR DEVELOPER (S)	TYPE OF PROJECT	CURRENT STATUS	COMMENTS
Thermopolis	Town of Thermopolis Private developers	District heating and space heating for greenhouses; space and water heating for existing spa resorts.	The Site Specific Development Analysis has been completed. The State Team will present the analysis to the Thermopolis Chamber of Commerce in November 1980.	Thermopolis has a thriving spa resort business. There appears to be a significant potential for geothermal energy use.

4.0 FINDINGS AND RECOMMENDATIONS

Significant progress is being reported in many areas of geothermal commercialization from each of the seven state teams. Definitive exploration continues to uncover interesting potential in the nature, extent and variety of heat pockets and broad stratigraphic zones in this Rocky Mountain Basin and Range region. Innovative applications and demonstrated results are accelerating the uses being developed for this resource. Public awareness is awakening to the impact that geothermal application can have on the use of fossil fuels, the reduced dependence upon foreign oil control, and the significant promotion of economic development of the region.

However, major concerns and obstacles hinder full utilization of this major energy resource. Action is needed to:

- Remove legal and institutional barriers. The difficulty of obtaining leases and permits on Federal lands is a principal barrier to geothermal development. It remains a significant barrier for sites with power generation potential. Further, some states have state legislative and regulatory barriers that impede, confuse and limit both small and large scale development, including problems in definition, taxation and authorized users. While the National Conference of State Legislatures provides significant assistance to states, a responsive and aggressive national policy can help significantly.

- Expand technical and administrative communication and assistance. Improved communication and assistance is needed for the geothermal developers and users, the State Commercialization Teams, and Department of Energy. (1) For the clients, the difficulty in obtaining a thorough engineering and economic assessment of a prospective project slows commercialization. State Teams need encouragement in developing state and regional lists of consultants, developers, and equipment vendors. Further, the concept of "Clearing House" services, also providing information on other alternative energy resources can expand joint-use development with solar/wind/biomass sources. (2) For the State Teams, organization of workshops, technical reviews and even short-term assignments of experienced geothermal personnel are being proposed. (3) DOE is being asked to provide greater input from State Teams in determining the direction of federal funding assistance for geothermal projects. Appropriate matching of ideas with local funding opportunities can enlarge the mutual effectiveness. (4) State agencies need to be made the focal points for all resource assessment, commercialization and technical assistance within each state; this arrangement has been put in place in New Mexico.

- Expand reservoir confirmation and utilization work. Still one of the most pervasive limitations is lack of sufficient geothermal reservoir information. Advances in scientific research and developer activities need continued encouragement. Expansion of both the State Coupled Resource Assessment Program and the User-Coupled Reservoir Confirmation Drilling Program are desired. Close coordination with the state commercialization projects are necessary to optimize the values of all programs; Colorado provides an excellent example of this coordination effort. Further, careful experiments and development of guidelines should be advanced for disposal of spent fluids, both by surface discharge and by reinjection.

- Support and expand funding for geothermal development. Both public and private funding sources need to be cultivated, increased and made more available. Federal funds are needed, not only to assist the maintenance of State Teams, to increase their effectiveness and visibility, but also to advance demonstration projects and loan guaranty programs as well. State funds in research and development should be established and/or increased. Significant efforts need to be advanced with the private lending institutions to inform them of the economic and community advantages of promoting and financing geothermal development and of the various state and federal technical and funding programs available to reduce the risks in these ventures.

- Enhance public acceptance and understanding of geothermal commercialization activities and potential. Greater awareness of the variety of tools, techniques, and strategies of formal and informal educational resources available in the communities are needed at all levels. Significant project accomplishments should be recognized and considered as models, case studies, or replicable process activities transferable to other areas. More information sharing between states, plus publicity from the national level would broaden the coverage and acceptance. Techniques for targeting major prospective users, as public facilities, home owners and developers, industries, agriculturalists, etc., can be systematically developed and shared. Promotion of geothermal energy is an element of national energy conservation and as a prime renewable energy resource needs to be popularized and advanced among state energy offices, energy extension services, and citizen advocacy organizations.

- Establish an organized and targeted market development program. The commercialization of geothermal energy will be largely dependent upon the transfer of the technology, the economics, the investment opportunities, and the social and environmental values to the community of investors, developers, and users in an organized and

and systematic manner. The commercialization of any emerging technology like any new consumer product will only be successful if a sophisticated marketing effort is designed and implemented. The principal components of a comprehensive marketing program are well known in industry and in commerce and have begun to appear in certain energy technology transfer operations, with solar energy being a prime example. Those key elements are <u>education</u>, <u>persuasion</u>, and <u>adoption</u>. A prospective investor, developer or user of geothermal energy has to be first educated in the technological applications, then persuaded of the technological, economic, environmental and social values, and finally encouraged into an action or adoption mode. These are well proven phases of involvement that almost all decision makers require and/or engage in. For geothermal energy to compete with the other alternative technologies and for the requisite investment dollars, the program must establish an organized and targeted market development activity as an integral part of the overall national geothermal program goal.

By removing legal and institutional barriers, by improving technical and administrative communication and assistance, by enhancing the knowledge and availability of the physical and financial resources, and by an organized and targeted marketing program, geothermal commercialization could indeed be accelerated. However, given the current scarcity of public and private funding for evaluation, exploration and development, geothermal energy may continue to lie dormant while U.S. reliance upon imported oil continues or grows.

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1980 MID-TERM REPORT
OF THE COLORADO
GEOTHERMAL COMMERCIALIZATION PROJECT

by

FRANK C. HEALY

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COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
Denver, Colorado

Prepared for
U.S. Department of Energy
Division of Geothermal Energy

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This report describes the accomplishments of the Colorado Geothermal Commercialization Planning Project for the period January 1, to June 30, 1980. The project is funded by the U.S. Department of Energy. Mr. Richard Pearl, Chief, Groundwater Investigations Section, is the Team Leader for the project.

NOTICE

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The persons who provided information and assistance leading to this report are numerous. Appreciation is extended to all those who participated and assisted.

1.0 INTRODUCTION

The Colorado State Geothermal Commercialization Project exists to promote the development and utilization of geothermal energy. The state has significant geothermal potential, most of which is not being utilized at the present time. This project is designed to assist and educate potential users of the energy present through the use of development analyses, outreach mechanisms and technical assistance.

The project is supported by funding from the U.S. Department of Energy. Team members are Richard H. Pearl, Chief, Groundwater Investigations Section, Principal Investigator, and Frank C. Healy, Project Chief.

2.0 TASK DESCRIPTION AND PRODUCTS

The activities and analyses conducted by the Colorado Commercialization Team during the first half of calendar year 1980 are summarized in the following sections.

2.1 Geothermal Prospect Identification

2.1.1 Resource Identification

Fifty-eight thermal wells and springs have been identified in the state. Colorado's resources, due to low and moderate temperatures present, are mainly developable for direct heat applications. Site locations are shown on Figure 1. Table 1 lists thermal site characteristics, including measured surface temperatures and range of estimated heat content. The total energy contained in these geothermal reservoirs is estimated to be between 4.890 and 12.326 quads (BTU's x 10^{15}) (Pearl, 1979). It should be noted that these estimates may be conservative, and continuing exploration efforts throughout the state may show the resource is much greater than previously estimated.

Many of the thermal areas of Colorado are in or near community centers, making them relatively simple to exploit. Twenty-three communities are within 10 miles of inventoried geothermal sites and 16 are virtually on site (Coe, 1978).

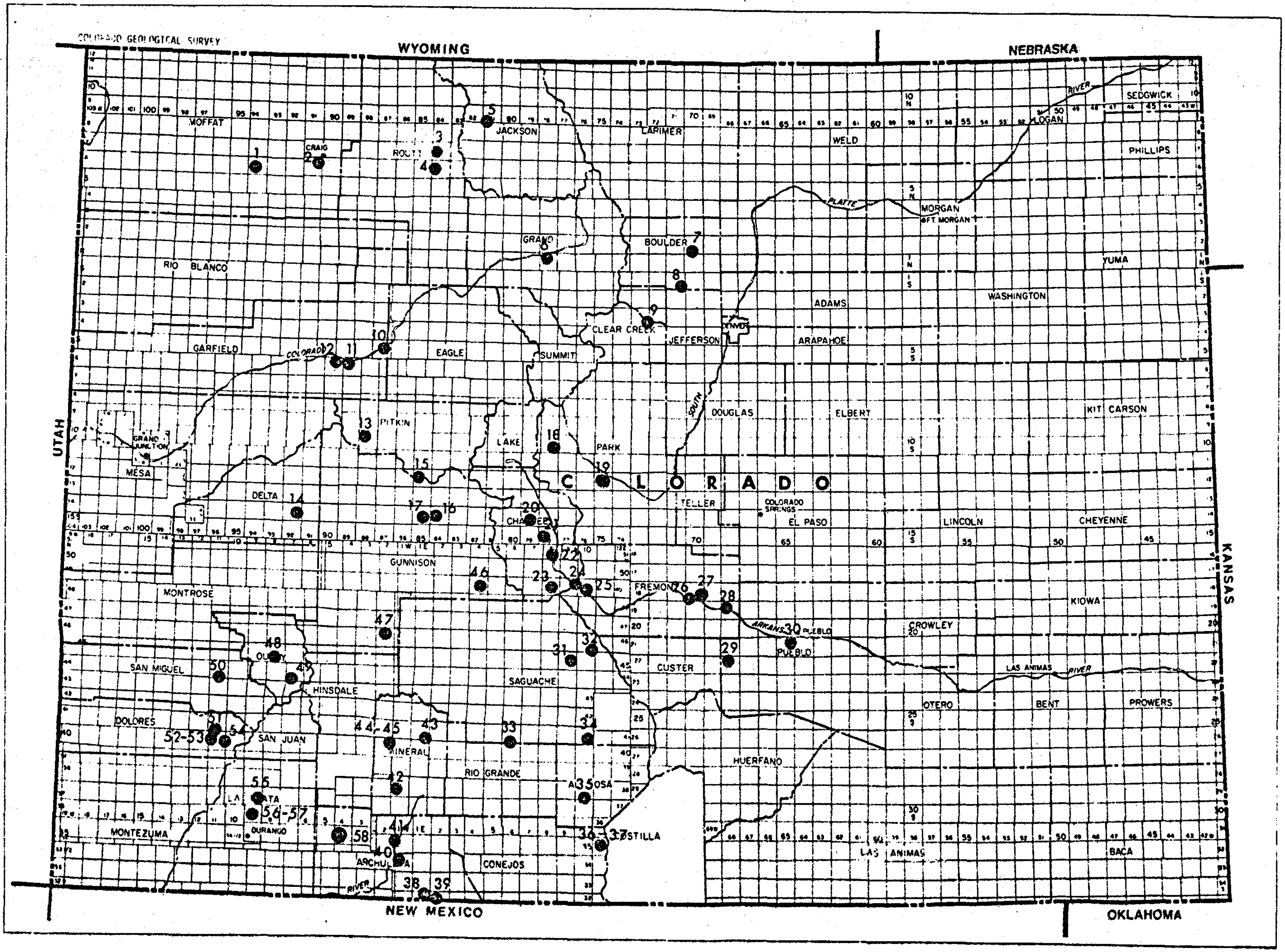

Figure 1.--Location of thermal springs and wells in Colorado. Numbers identify thermal areas.

TABLE 1

CHARACTERISTICS OF HYDROTHERMAL RESERVOIRS IN COLORADO

	Site	HIGHEST MEASURED SURFACE TEMPERATURE (°C)	ESTIMATED PROBABLE SUBSURFACE TEMPERATURE (°C)	ESTIMATED PROBABLE HEAT CONTENT (BTU's x 1015)
01	Juniper	38	50-75	0.016
02	Craig	39	40-60	0.033-0.340
03	Routt	64	125-175	0.111-0.166
04	Steamboat	39	125-130	0.049
05	Brand's Ranch	42	42-55	0.004-0.016
06	Hot Sulphur	44	75-150	0.070
07	Haystack Butte	28	50	0.006-0.017
08	Eldorado	26	26-40	0.015
09	Idaho	46	NA	0.171
10	Dotsero	32	32-45	0.005
11	Glenwood	51	NA	0.038
12	South Canyon	49	100-130	0.002
13	Penny	56	60-90	0.166-0.486
14	Col. Chinn	42	NA	0.018
15	Conundrum	38	40-50	0.004
16	Cement Creek	25	30-60	0.013-0.066
17	Ranger	27	30-60	0.002-0.006
18	Rhodes	24	25-35	0.043-0.200
19	Hartsel	52	NA	0.047
20	Cottonwood	58	105-182	0.389-1.167
21	*Chalk Creek		150-200	1.062-3.810
	Mt. Princeton	56	150-200	
	Wright	72	150-200	
	Hortense	82	150-200	
	Woolmington	39	150-200	
22	Brown's Canyon	25	50-100	0.226-0.486
23	*Poncha	71	115-145	0.141-1.191
24	Wellsville	33	35-50	0.009-0.015
25	Swissvale	28	35-50	
26	Canon City	40	NA	0.003
27	Fremont	35	35-50	0.010
28	Florence	28	34-50	0.008-0.043
29	Don K Ranch	28	NA	0.035
30	Clark	25	25-50	0.008
31	Mineral	60	70-90	0.949
32	Valley View	37	40-50	0.056
33	Shaws	30	30-60	0.015
34	Sand Dunes	44	NA	0.155
35	Splashland	40	40-100	0.155

TABLE 1 CONTINUED

	Site	HIGHEST MEASURED SURFACE TEMPERATURE (°C)	ESTIMATED PROBABLE SUBSURFACE TEMPERATURE (°C)	ESTIMATED PROBABLE HEAT CONTENT (BTU's x 10^{15})
36	Dexter	20	20-50	0.034
37	McIntyre	14	20-50	
38	Dutch Crowley	70	70-80	0.026-0.062
39	Stinking Springs	27	40-60	
40	Eoff	39	40-60	0.017
41	Pagosa	58	80-150	0.023
42	Rainbow 40	40	40-50	0.047-0.094
43	Wagon Wheel Gap	57	NA	0.063-1.429
44	Antelope	32	35-52	0.011-0.088
45	Birdsie	30	35-52	
46	Waunita	80	175-225	0.061
47	*Cebolla	40	NA	0.048
48	Orvis	52	NA	0.028-0.131
49	Ouray	69	70-90	0.226
50	Lemon	33	NA	0.015
51	Dunton	42	50-70	0.007
52	Geyser	28	60-120	0.007
53	Paradise	46	NA	0.023
54	Rico	44	NA	0.174
55	Pinkerton	33	75-125	0.010-0.021
56	Tripp/Trimble	44	45-70	0.036

*Potential Electric Power Generation Sites

SOURCE: Pearl, 1979

Electrical power generation potential may exist at 3 sites within the state. Poncha Springs, Chalk Creek, Mt. Princeton and Cebolla are currently in different stages of exploration by energy companies.

More extensive information concerning the hydrothermal wells and springs in the state is available from various publications including Barrett and Pearl, 1976, Barrett and Pearl, 1978, Coe, 1978 and Pearl, 1979. In addition, several areas have been reported but have not yet been investigated.

2.2.1 Leasing Activity

Leases and lease applications are indicative of development interest and activity in a potential geothermal area. With a large portion of the geothermal sites in Colorado on or near public lands, this leasing information becomes increasingly important. Table 2 lists current non competitive leases on Federally owned land, Table 3 lists current competitive Federal leases (Known Geothermal Resource Areas -KGRA's), Table 4 lists current Colorado State leases. In addition, lease applications for Federal lands awaiting approval or disapproval are shown on Table 5. Many of these lease applications were made as early as 1974 and are still awaiting action by the U.S. Forest Service. Chalk Creek, Mt. Princeton and Poncha Springs are potential electrical power generation sites where exploration activities have been delayed due to waiting for federal action. Also, the large proportion of lease applications compared to current federal leases is an indication of the level of interest in geothermal development in the state. It should be noted that Atlantic Richfield Co. has recently applied for large acreage of federal leases in Dolores and San Juan counties in southwestern Colorado.

TABLE 2

FEDERAL GEOTHERMAL LEASES IN COLORADO

MARCH, 1980

LESSEE	ACRES	TOWNSHIP AND RANGE	COUNTY	DATE ISSUED
Phillips Petroleum Co.	329.50	49N,11E	Fremont	11-75
Occidental Petroleum, Inc.	80.00	49N,8E	Chaffee	11-75
Petro-Lewis Corp. - 50% Petroleum, Inc. - 50%	1549.66	49N,9E	Chaffee	7-75
"	1280.00	49N,8E	Chaffee	11-75
"	2113.30	49N,7&8E	Chaffee	11-75
"	1286.17	51N,8E	Chaffee	7-75
Chevron Oil Co.	1867.94	46&47N, 2&3W	Gunnison	1-77
"	2127.56	46&47N,3W	Gunnison	1-77
"	645.74	47N,3W	Gunnison	1-77
Geothermal Kinetics, Inc.	1795.11	37&38N, 12&13E	Alamosa	11-75
"	1203.15	29S,73W	Alamosa	11-75
"	320.00	38N,12E	Alamosa	8-79
"	642.88	37N,12E	Alamosa	8-79
"	827.31	38N&29S 1eE&73W	Alamosa	11-75
"	1335.99	29S,73W	Alamosa	11-75
Utah International, Inc.	2326.89	40&41N,1E	Mineral	8-79
"	2335.22	40&41,1E	Mineral	8-79
Buttes Resource Co.	781.32	46N,2W	Gunnison	1-77
"	2226.88	46N,1&2W	Gunnison	1-77
"	1804.57	46N,1-1/2W	Gunnison	1-77
"	1040.04	46&47N,2W	Gunnison	1-77
"	1970.30	46&47N,2W	Gunnison	1-77
TOTAL	29889.53	ACRES		

Source: Bureau of Land Management

TABLE 3

FEDERAL COMPETITIVE GEOTHERMAL LEASES IN COLORADO -KGRA's

MARCH, 1980

LESSEE	ACRES	TOWNSHIP AND RANGE	COUNTY	DATE ISSUED
Occidental Geothermal, Inc. - 50%				
Petro-Lewis Corp. - 50%	915.84	49N,8E	Chaffee	1976
Phillips Petroleum Co.	2484.28	45N,9E 46N,9E	Saguache	1975
Phillips Petroleum Co.	1636.42	45N,10E 46N,10E	Saguache	1975
TOTAL	5036.54 ACRES			

Source: Bureau of Land Management

TABLE 4

COLORADO STATE GEOTHERMAL LEASES

MARCH, 1980

LESSEE	ACRES	TOWNSHIP AND RANGE	COUNTY
AMAX Exploration	640.00	14S,79W	Chaffee
"	2004.85	14S,78W	Chaffee
"	4332.31	15S,78W	Chaffee
General Geothermal, Inc.	2840.00	41N,10E	Saguache
Occidental Geothermal, Inc.	360.00	49N,8E	Chaffee
Petro Lewis Corp.	3226.61	50N,8E	Chaffee
"	1560.00	49N,7E 50N,8E 49N,9E	Chaffee
Phillips Petroleum Co. "	1764.40	49N,4E 49N,5E 48N,5E 48N,4E	Gunnison and Saguache
TOTAL	16728.17 ACRES		

Source: Colorado State Board of Land Commissioners

TABLE 5

FEDERAL GEOTHERMAL LEASE APPLICATIONS IN COLORADO

MAY, 1980

LESSEE	ACRES	TOWNSHIP AND RANGE	COUNTY	DATE OF APPLICATION
AMAX Exploration, Inc.	5420.00	14S,79W	Chaffee	1974
"	3473.98	15S,78W	Chaffee	1974
"	1478.62	51N,7E 15S,79W	Chaffee	1974
"	2456.70	51N,7E	Chaffee	1974
"	2300.00	15S,79W 15S,78W	Chaffee	1974
"	2180.00	15S,79W	Chaffee	1974
"	2202.20	14S,79W 15S,79W	Chaffee	1974
Atlantic Richfield Co.	5119.53	39N,10W	Dolores- San Juan	1980
"	2560.00	40N,10W	Dolores- San Juan	1980
"	5154.02	39N,11W 40N,11W	Dolores	1980
"	5130.52	39N,11W	Dolores	1980
"	2562.88	39N,10W	Dolores	1980
"	8636.57	40N,10W	Dolores	1980
"	20267.57	40N,11W	Dolores	1980
"	9600.70	40N,12W	Dolores	1980
"	4049.95	41N,10W	Dolores	1980
"	17696.16	41N,11W	Dolores	1980
"	5120.00	41N,12W	Dolores	1980
"	2675.36	41N,12W	Dolores	1980
		40N,12W	Dolores	1980
Austral Oil Co., Inc.	2531.02	50N,4E	Gunnison	1974
"	3102.57	49N,4E	Gunnison	1974
Buttes Resources Co.	120.00	46N,2W	Gunnison	1975
Earth Power Corp.	2568.50	7N,84W	Routt	1975
Fluid Energy Corp.	1599.99	45N,8WE 44N,8W	Ouray	1975
"	1719.05	45N,8W	Ouray	1975
"	243.99	44N,8W	Ouray	1975

TABLE 5 CONTINUED

LESSEE	ACRES	TOWNSHIP AND RANGE	COUNTY	DATE OF APPLICATION
James E. Franklin	2480.00	45N,9E 46N,9E	Saguache	1979
"	2480.00	46N,10E	Saguache	1979
"	1200.00	45N,10E	Saguache	1979
Geothermal Kinetics, Inc.	1120.00	38N,12E	Alamosa	1974
"	827.31	38N,13E	Alamosa	1974
"	1203.15	29S,73W	Alamosa	1974
Occidental Geothermal, Inc.	4677.93	49N,10E	Fremont	1979
"	640.00	51N,8E	Chaffee	1979
"	2400.00	49N,9E	Chaffee & Fremont	1979
"	860.00	49N,9E	Fremont	1979
"	2518.00	50N,8E 50N,9E	Chaffee	1979
"	2528.00	50N,9E	Chaffee	1979
Phillips Petroleum Co.	1298.97	40N,11W	Dolores	1974
"	2311.18	7N,84W 7N,85W	Routt	1974
"	2089.91	49N,4E	Gunnison	1974
"	1849.44	41N,11W	Dolores	1974
D. L. Percell	3200.00	15S,79W	Chaffee	1974
"	1039.34	14S,79W	Chaffee	1974
Thermal Resources	2542.80	46N,9E 46N,10E	Saguache	1974
George M. Wilkinson	60.00	6S,90W	Garfeild	1979
"	127.00	37N,9W	La Plata	1980

TOTAL 157,422.91 ACRES

Source: Bureau of Land Management
Petroleum Information Corp.

2.2 Area Development Plan and Site Specific Development Analysis

Final editing and document assembly for the San Luis Valley Region analysis was completed and forwarded to the Department of Energy. The study determined that if funds were available and savings in energy costs demonstrated, communities in the San Luis Valley could develop geothermal energy estimated to be as much as 450×10^{10} BTU's (Coe, 1980).

An assessment of Chaffee County in central Colorado was completed and forwarded to the Department of Energy. Current geothermal use in the area is limited to mainly resort applications (swimming pools, space heating, etc.) and small greenhouse heating. Conditions for larger scale geothermal development are favorable for the area with abundant resources present, estimated between 0.1 and 0.4 quads from the Cottonwood Creek, Chalk Creek, Poncha Springs and Brown's Canyon thermal resource areas (Pearl, 1979). Estimates of energy consumption for 1980 are 33.9×10^{10} BTU's for residential and commercial use and 9.0×10^{10} BTU's for industrial use.

The main possibilities for development are in the field of electric power generation and direct heat applications for residential and commercial consumers. Energy exploration firms are active in the Chalk Creek and Poncha Springs area with interest primarily in electrical power generation. Geothermal leasing activity in the county includes state leasing (12,124 acres), federal non-competitive leasing (6,309 acres) and one federal Known Geothermal Resource Area (KGRA) in the Poncha Springs area (916 acres). Potential development for electric power generation is estimated at 200 MWe.

In addition, direct heat applications are favorable for development, anticipating utilization of wastewater from the power plants. The potential direct thermal energy on line before the year 2020 from the area's resources is estimated to be at least 52.7×10^{10} BTU's, adequate to serve much of the energy demand of the county.

As with many other potential developments, funding and leasing delays are the main constraints delaying large scale geothermal development in the county.

An Area Development Plan is currently being prepared for the Steamboat Springs area. The town is ideal for the development of geothermal for direct heating purposes, including resource virtually onsite, a growing economy and major highways, railroads and airports in the immediate area. The geothermal resource for Steamboat Springs has been estimated to be approximately 0.049 quads with subsurface temperatures between 125°C and 130°C (Pearl, 1979). The annual heat demand for Steamboat Springs is estimated at 53.3×10^9 BTU (NMEI, 1980). Preliminary economic analyses by the New Mexico Energy Institute indicates that geothermal energy could be supplied to the town for $2.04 to $2.45 per MMBTU, while the price of natural gas is currently higher ($3.78 per MMBTU).

2.3 State Aggregates of Prospective Geothermal Utilization

The estimated geothermal energy developable by the year 2020 is shown on Table 6. Revisions have been made from previous estimates and will be updated as data is collected.

TABLE 6

POTENTIAL ENERGY ON LINE BY THE YEAR 2020

ELECTRIC POWER GENERATION SITES

Site		Estimated MWe
Chalk Creek #21		100
Poncha Springs #23		100
Cebolla #47		200
	TOTAL	400

DIRECT THERMAL SITES

		Estimated 10^{10} BTU's
San Luis Valley #31,32,33,34,35,36,37,43,44,45		422.0
Pagosa Springs #41		189.0
Glenwood Springs #11		129.0
Hartsel #19		4.0
Waunita #46		12.0
Routt/Steamboat #3,4		25.0
Hot Sulpher #6		14.0
Haystack Butte #7		3.0
Eldorado #8		2.0
Idaho #9		8.0
Ouray #49		15.0
Dunton/Geyser/Paradise #51,52,53		5.0
Juniper/Craig #1,2		12.0
Brand's Ranch #5		0.7
South Canyon #12		2.0
Penny #13		10.0
Colonel Chinn #14		4.0
Cement Creek/Ranger #16,17		3.0
Wellsville/Swissvale #24,25		2.0
Canon City, Fremont #26,27		3.0
Don K. Ranch, Florence #28,29		19.0
Clark #30		2.0
Wagon Wheel Gap #43		4.0
Orvis #48		6.0
Rico #54		4.0
Pinkerton/Mound #55		2.0
Tripp/Trimble #56		7.0
Cottonwood #20		18.0
Poncha Springs #23		34.7
	TOTAL	961.4

2.4 Institutional Analysis

Final editing and document assembly was completed for the Colorado institutional handbook, The Regulation of Geothermal Energy in Colorado (Coe and Forman, 1980), and was forwarded to the Department of Energy. The handbook is also available from the Colorado Geological Survey (Information Series 15, Regulation of Geothermal Energy Development in Colorado, Coe and Forman, 1980).

2.5 Public Outreach Program

2.5.1 Outreach Mechanisms

Existing Mechanisms

Information collected and prepared in brochure form by the Colorado Geological Survey and Department of Energy is distributed to interested parties. A display describing geothermal energy in the state was shown at energy and science fairs.

Lectures were presented in Glenwood Springs and Rifle at the Colorado Mountain College campuses in these cities.

Geothermal activities and potential are represented in the news media, including coverage by television, radio, local and regional newspapers and business news publications.

Personal meetings are conducted on a regular basis. Contacts with government, business, industry and individuals are held as part of the educational process of geothermal development and during data collection for area plans and resource identification. This outreach method is probably the most effective, given the rural character of most of the geothermal resources found in the state. Telephone interviews and conversations are also an effective outreach mechanism conducted on a regular basis.

Recommended Mechanisms

A newsletter of geothermal news could be distributed to geothermally interested developers, consultants, local and regional governments, citizens and other interested parties. Coverage on a quarterly or monthly basis would be adequate. A newsletter, if undertaken, would be more effective if continued on a long term basis. If terminated after a short period of time, many parties on the distribution list may be dismayed at the actual geothermal potential with a short lived newsletter.

More effective means of distributing to the public geothermal publications published with public funds should be utilized. All too often, a report will never make it to the people to whom it will do the most good, i.e.; local planners, developers, resource owners, etc.

2.5.2 Summary of Contacts and Results

TABLE 7

Contact	Comments
INDUSTRY, CONSULTANTS, ETC.	
AMAX Exploration, Inc.	electric power generation
Willard Owens Assoc., Inc.	district heating -heat pump applications
Chaffee Geothermal	industrial park
Montrose Press	news article
Fox & Assoc., Inc.	district heating
American Thermal Resources	electric power generation
Mahoney & Co.	district heating - ski resorts
Petroleum Information Corp.	leasing
Ethanol International, Inc.	agribusiness
Basil Engineering	district heating
Denver Business World	news article
BDM Corp.	general
Energy Systems Management	heat pumps

Denver Research Institute	energy fact book
ComFurT Gas Co.	energy consumption
Greeley Gas Co.	energy consumption
Public Service Co.	energy consumption
Chaffee County Times	news article
Occidental Oil, Inc.	electric power generation
Petro-Lewis Corp.	electric power generation
McGrath and Co.	heat pump applications

INDIVIDUALS

Leonard Cassara	heat pump applications
David Vince	agribusiness
Robert Owens	shopping center heating
Larry Howser	alcohol production
Norma Swanson	real estate and geothermal development
Yvonne Reid	hot springs owner
George Vranish	direct heat applications
Bill Fowler	hot springs resort owner

LOCAL GOVERNMENT

Ouray City Council - Walt Garrod	district heating
Ouray City Engineer - Jerry Morris	district heating
Salida Mayor - Ed Touber	district heating - industrial applications
Salida Chamber of Commerce	general
Four Corners Regional Commission	general
Chaffee County	geothermal exhibit
Idaho Springs Mayor Dorothy Kyler	district heating
Idaho Springs City Administrator T.G. Johnson	district heating

Buena Vista Chamber of Commerce Margery Dorfmeister	alternative energy systems
Upper Arkansas Council of Governments	general
Chaffee County Planning Office Bob Staedler	district heating
Buena Vista City Manager Justin Hammil	district heating
Mayor's Office - Denver	general

COLORADO STATE GOVERNMENT

Colorado State Science Fair	geothermal exhibit
Colorado Energy Conservation Office	general
Oil and Gas Conservation Commission	general
Board of Land Commissioners	general
Public Utilities Commission	energy consumption
Division of Planning	demography
Division of Commerce and Development	general
Division of Energy and Mineral Impact	general
Department of Corrections	state prison heating potential at Canon City and Rifle facilities
Department of Highways	interstate highway deicing
Division of Employment and Training	employment statistics
Division of State Buildings	heat state buildings

FEDERAL GOVERNMENT

NOAA	Colorado geothermal map
U.S. Forest Service	leasing
Bureau of Power and Water Resources	desalination - Glenwood Springs and Dotsero Hot Springs
Bureau of Land Management	leasing
Solar Energy Research Institute	energy requirements

2.5.3 Overall Prospectus for Future Geothermal Activity

Electric power generation potential has definitely been slowed by leasing delays on federal lands. At the present time, exploration firms interested in the Chalk Creek, Poncha Springs and Cebolla resource areas are awaiting federal action before continuing exploration and possible development activity. If the constraints inhibiting these developments were lifted, power generation may be a reality.

Funding, or lack of developer expenditure, both in the private and public sector continues to plague the geothermal industry. If high front end costs and reservoir uncertainties were overcome, more development in the direct heat application area would certainly occur. Agribusiness applications in the San Luis Valley and commercial and industrial uses in Chaffee County might be expanded.

In addition, certain larger organizations such as the City and County of Denver, Colorado State Department of Corrections and other state owned buildings are interested in developing geothermal (heat pumps or direct thermal) for space and water heating municipal and institutional structures.

Municipal organizations are in different stages of development. The Pagosa Springs heating district and wells are anticipating completion within one year. Ouray and Glenwood Springs are both conducting feasibility studies and investigating funding possibilities.

Based upon the large increases in the pricing of fossil fuels in recent months, alternative energy sources such as geothermal should become increasingly favorable to potential developers or existing installations.

3.0 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

The major efforts of the Colorado Geothermal Project during the first half of 1980 were concentrated on the Chaffee County report, geothermal leasing progress, outreach activities and updating resource information. It is evident that Colorado has definite geothermal potential. While the high temperature resources of the state, if any, remain to be proven, the low and moderate temperature potential is relatively abundant in the mountainous portions of the state (Figure 1). Currently, the state's resources are estimated to contain between 5 and 12 quads of energy (Pearl, 1979). As population increases and resultant growth in the state continue, it is anticipated that geothermal energy play a more important role in energy requirements.

Recommendations: The following recommendations are suggested in order to promote the utilization of geothermal energy in Colorado.

- Continuation of federal funding for the state commercialization and resource assessment programs to provide an information source for interested users and developers within the individual states.

- Issuance of federal leases to enable energy firms to conduct further exploration for potential high temperature electrical power generation sites.

- Provide additional front end funding for feasibility and exploration studies for potential development for primarily industrial and municipal users.

- Additional emphasis should be placed on the heat pump application possibilities for individual residential, commercial and industrial applications.

- Department of Energy geothermal publications compiled by state teams and DOE subcontractors should be distributed on a local basis, where developers and consultants may better utilize the information they contain.

- Continuation of existing Department of Energy funding for prospective geothermal developments (User Coupled Drilling Program, Geothermal Loan Guaranty Program, etc.).

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MONTANA GEOTHERMAL COMMERCIALIZATION PROJECT

Semi-Annual Progress Report

January-August 1980

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U.S. Department of Energy
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INTRODUCTION

Geothermal energy has the potential of supplying a significant portion of Montana's energy needs. To promote the development of this resource, a geothermal commercialization program was established in 1978. This program, jointly funded by the U.S. Department of Energy and the Montana Department of Natural Resources and Conservation, has evolved considerably since its inception. Mid-term reports have been prepared approximately every six months to monitor this evolution. This mid-term, the latest in the series, covers the period of work from January 1980 through August 1980, and describes the accomplishments of the program during that time. It also briefly discusses the direction of the Montana program during the next contract year.

Earlier mid-term reports contain lists of Montana's geothermal resources, state aggregations of predicted energy on-line, and several area development plans. Little of that information is repeated in this report. Instead, brief summaries of work accomplishments and of recent geothermal developments in the state are presented.

PAST ACCOMPLISHMENTS AND PROGRAM DIRECTIONS

During the first year of the geothermal program, minimal marketing of the geothermal resource was done. Instead, approximately 80% of our time was spent in writing development plans, energy scenarios, and computer models of geothermal systems in Montana. While these studies were necessary to supply DOE with data to defend the geothermal budget to Congress, they accomplished little in actually getting energy on-line.

Another task during the first phase of the commercialization project was the establishment of a working relationship with the geothermal Resource Assessment Team (RAT). The Resource Assessment Team has been very responsive to the request for information from the commercialization team, and has assisted numerous hot springs owners in evaluating their reservoirs. The interaction between the two teams was also responsible for the securing of a $400,000 grant from DOE. This money is being used for geothermal reservoir assessments in several areas of Montana that are co-located with population centers. Currently, geophysical data is being collected in the Boulder and Helena Valleys, with work in the Deer Lodge valley scheduled for next year.

Acquiring knowledge of the number and quality of the hot springs in Montana was another major task in the early phases of the program. Approximately 70 hot springs have been identified in the state, and their surface temperature, flow rate and geothermometry measurements have been completed. This knowledge is extremely valuable in assessing Montana's aggregated geothermal resource.

CURRENT PROGRAM DIRECTIONS

During the past six months, the emphasis of the Montana Geothermal Program has changed considerably. Area development plans and energy scenarios have been deemphasized as the geothermal team became more involved in direct marketing strategies. These strategies can be broken down into 1) Increasing public awareness of geothermal; 2) Identifying institutional barriers to geothermal development; and 3) Providing technical assistance to geothermal developers. Our activities in these three areas during the last six months are described below.

1) Increasing Public Awareness

A large portion of our efforts during the past six months was spent in informing Montanans of the value and cost effectiveness of geothermal energy in the state. A statewide geothermal conference was held in May to discuss the current status of geothermal exploration, development and laws in Montana. The conference had over 50 attendees, and received coverage by the major newspapers in the state. Other newspaper stories on geothermal energy occurred during the summer, including a full page story on geothermal development in the Butte Standard.

A slide show on Montana's geothermal resources was prepared this summer, and will receive extensive use in future outreach activities. The slide show will be particularly helpful in other energy fairs and county fairs throughout Montana. Another film production is presently underway, made possible by funding from the Montana Alternative Energy Grants Program. This production will consist of a 30 minute videotape on geothermal development in Montana, and will feature the work of the state commercialization team. The videotape will hopefully be completed and ready for television airing before 1981.

2) Identifying Geothermal Barriers

One of the major obstacles to the development of geothermal energy in Montana is the lack of workable laws and regulations pertaining to geothermal.

3) Technical Assistance to Geothermal Developers

One of the most effective means of getting geothermal energy on-line is to provide engineering and other technical assistance to the geothermal developer as he designs and constructs a geothermal facility. Our program is increasing its technical assistance to developers, and we see this as the major task of the geothermal program in the coming year.

A benefit to working in the Montana energy division is that Montana has a large renewable energy grants program. Nine geothermal projects have been funded under this program in the state, averaging $15,000 per grant. We see this program as being a great stimulus to geothermal development in the state, and have and will spend a great deal of our time soliciting geothermal proposals suitable for funding. We are currently assisting three potential grantees with geothermal proposals under the latest cycle.

SITE SPECIFIC ANALYSES

In the past 8 months, four major site specific analyses have been completed. These site specifics are summarized in the following section. Computer analyses by NMEI have been completed for most of these analyses, but are not presented here.

1. Baker, Montana

Economy: Baker is situated at the crest of the Cedar Creek Anticline, a geological formation that has produced oil and natural gas in abundance for over twenty years. The area economy is based about 70 percent on oil and about 30 percent on agriculture and ranching. A considerable portion of the population of Baker works in oil or oil-related enterprises; the economy is commensurately strong and the tax base is good. Growth has been slow and is expected to remain so.

Resource: There are no surface manifestations of geothermal activity in the area of Baker, as is true of most of eastern Montana. However, oil well drilling along the anticline has almost invariably penetrated water bearing strata at considerable depth (4,000-7,000 feet). Typically, the water is under artesian pressure and of a temperature predictable from the geothermal gradient (180 degrees F at 7,000 feet). Baker is surrounded by oil wells, many active, some abandoned, and some temporarily abandoned. Usually the geothermal strata have been cased over, but in a few cases the water has been used, for instance for oil-water separation in a heat exchanger. Water quality from most Madison formation wells is abominable, but at Baker the water is anomalously clean. If used for space or process heating, it might be possible to put it to secondary use for irrigation.

History of Our Involvement: The geothermal office was contacted in February of 1980 by Tom Green of Juniper Oil. He had talked with one of the researchers on the Lemmon, South Dakota project, and the presence of abundant geothermal in the area of Baker had suggested a similar potential for the town.

After extensive discussion it was decided that the best plan of attack would be to acquire a well for testing from one of the oil companies, if they would aree to its release. If the well showed sufficient potential, it might be used for a district heating system. The initial thought was to retrofit the whole town of 3,000 (1100 buildings).

With this in mind, the commercialization team visited NMEI in March and did a thorough analysis of Baker with the BTHERM model. The results indicated that the system would be an expensive one to install, and would require about five wells, if flow rates were consistent with other wells in the area. A conceptual model of the district heating system was drawn up and sent to Baker, along with an analysis of the computer runs. This analysis, along with two personal visits, were given considerable publicity in the Fallon County Times.

Tom Green, in conjunction with city and county officials, applied to the Appropriate Technology Small Grants Program for money to conduct an engineering feasibility study of geothermal and district heating potentials. In this effort the geothermal office offered substantial advice in composing the grant proposal.

In early September a city planner from Baker called the office to ask for a letter of support for the reviewers of Denver, who had given conditional approval to the project, but needed more information. The letter was written, and the grant has since been approved. The services of a qualified engineering firm have also been tentatively secured by the office. Finally, almost at the same time as notification of the grant, Baker was successful at acquiring a well near town from an oil company for testing.

The present plan for Baker is to investigate the well and assess what end use is most appropriate. Depending on the outcome of the feasibility study, further effort will be invested in applying to the User Coupled Drilling Program, the Loan Guaranty Program, and the Montana renewable energy grants program.

Baker offers the potential of being a showcase project, not only for Montana, but for the West as a whole. If water quality proves to be adequate, secondary use of the resource promises to avoid some of the problems of injection that otherwise could increase the cost of the project. The community seems to be solidly behind the idea of a district heating system, knowing that the price of natural gas, the sole supplier of heat in Baker presently, is bound to rise dramatically in the next few years, while the available oil products of the anticline are bound to decline.

2. Boulder, Montana

Economy: Jefferson County as a whole is considered a chronically depressed area. According to a report commissioned by the county Overall Economic Development Committee, the major reasons for this include: a disparately small tax base, due to the fact that much of the county is owned by the state, the Forest Service, or is otherwise taken out of production; lack of industry and/or commercial activity, due to the proximity of Butte and Helena, which capture most of the buying power; and the fact that most of the new county residents (40 percent growth in ten years) live on its borders and work and spend elsewhere.

Resource: Boulder Hot Springs is situated about two and one half miles to the southeast of the town of Boulder. At the spring site is the old Diamond S resort, popular with Butte copper people through the 1920s, but now rather dilapidated. Surface temperature is in excess of 160°F (71°C) and a flow of about 500 gallons per minute, qualifying it as one of the very best prospects in the state. Opinions vary as to the ultimate reservoir potential of the spring, but even at present levels of flow and temperature, calculations indicate that a large facility could be space heated with the water.

History of Our Involvement: The managers of Boulder Hot Springs applied for a grant from the Renewable Energy Bureau at the end of 1979, after having constructed a rough but effective greenhouse from plastic, lodgepole pine, and recycled radiators using waste water from the hotel. The proposal was not accepted.

In December 1979, the geothermal office was contacted by the author of the report for the OEDP committee. He wondered about the potential of using Boulder Hot Springs water to provide either process heat or space heat for an industrial development. It was his conclusion that the development of geothermal should be the highest priority for Jefferson County's planners, which would give them a lever with government agencies like the Economic Development Administration.

Joe Keller at EG&G was contacted, and he provided planners with the necessary figures on the heat requirements for a brewery and for aquaculture. The brewery received low marks, and the aquaculture high marks. Through the geothermal office, they were also put in touch with Leo Ray in Idaho, and several other people in similar businesses.

Through conversations with the new owner of the hot springs it was learned that he was interested in drilling for more water, which he might then sell to the town. The major problem at that time seemed to be the question of where to drill. He leaned toward drilling at the site of the spring, but was discouraged by the fact that drilling thus in a fault-dominated system offered no guarantee of hitting hot water.

In the spring of 1980 a meeting was held in Butte with DOE, UURI, the geothermal team, and the resource assessment team to discuss a proposal for funding for expanded geophysical studies in Montana. Money from the DNRC was to be used as a match to the DOE funds. The program was given approval, contingent on the state funding. At that time, Boulder was targeted by the geothermal team as a preferred site, a choice that ran counter to the expressed wishes of the resource assessment team.

Later the Renewable Energy Advisory Council suggested that the amount asked for by the resource assessment team be diminished from $30,000 to $20,000. The geothermal team at that time was able to get the additional $10,000 reinstated, with the provision that Boulder be treated as a preferential target. The resource assessment team agreed to this, contingent upon the receipt of data already taken on the Boulder site by others. Eventually the data were received and analyzed, and as a result it was determined that a suitable drilling site could be identified. The site, however, was not on land owned by the Diamond S, but about a quarter mile away. The landowner was agreeable to the proposed drilling, and a drill site was chosen in early June. County and town officials were apprised of the intent to drill a test well before the end of the year, as was the owner of the hot springs. The well would be drilled and the resulting geothermal output tested, if any. One particularly useful question that stood to be answered was that of whether there is any connection between a postulated valley reservoir and the hot springs.

Prior to drilling, however, the owner of the present hot spring wrote a letter to the geothermal office outlining his position with respect to the possible effects on his spring (see Appendix) and this letter effectively ended any involvement of the parties concerned in pursuing the project.

The letter itself would not be considered reason to call off an exploration attempt, since it could be met with adequate assurances that the owner's interests would be protected. There were, however, numerous background considerations that influenced the principals in the investigation to decide that the threat of a lawsuit outweighed the benefit to be gained from the drilling. For one thing, a lawsuit, even if spurious, would take time and money. If in fact the near-impossible should happen, i.e., that the test well actually were to interfere with the existing hot spring, the landowner would stand to lose considerable sums, as would the overseers of the project. Conceivably, also, a court case might expose information on the drilling that was to be kept in strict confidentiality, which might then result in the loss of further information at a future time. Finally, there were questions as to the hot spring owner's motives. It was suggested that he might not be doing too well financially, and might welcome a chance to sue the state.

All of these considerations discouraged the further attempts to pursue drilling. This was regarded as unfortunate, in view of the economic woes of the town of Boulder, and the potential of the resource there.

It had long been expected that any development at Boulder would provide an interesting test case of numerous ill-defined concepts surrounding geothermal development. In a sense quite apart from the loss of aid to Boulder, it is unfortunate that the project was so abruptly terminated due to personality problems before clarification could be attained on any of these questions except the ability of one man to stymie the project.

At any rate, the failure of the Boulder project left $4,000 that had been earmarked for drilling. It was decided that the best use of that money would be to finance part of the drilling expense at another location. It so happened that the owners of the hot spring at Ennis, Montana, were in the process of trying to decide whether to drill at their place for scientific and practical reasons. It was therefore decided to transfer the money to that location, if an agreement could be worked out among the owners, the resource assessment team, and the DNRC.

Although Boulder seems at the moment to be a dead issue, in fact it may surface at a later time in new dress. Hopefully at that time a better match of resource and need may be worked out.

3. Two miles east of Avon, Powell County, 30 miles west of Helena

Economy: Avon is situated in an area that is almost entirely agricultural. Many of its present residents commute to Helena to work, and the town itself has few services to offer.

Resource: Several springs and seeps issue from a travertine deposit on land occuppied by Tom Harpole. Depending on the time of year, the temperature runs between 85 and 90 degrees F. Flow has never been measured, but estimates of the main spring put it at about 30 gallons per minute. That spring was formed by dynamiting the travertine, suggesting that it might be further augmented, or that more springs might be so formed.

History of our involvement: The geothermal office was contacted in May by representatives of a newly formed, nonprofit corporation that had been put together to build and manage a solar-geothermal greenhouse on the site. The geothermal team visited the site soon thereafter, and since then there have been frequent meetings. Aid has been provided in two major areas, that of grant writing for the renewable energy program, and that of engineering technical assistance. The principals are well-versed in construction practices and materials, but lack indepth knowledge of design factors for either greenhouses or hydronic heating systems. Technical assistance has included performing a heat balance calculation on the greenhouse and the geothermal system, based upon weather data from the area. Preliminary drawings of the structure and the heating system have also been prepared.

Whether or not the grant request is successful, the corporation intends to build and operate the greenhouse, to promote self-sufficiency, to produce a measure of the edibles consumed locally, and to use the facilities as an educational tool for local school children. They have received verbal committments from town leaders and the school, and considerable material has been purchased already for construction.

The Avon project provides a good example of how a state agency can help even those of small scale, who may lack expertise in some aspects of a particular project, but who have the resource and the perserverance to see it through when provided with modest assistance.

4. White Sulphur Springs, Meagher County, 70 miles east of Helena, population 1200

Economy: White Sulphur Springs is the hub of a large area given over almost entirely to ranching. Most of the services provided in the town are in support of this activity.

Resource: Naturally occurring springs have been in constant use for centuries. Within the last 50 years a spa and motel have been built at the site, but apparently the resource is much greater than is presently used. Earlier this year a geothermal heating system in the First National Bank was dedicated formally after two years of construction. This state-funded project draws 122 degree F water from a well 250 feet deep. Presently the main street has been excavated for the laying of a new sewer pipe, and water at 108 degrees F is being pumped out at a rate of about 500 gallons per minute. Hand-dug holes behind the motel have struck hot water three feet from the surface.

Possible Applications: The state has been involved in geothermal development in White Sulphur Springs for over three years to date, mainly with the bank project. Over the last few months there has been a growing interest on the part of several people relative to the development of other projects. The resource seems to be great enough to support considerable development, and the town is small enough that water could be piped almost anywhere.

One project, for instance, would be the heating of the public buildings in town, specifically, two schools, a hospital, and the county courthouse. Analysis by the BTHERM model indicated that such a system would be immediately cost competitive.

The board of directors of the Mountain View Memorial Hospital approached the geothermal office with an energy problem last spring. Heating water for the hospital laundry was costing over $1,400 per month. The suggestion was made that a large cubical crib be dug behind the hospital, where hot water is known to occur next to the surface, and a long coil of copper pipe be installed, through which 36 degree F city water would be circulated and prewarmed. Computations indicated that if the water could be warmed to 90 degrees F, the hospital would save about 70 percent of its hot water bill. Further analysis has indicated that the original idea of copper tubing in the crib is probably infeasible due to high water velocity and consequent short residence time in the crib, but the essential concept of a simple preheat system remains viable.

The senior citizens' center at White Sulphur Springs has recently been granted money to construct a large solar greenhouse at the facility. Representatives of the project have now contacted the office about the possibility of heating the greenhouse geothermally.

All of these projects are fairly small, not too expensive, and probably represent a short payback period if undertaken. The geothermal team expects to work closely with these and others as they occur.

LOOKING AHEAD: FUTURE SITE SPECIFICS

There are several projects in the offing that have not yet gone far enough to warrant site specific plans, but which are worthy of mention. Some are quite recent, as the case of Camp Aqua, and others have been around inactive for quite some time.

1. Ennis, Madison County

The geothermal potential of this area is expected to be great, but so far is all but undeveloped. People drilling wells have routinely hit water in excess of 110 degrees F (to their disappointment), over a fairly extensive area bout a mile and a half from town. The owners of the hot spring site are interested in drilling to prove up the resource, and some of the money that was to be used for the Boulder project may find its way into that effort. Many details remain to be worked out in addition to those associated with drilling, particularly relating to end use.

The most immediate use would be for an existing trailer court for space heat, but if the resource should prove to be as great as expected, and as hot (above boiling), the challenge will then become what to do with it. The town has shown interest in piping the water in for space heating for a commercial district, or for heating county buildings. Serious thought has been given to an ethanol facility, using the geothermal as process heat, but little detail has been worked out as to feedstock, shipping/piping, or environmental impacts.

2. Camp Aqua, Sanders County

Energy Engineeering of Kalispell has put together a complete package for an ethanol plant using geothermal water from this old resort, and to that end, they have leased the property. They are unwilling to seek out government funding or loan guarantees due to the delays that seem always to attend such programs. However, borrowing power on an unproven resource is difficult, and they have therefore come to the Renewable Bureau seeking money for exploratory drilling. The expected cost for the well, which is envisioned to be about 3000 feet deep, is on the order of $100 per foot. As a sidelight, the office had heard about the intentions of the firm to use geothermal, but heard nothing from them directly until shortly before this report. It was assumed from their apparent attitude that they knew all that was necessary about the resource; now it appears otherwise.

3. Silver Star, Madison County, south of Whitehall

Silver Star is another of the few Montana resources expected to exceed boiling temperatures. Its location is remote from populated areas, but in a good location for feedstock for ethanol and close to a pipeline that might be used to transport it. As in many other cases, the most immediate need is for resource confirmation. One unsuccessful grant proposal was sent to the Renewable Bureau last year, and another was submitted to the Appropriate Technology Small Grants Program in 1980. The owner intends to put in another proposal for this year's cycle. The project is in preliminary stages, however, and much serious work must be done before a full scale ethanol facility can be envisioned for this site.

SITE SPECIFIC ANALYSES: CONCLUSIONS AND PROJECTIONS

As the Montana project has advanced over the last two years, it has evolved from a planning function consisting of broad generalities toward a more concentrated effort oriented toward specific projects. It now seems clear that the planning function lacks validity or realism from the standpoint of the actual situation in the state. Conversely, the site specific analyses are just that, highly specific, and cannot therefore be used as generic models applicable to a variety of situations. If the purpose of the DOE program is to stimulate the growth of interest in geothermal energy in the states, then in Montana it has been doing its job, both from the standpoint of the funding programs available, and, perhaps more importantly, because there are now people in state government trained to handle geothermal projects, whereas before, there were none.

The projects now in process in Montana represent a good cross-section of magnitude, from multi-million dollar heating systems like that proposed for Baker, to the employment of a low temperature resource like that at Avon for a localized development affecting a small number of people. We think this is healthy; that geothermal resources are useable by the little guy as well as large, commercially oriented ventures.

The greatest perceived need at this point in the development of geothermal energy is twofold: The clarification of legal issues surrounding it, and the development of financial awareness on the part of money lenders and other financial institutions. For the first of these, the legal questions, we are looking to NCSL for help. For the second, the financial questions, we intend to hire a replacement for one of the team members with lending background and administrative experience. Hopefully with this combination of personnel, the geothermal world of Montana can advance to its next logical critical decision point on that big old activity line of life.

APPENDIX

Stuart F. Lewin
'torney at Law

Boulder, Montana 59632
Telephone 406-225-4272

Boulder Hot Springs
July 29, 1980

Micheal Chapman
DNRC
32 South Ewing
Helena, Montana 59601

Re: Geothermal Drilling in Boulder Valley

Dear Mr. Chapman:

I write you on behalf of the owners and operators of Boulder Hot Springs. This resort has been in existence for well over 100 years using the geothermal waters coming from our springs located on our property. We, of course, place an extremely high value on our springs. It is our understanding that you intend to drill a test well on John Heide's land for a possible geothermal source. We are concerned that this drilling is too hastily determined.

Please be advised that we intend to hold you, your department, the State of Montana, the land owners, and everyone else involved responsible for any loss in temperature or in water flow (duration or amount) of our springs resulting from your drilling and/or well use.

We hereby request that you <u>do not</u> commence <u>any</u> drilling until the following conditions are met:

1. A minimum of one year measurement is made of our springs to determine temperature and duration of the springs by a system approved by both you and us. In this manner, we will be able to determine damage, if any, caused by your drilling and/or well use, and
2. That you post a bond for an amount agreeable to us and payable to us to cover any and all damages caused by the drilling and/or use of your well, and
3. That all legal remedies and damages as provided by law be afforded us.

We are open to any suggestions you may have so that you can proceed with your drilling while our interests in the springs are protected.

Sincerely yours,
LEWIN LAW OFFICES

Stuart F. Lewin

SFL/mw

cc: Mike Greely, Montana State Attorney General
Jefferson County Commissioners
John L. Sonderegger, PH.D
John Heide, Jr.
Robert Ryan

NEW MEXICO GEOTHERMAL COMMERCIALIZATION PLANNING

SEMI-ANNUAL PROGRESS REPORT

January 1, 1980 - June 30, 1980

Prepared by:

Dennis Fedor

NEW MEXICO ENERGY AND MINERALS DEPARTMENT

SANTA FE, NEW MEXICO 87501

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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 currect or potential end-users of geothermal energy with technical assistance. This effort has undoubtedly provided good experience and greater insight into the marketing needs and demands by the end-users.

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 7 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 are available favorable quantitative data on the measured subsurface temperatures, volume, and water flows.

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
	S.D.	Jemez Reservoir
		Lordsburg
		Lower Frisco H.S.
		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 H.S.	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
	Radium Springs	Mamby's H.S.
	San Diego Mtn.	Mancisco Mesa
	San Ysidro	Montezuma H.S.
	Socorro	Southern Tularosa Basin
	Turkey Creek H.S.	Tohatchi
	Upper Frisco H.S.	

TABLE 2

STATE OF NEW MEXICO
PROVEN AND POTENTIAL DIRECT THERMAL APPLICATIONS

SITE	LATITUDE / LONGITUDE	TEMPERATURE (°C) SURFACE	SUBSURFACE	ESTIMATED VOLUME (km^3)	ESTIMATED ENERGY (MWe) PROVEN	POTENTIAL	TOTAL
Albuquerque	35° 05' 106° 45'	27	30°	3.0			0.0449
Faywood H.S.	32° 33' 108° 00'	54		1.0			
Gila H.S.	33° 12' 108° 12'	68	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
Truth or Consequences	33° 9' 107° 15'	36-46	100	1.0		0.0269	0.4563
Animas	32° 85'	102	144	3.0		.0359	0.4102
					0	0.0834	2.1508

TABLE 3

STATE OF NEW MEXICO
PROVEN AND POTENTIAL ELECTRIC APPLICATIONS

SITE	LATITUDE LONGITUDE	TEMPERATURE (°C) SURFACE	 SUBSURFACE	ESTIMATED VOLUME (km^3)	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

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.

2.2 Area Development Plans

2.2.1 State Geothermal Planning Areas

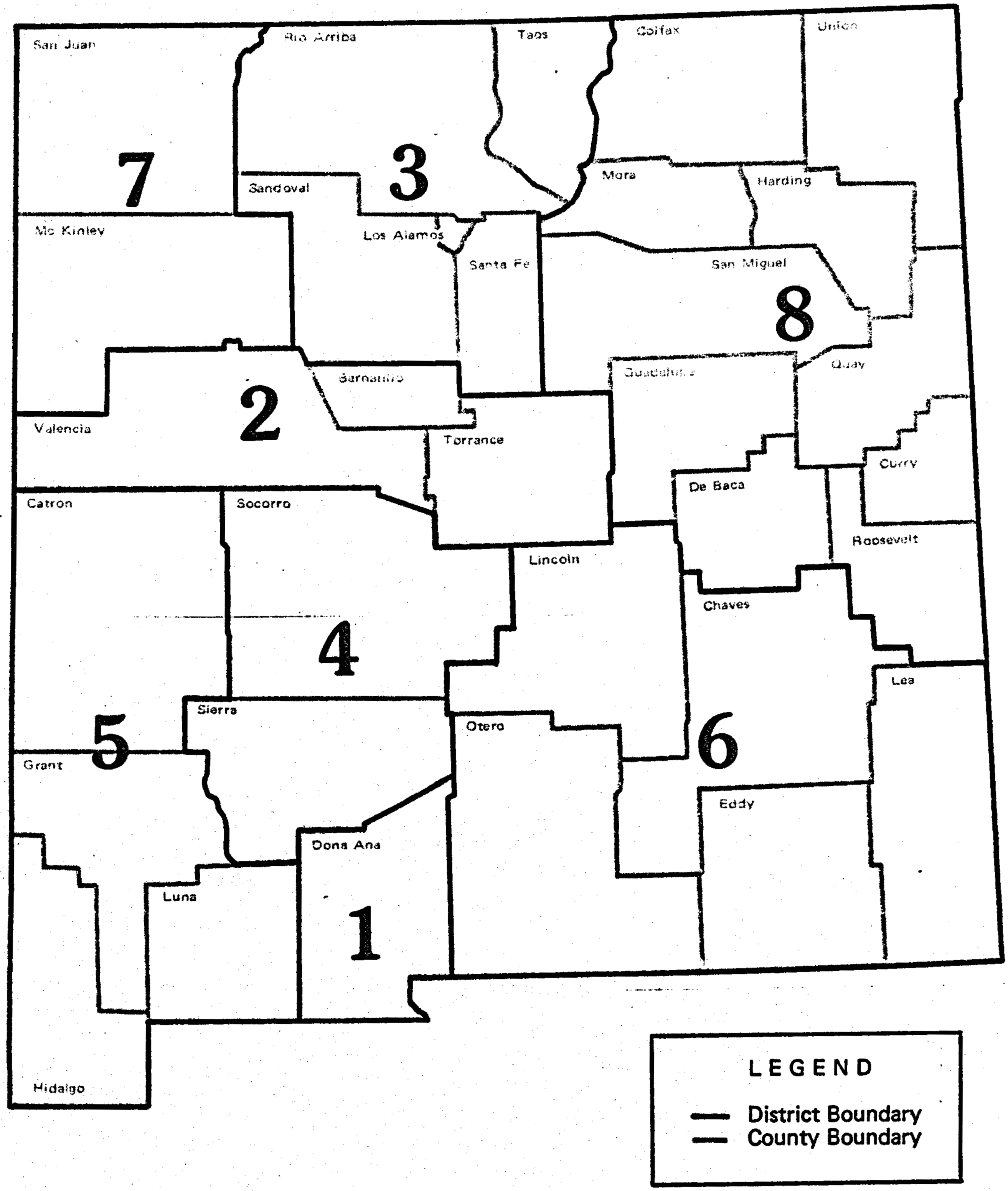
The New Mexico State Team is defining 3 substate geographical areas for which the development and utilization of geothermal energy prospects are likely between now and the year 2020.

The areas considered for commercialization planning are primarily multi-county substate areas based on the state planning district format. These substate regions also coincide with geological provinces and with distributions of geothermal resource sites that are unique to those respective areas.

The 1st-priority target areas for area development planning are centered on the Rio Grande River Valley throughout its entire length within the state.

FIGURE 1

STATE GEOTHERMAL PLANNING AREAS



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 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 2 KGRA's in the county: Radium Springs and Kilbourne Hole. The Kilbourne Hole KGRA, located next to the U.S. - Mexico border, has 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. 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 some degree, most current food drying processes could be 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: $7,849 \times 10^{-8}$ quad

Estimated Reservoir Size: 3.3 km^3

Los Alturas

Current Applications: Space-heating of home for the president of New Mexico State University and source of domestic water supply for Los Alturas subdivision.

Anticipated Application: Industrial process heat - L'eggs Corp., space heating: shopping center, hospital 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, Carrie Tingley Hospital therapeutic pools, space-heating of Yucca Lodge. Preheated boiler feedwater system for Carrie Tingley Hospital.

Anticipated Application: Spaceheating of senior citizens center, 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 multi-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.

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 public 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 will begin start up operations in September. The system will be monitored and evaluated until June 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.

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 president's residence is located. The space-heating system uses 50°C water from a depth of 137 meters at a flow rate of 64.3 liters/min. The project started June 28, 1979, the construction was completed in September 1980 with the monitoring and reporting continuing until June 1981.

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 132.51./m. 57°C. 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 nearly completed as of August 1980.

4. City of Truth or Consequences Senior Citizens Center. This is a retrofit space-heating project which will tap the underlying artesian thermal water basin under the city. The well water temperature in the area averages 43°C. The geothermal water will be pumped from a 154 meter or less well which is being drilled on city property. This well will be 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 will be completed by June 1981. The project was commenced on June 28, 1979.

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 will finish December 1980.

6. L'eggs Products, Inc., Mesilla Park. This project is evaluating 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 were encountered. It was determined from a series of economic and engineering sereis that the development of a deep resource would be technically feasible but not economically suitable for the company's requirement and needs. Study is still continuing on alternative sites for placement of a geothermal well.

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 10kg 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 18 wells and probably 13 to 16 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. Two hothouse 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 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 60° to 70°F. The deeper well supplies warm water at 78° to 80°F. The water is withdrawn from either the cool or warm well, depending on the season, and injected into the other well. A heat exchanger and three 100 horsepower compressors are used to boost or lower the water temperatures for winter heating or summer cooling. Heating requires 2,518,000 BTU/h and cooling requires 3,467,182 BTU/h.

2.5 State Aggregation of Prospective Geothermal Utilization

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

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

(Data Source PSL/NMEI)

ADP	1985	1990	2000	2020
#1	6.47	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 (COUNTIES)

1. Dona Ana County
2. Albuquerque Area - Bernalillo, Torrance and Valencia
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 and San Juan
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.

At any rate, district heating legislation and amendments to state geothermal leasing policies will not be examined any further until the 1981 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, yeilded 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, most geothermal development undoubtedly is clouded by this provision in the statute, and it deserves legislative review.

Only one legislative item was enacted in the 1981 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 current 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:

- o State EMD geothermal energy research and development program
- o DOE Region 6 Approprate Energy Technology Small-Grants Program

- State Geothermal Demonstration Program
- Energy Extension Service

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.

The monitoring is continuing on the construction, operation and evaluation of the six demo 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 is workingwith 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.

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 six 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 drilled for geothermal energy on campus. The university has successfully completed several wells and obtained DOE financial assistance for campus space-heating.

Columbus, which is located on the Mexico border, is presently being evaluated for a twin industrial park. Local leaders and the New Mexico Department of Commerce and Industry have shown great interest in evaluating the geothermal potential of the area. Geophysical testing in the area is being conducted by Dr. Swanberg.

EMD personnel have been working with community leader in Dona Ana County to identify potential users. Initial information has furnished prospects in the areas of space-heating for a shopping center, process heat for a pet food processor and geothermal application for a dairy.

Finally, the West Mesa area Albuquerque has become the focal point of geothermal exploration. The West Mesa area is the center of new growth in Albuquerque and geothermal applications may have a viable future. Plans for further exploration in this area are being developed.

All in all, New Mexico's geothermal future is 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.

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 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 projects valued at more than $500,000.

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

5. DOE needs to understand each state program to a greater degree and should work with the states to enhance the state's objectives. For example, here in New Mexico we have an aggressive R&D Program and Geothermal Demonstration Program yet our present contract requires that more effort go into resource planning (under DOE procedures and guidelines) then go into R&D.

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

7. 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.

APPENDICES

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: (111 Leases)	45,663
TOTAL OF ALL ACREAGES LEASED	271,373

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)

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
DONA ANA		
Chevron	639.36 (1)	08/14/79
Energetic Corp.	640.00 (1)	07/19/79
GRANT		
Aminoil USA	4,695.63 (18)	08/08/79 & 03/12/75
Supron Energy Corp.	3,868.90 (18)	03/12/75
HIDALGO		
Amax Exploration	8,176.00 (19)	07/10/79 & 07/19/79
Aminoil USA	11,078.55 (25)	08/03/79 & 03/12/75
SANDOVAL		
Cherokee & Pittsburg Mining	4,433.19 (7)	03/12/75
E.E. Fogelson	1,280.00 (2)	03/12/75
SOCORRO		
Arco	5,437.00 (10)	07/19/79
J.W. Covello	640.00 (1)	03/12/75
J.M. Kelly	2,624.27 (5)	03/12/75
Gulf Oil Corp.	2,150.56 (4)	03/12/75

POTENTIAL DEVELOPERS AND END-USERS

CONTACTED

CONTACT DONA ANA COUNTY:	PROSPECTIVE APPLICATION	COMMENTS
Frank Cobb, Pres. Sandyland Nurseries	Well drilling and space-heating	Seeking technical and financial assistance for large expanded greenhouse operation
Stan Smith, Mgr. L'Eggs Products, Inc.	Well drilling, space-heating, and industrial process heat	Test hole indicates no shallow resource on plant site
Rick Squires Western Dev. Corp.	District Heating System	New large subdivision to be developed in vicinity of possible resource
Joe Pomplin, Adm., Good Samaritan Village	Space-heating	Needs funds and technical assistance
Tom Young Tom Young Racquet and Health Club	Space-heating and preheat hot water system	
American Linen Co.	Industrial process heat	
Price's Dairy Farm Anthony, NM		
Los Alturas Estates Home owners: C.L. Traylor Thomas Johnson Clifford Clemens	District Heating System	Seeking information on opportunities
Aquaculture Products Technology, Ltd. Denver, CO	Shrimp Farm development	Seeking site-specific data
Roger Bowers Hunt Energy Corp.	Geothermal Electrical generation	Deep production well drilling has commenced
Don Ainsworth American Drilling & Grouting Co.	Geothermal Ethanol Plant in Mesilla Valley	Feasibility study request
Scott McInnis McCulloch Geothermal	Deep well for ethanol or power generation in Mesilla Valley	Interaction with L'EGGS and other potential users

Potential Developers (Cont.)

CONTACT	PROSPECTIVE APPLICATION	COMMENTS
Southwestern New Mexico:		
Tom McCants Animas, NM	Greenhouse and orchard soil warming operation	Awarded 1979 DOE AET grant
Dale Burgett Animas, NM	Large commercial greenhouse op.	Will expand current geothermal space-heated facilities
Doc Campbell Gila Hot Spring	Space-heating and dow temp. electrical generation	
S. M. Roberts Mirador Corp. Silver City, NM	Professional development service	Applied to Geothermal Loan Guarantee Pros. for fuel alcohol prod. project
State Wide:		
Gerald Huttrer Exploration Manager Republic Geothermal, Inc.	Prof. development service	Seeking investment opportunities
Bob Grant Private Consultant	Prof. developement service	Major advisor in numerous areas of geothermal commercialization
Russ Johns, President Prepared Foods, Inc. El Paso, TX	Process heat for beef	Preparing to relocate into Dona Ana County
Truth or Consequences:		
Randy Ashbough, Inc. Building Contractor	Space-heating	Seeking opportunities with current warm water well
Karl Kortimeier Owner, Yucca Lodge	Space-heating	Building geothermally heated condos
Gallup:		
Dale Lang Kilde Corp. P.O. Box 2125 Gallup, NM 87301	Construction and development of industrial facilities	Seeking investment opportunities

PARTICIPANTS IN THE STATE GEOTHERMAL
DEMONSTRATION & COMMERCIALIZATION PROJECTS

CONTACT	ROLE	STATUS & COMMENTS
Arthur Mansure BDM Corporation	Principal Investigator and proj. mgr. for Carrie Tingley Hosp. Demo Proj.	Construction and installation completed
Dan Romero Coupland & Moran	Electrical Engineer	Electrical subcontractor for Carrie Tingley Hosp. Demo Proj.
A. Bruce Cantrell Energy Control, Inc.	Supplier of energy system monitors	Instrumentation subcontractor for Carrie Tingley Hosp. Demo Proj.
Joe Klose Solar America, Inc.	Project Manager for greenhouse space-heating demo project at Taos	Construction nearing completion
Jewell Burk Southwestern Services to Handicapped Children and Adults, Inc.	Proj. Mgr. for Space-heating of Native Plant Greenhouse at Faywood H.S.	Construction and operation by handicapped labor
George Abernathy Dir., Agricultural Engineering NMSU	Technical Consultant & Ag. Eng. for SWSH	Engineering subcontractor on Faywood greenhouse
L. D. Clark Energetics Corp.	Principle Inv. for L'Eggs to evaluate geothermal energy on factory site	Study made for industrial process heat and test well was drilled
Larry Johnson L. Johnson Drilling Co.	Driller	Drilling subcontractor for L'Eggs project
Thomas Mancini Mech. Eng. Dept. NMSU	Principle Inv. for T or C Senior Citizens Center Space-Heating Proj.	Negotiating for driller subcontractor
Tom Gebhard Private Consultant	Consultant to T or C on the S.C.C. Proj.	
Dr. Harold Daw Assist. V.P., NMSU	Principle Inv. for NMSU President's home space-heating proj.	Production well completed and space-heating system installed
Roy Cunniff Physical Science Lab	Prin. Inv. for NMSU Campus heating project Technical Advisor for all demo projects	Production well and tests completed

Participants (Cont.)

Arlene Starkey Assist. Dir., NMEI	Chief Advisor for Dona Ana County Geothermal Task Force	Task Force preparing recommendations for commercialization

Businessmen and Government Personnel

Contacted in Albuquerque through the

Geothermal Commercialization Outreach

Jack Button
Butter Krust Baking Co.
717 Coal Ave. S.E.
Albuquerque, NM
243-9541

David Dyer
Coca-Cola Bottling Co.
205 Marquette Ave. N.E.
Albuquerque, NM
243-2811

Rusty Easton (Ms.)
Bureau of Education
Energy Management Office
915 Locust S.E.
Albuquerque, NM 87106
765-5950

Cloyce Harrison
CREGO Block Co.
P.O. Box 6025
Albuquerque, NM 87197
345-4451

Wade Oney
Swift & Co.
2200 Zearing Ave. N.W.
Albuquerque, NM
243-5676

Marvin Reiff
American Gypsum Co.
P.O. Box 6345
Albuquerque, NM 87197

Rick Squires
Candlelight Homes
1224 Pennsylvania N.E.
Albuquerque, NM 87110
268-4395

Lynn Starr
Borden Inc.
1710 4 N.W.
Albuquerque, NM
242-2851

Terry Story
Clover Club Foods
2500 Gibson Blvd. S.E.
Albuquerque, NM
247-0466

Gary Swartzman
Swartzman Meat Packing Co.
3301 2 S.W.
Albuquerque, NM
877-2550

Mr. Ansley
Ansley Manufacturing Co.
103 Aztec Rd. N.W.
344-9128

Dennis Rishel
Residential Loan Officer
Albuquerque Federal S & L
6400 Uptown Blvd. N.E.
883-3100

Ernie Torres
Northwestern Woodworks
320 Roehl Rd. N.W.
898-4969

Debbie Belsich
Albuquerque Public Schools
915 Locust St. S.E.
Lead/Coal Exit
Lead east to Cedar
South one block
Hazeldine Right (West) becomes
Locust at deadend on Right

Dave Derringer Enterprises
415 B. Marble Ave. N.W.
242-5792

Mr. Cannizzaro
Rio Rancho Independent
Development
3900 Southern Blvd. S.E.
898-4060

Dr. Ferran
El Centre Villa Nursing Home
236 H N.E.
243-4500

John Ward
Commercial Laundry
3340 Columbia Drive N.E.
345-8828

Bob Rushlo
Design Professionals Inc.
4210 Carlisle Blvd. N.E.
881-6336

Mr. Foster
Albuquerque Industrial Laundry
215 Altez S.E.
298-1882

Mike Voils
Rio Grande Metals & Supply
108 Dale S.E.
877-8000

Mr. Walker
Coda-Roberson Property Mgt. Inc.
9212 Trumbull Ave. S.E.
298-5540

Mr. Brooks
Brooks Photography
401 Edith Blvd. N.E.
842-5874

Brick Hisen (?)
New Mexico Marine Supply
4946 Jefferson N.E.
881-0636

Fred Marcilla
The Energy Store
2404 San Mateo N.E.
(2432 San Mateo N.E.)??
884-6108

Pat Wright
Argyle Medical Supply Co.
2031 Candelaria
345-1833

Nancy Nesbitt
Nesbitt Greenhouse
1201 San Mateo S.E.

Ralph Walker
The Insurance Center
1911 Wyoming Blvd. N.E.
296-9501

Frank Walters
Form Eye Systems
(Construction)
6200 St. Hwy. 47 S.E.
877-8100

Wayne Davis
IMS Corporation
3008-A Altez N.E.
292-3166

Jim Smith
Am Dec Developers
6400 Uptown Blvd.
(Smith of Coronado Shppng.Cntr)

Erv Baumgart
Amith Leather Products
6700 Bluewater Blvd. N.W.
836-1122

Ron Lehman
Modern Press
1501 12th St. N.W.
843-7537

Tim Dowling
Four Seasons Motor Hotel
Carlisle & I-40
265-1211

James Ewert
Southwest Forest Industries
Call Monday
1415 Broadway N.E.
247-2371

Edward Whaley
Gulton Industries
San Mateo/Osuna Exit
Exit West on Osuna
Gulton Court Left
345-9031

Jim Harrison
Ponderosa Products
1701 Bellamah N.W.
843-7400

Walter Mabie
Butter Krust Baking
717 Coal Ave. S.E.
243-9541

Tim Sloan
Security Federal S & L
6501 Indian School Rd. N.E.
883-6900

Pedro Fernandez
Dura-Box Company Inc.
4525 Los Angeles Blvd. N.E.
897-0170

Randy Pugh
Daniel's Insurance
4115 Montgomery Blvd. N.E.
884-8113

Harry Montgomery
Albuquerque National Bank
303 Roma N.W.
765-2371

Mr. Hendon
Savon Florists
3520 Candelaria Rd. N.E.
345-2090

Mr. Haner
Boulevard Nursery/Greenhouse
3838 Rio Grande Blvd. N.W.
344-4781

Lee Foltz
Paradise Hill Country Club
10035 Country Club Lane N.W.
898-0960

Charles Johnson
Continental Machining Co.
6824 Washington N.E.
345-2483

1. Winrock Shopping Center - Management office - 51 Winrock Center 883-611

2. J.C. Penney - 39 Winrock Shopping Center - 883-5800

3. Montgomery Ward & Co. - 90 Winrock Center N 1 - N 2:30 G.R. McGeeney 883-5500

4. Furrs Inc. - 6100 Central Ave. S.E. - 265-7516 Jim Rogers

5. Circle K Corp. - 7445 W. Frontage Road N - 345-5545 Jan Rosen Blum

6. Sears Roebuck & Co. - 600 Coronado Center - 881-5511 JN Kane

7. Ramada Inn - Down Town 717 Central Ave. - N 3:00 Mr. Hope 247-1501

8. Montana Mining - 2292 Wyoming Blvd. - Tom Grundman 294-5089 (Call back. He's not sure about this week.)

9. K-Mart - 2100 Carlisle Blvd. - Mr. Imel 265-5911.

10. Hilton Inn - 1901 University Blvd. - David Sanders 243-8661

11. Albertson's - 2200 Juan Tabo Blvd. - Mr. Carpenter 292-1695

12. Tinnie Mercentile - 618 Rio Grande Blvd. - 292-1698 Fridays

13. Globe Furniture - 208 Gold Ave. - Herman & Block 242-5036

14. Safeway Stores - 4100 Silver Ave. - R.G. Ortega

15. Dillards Department Stores - 115 Winrock Shopping Center - Bill Wilson 883-5900

16. Coronado Center - 1100 Coronado Center - Gary Laubert 881-2700 Call him.

17. American Furniture -- E. Blaugrund 883-2211

18. Ben Franklin - 107 Montgomery Pl. - Charles Cain 883-2889 883-5190

19. Lucas Office Supply - 5416 Kathryn - Dick Tipton 268-2438

Lenard Nuckolls
Vista Sandia Hosp.

Frank Young
Lovelace Medical Center

David Dyer
Coca-Cola
205 Marquette Ave.

Craig Swartzner
Swartzner Packing

Pete Marquez
Pioneer Areas

Mr. Imel
K-Mart
2100 Carlisle

Marvin Reiff
American Gypsum

Lynn Starr
Borden Inc. 242-2851

Terry Story
Clover Club Foods
247-0466

Dr. A. Snroka
Univ of Albuqu.

Cloyce Harrison
CREGO Block Co.
345-4451

Steve Morgun - 243-2121
Univ. of New Mexico
Hosp.

H.E. Miller
Memorial Hospital
243-5543

Potential Developers and End-Users

In Dona Ana County Contracted through

Geothermal Commercialization Outreach

Clive Ashton, Manager
Sandyland Nursery
Mesilla Park, NM 88047

Dick Burmeister, Director
Dona Ana County Office of Planning
& Building Inspection
Room 209
County Courthouse
Las Cruces, NM 88001

Don Fredrickson
K-Mart Stores
1240 El Paseo Rd.
Las Cruces, NM 88001

Mike Grijalva, President
Las Cruces Foods, Inc.
3070 Harrelson
Las Cruces, NM 88001

Bud Hettinga, President
Highland Enterprises, Inc.
645 S. Compress Rd.
Las Cruces, NM 88001

Tom Kerens
Rehab Services
1900 C Telshor Ave.
Las Cruces, NM 88001

Turk Reynolds (J. P.), Gen. Manager
Coca-Cola Bottling Co.
2100 S. Valley Drive
Las Cruces, NM 88001

Gary Anderson
Gibson Discount Department Store
1300 El Paseo Rd.
Las Cruces, NM 88001
524-3583

Ernest Riggs
Cal-Compack Foods, Inc.
1822 W. Amador Ave.
Las Cruces, NM 88001
524-8577

Stan Smith, Plant Manager
L'Eggs Products, Inc.
Mesilla Park, NM 88047

Ralph Taylor, President
Joy Canning Co.
Box 39
West Amador Ave.
Las Cruces, NM 88001

Pardner Tellyer (H. B.)
President
Tellbrook, Inc. (Tellyer Co. Land Developers)
P.O. Box 1318
Las Cruces, NM 88001

Jim Stokes Gary Kendrick--Asst. Administrator
Memorial General Hospital
Telshor & University Chuck Daniels--
Las Cruces, NM 88001 Maintenance Manager

Rick Squires
Candlelight Homes
1224 Pennsylvania N.E.
Albuquerque, NM 87110

Joe Pomplon, Administrator
Good Samaritan Village
3025 Terrace Dr.
Las Cruces, NM 88001
522-1362

Carl Powe
Wells Lamont Corp.
755 N 17
P.O. Box 1438
Las Cruces, NM 88001
524-8567

Potential Developers (Cont.)

Bob Riddle
Gadsden School District
Director of Special Services
P.O. Drawer 70
Anthony, NM 88021

Jack Weaver, Editor
Las Cruces Sun-News
256 W. Las Cruces Ave.
Las Cruces, NM 88001
523-4581

Fred Ismond
City Utilities Director
City of Las Cruces
P.O. Box CLC
Las Cruces, NM 88001
526-0240

Businessmen and Civic Officials

Contacted in Las Vegas through the

Geothermal Commercialization Outreach

Mr. Lopez
Las Vegas School District
901 Douglas Ave.
425-6784

Mr. Maestas
Vegas Grande Intermediate Care Facility Inc.
2301 Collins Drive
425-9362

Virginia Roybal
Town House Motel
1215 Grand Ave.
425-6717

Rick Walters, President
Bank of Las Vegas
622 Douglas Ave.
425-7565

Potential Developers and End-Users

in Truth or Consequences Contracted

through Geothermal Commercialization Outreach

Bill Buhler
Attorney of Law
418 Main
Truth or Consequences, NM

John Carr
Administrator
Carrie Tingley Hospital
1400 S. Broadway
Truth or Consequences, NM
894-2121

Gordon Fulkerson
President
First Sierra National Bank
310 Main
Truth or Consequences, NM
894-3075

Charlie Haye
City Editor
Sierra County Sentinel
1725 E. 3rd
Truth or Consequences, NM
894-3088

William Leigon
City Electric Consultant
605 Sims
Truth or Consequences, NM
894-3439

V. Karl Kortemeier
Yucca Lodge, Owner
316 Austin
Truth or Consequences, NM
894-3779 Albuq. 867-5727

Pia Marie Joerger
Secretary to City Manager &
Personnel Officer
605 Sims Street
Truth or Consequences, NM 87901

Terry Miller
Vice President
Western Bank
601 Broadway
Truth or Consequences, NM
894-7171

Ms. Dee Rush
Administrator
St. Ann's Hospital
800 E. Ninth
Truth or Consequences, NM
894-2111

Ms. B. E. Shantz
City Finance Director
605 Sime
Truth or Consequences, NM
894-6674

Barry Stout
City Attorney
418 Main
Truth or Consequences, NM
894-3031

Ms. Maureen Tooley
Herald Publishing Co.--Board of Education
1006 Date
Truth or Consequences, NM
894-2143

Neil R. Baird, Sr.
Publisher
Sierra County Sentinel
1725 E. 3rd
Truth or Consequences, NM 87901
894-3088

TABLE A-6

PLANNED ACTIVITY 1980-1981

FOR MAJOR ENERGY FIRMS AND AREAS OF INTEREST

Deep Wells (10,000 feet)

Radium Springs (1 or more)
North Central NM (1)
Animas Valley (1)

Exploratory Wells (800 - 2000 feet)

Radium Springs 1
Socorro Area 8
Lordsburg - Animas Valley 6
Dona Ana County 3
North Central NM 1

Shallow Gradient Wells

Radium Springs 18
Socorro Area 10
Animas Valley 23
Dona Ana County 40
Lordsburg - Animas Valley 3

TABLE A-6 (continued)

MAJOR ENERGY FIRMS AREAS OF INTEREST

Earth Power Corporation, Tulsa, OK

Lightning Dock KGRA

Thermal Power Co., San Francisco, CA

Socorro Peek KGRA

Occidental Geothermal Inc., Bakersfield, CA

19,000 acres in NM

Chevron Resources Co., San Francisco, CA

Radium Springs KGRA
Socorro KGRA
Lordsburg, Animas Valley

Sunoco Energy Development Co., Dallas, TX

68,722 acres
North-Central NM

Amax, Denver, CO

Rio Grande Path
Animas Valley
Baca

Gulf, Denver, CO

Socorro Area
Animas Valley

Texaco, Denver, CO

Undefined bases

Fluid Energy Corporation, Denver, CO

Truth or Consequences Area
Dona Ana County

Southland Royalty Co., TX

Radium Springs Area
Dona Ana County

(Table A-6 Continued)

Phillips Petroleum Co.

Dona Ana County

McCullock Geothermal Co., Los Angeles, CA

Dona Ana County
Socorro Area

American Drilling & Grouting Co, Clinton, MS

Dona Ana County

Hunt Exploration, Dallas, TX

Radium Springs KGRA
Dona Ana County

Exxon Corporation

Hidalgo County
Animas Valley

Union Geothermal

Baca

NORTH DAKOTA

GEOTHERMAL COMMERCIALIZATION PROJECT

MID-YEAR PROGRESS REPORT

JANUARY 1, 1980 TO JUNE 30, 1980

AGREEMENT NO. DE-FC07-79ID12011

TABLE OF CONTENTS

1.0 INTRODUCTION

North Dakota has a significant but largely undeveloped geothermal energy potential. Most of the known geothermal fluids are of low to moderate temperature. Fluids in this temperature range could be used extensively for industrial process heat and space heating.

There are several obstacles to developing the geothermal resource in North Dakota:

- A lack of information regarding qualities and quantities of geothermal reservoirs
- A lack of geothermal legislation and incentives
- Uncertainties regarding cost
- General public lack of knowledge about geothermal resources
- Limited amount of public and private funding

The North Dakota Geothermal Commercialization Project is seeking to assess and remove these obstacles through all the facets of our program. The state commercialization team has completed one area development plan, and work is progressing on the second plan. More importantly, marketing activities have been implemented and are generating solid interest from a number of individuals and commercial enterprises.

After ten months of research, it is the initial conclusion of this project that there is unlimited opportunity and potential for geothermal resource development throughout the state. The degree to which geothermal resources are developed in North Dakota will depend on further study, experimentation, and marketing capabilities.

1.1 Purpose of Project

The North Dakota Geothermal Commercialization Project is funded by the United States Department of Energy (DOE) and the State of North Dakota.

The purpose of the project is to provide DOE and North Dakota with technical and economic planning data and to promote geothermal commercialization within the state. The project also serves an educational function by providing geothermal resource and development information to interested parties.

1.2 Objectives

The objectives of the North Dakota Geothermal Commercialization Project are as follows:

- Identify current and prospective geothermal users and developers within North Dakota
- Evaluate the potential uses of geothermal resources
- Determine a realistic projection of geothermal energy on-line in North Dakota
- Identify institutional considerations pertaining to geothermal development in the state
- Provide assistance to those entities interested in developing geothermal resources, e.g. identify possible funding sources, assist in minimizing state and federal deterrents to geothermal development, and provide limited engineering assistance
- Organize and conduct a statewide geothermal outreach program

1.3 Technical Approach and Team Members

To evaluate the possibilities for geothermal commercialization in North Dakota, 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 and industrial development, institutional considerations, current and projected energy demand, and economic activity. This information forms the basis for the following activities:

- Area development plans
- Site-specific development analyses

- Commercialization plans
- Institutional assessments
- Economic assessments
- Outreach programs

The Geothermal Energy Office is conducting the North Dakota Geothermal Commercialization Project. The state commercialization team members are as follows:

- Bruce A. Gaugler, Project Coordinator
- Jolene Wetch, Graphics and Statistics Analyst and Secretary
- Jill D. Ritz, Technical Writer

In addition, the state team calls upon other state agencies to perform selected Geothermal Commercialization Project activities on an ad hoc basis.

1.4 Benefits of Project 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. By increasing the level of understanding regarding the nature and advantages of geothermal energy, the North Dakota project hopes to encourage the use of geothermal energy in the state, thereby lessening 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. These data will indicate the contribution that North Dakota's geothermal resources can make to the national energy demand and will provide a data base for long-range energy development planning.

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Geothermal Prospect Identification

The potential for geothermal direct use development in North Dakota is unlimited. The Dakota and Madison formations underlie the western three quarters of the state. All test results from these aquifers demonstrate some geothermal usage potential. As Appendix A illustrates, all growth centers in the Lewis and Clark 1905 Region,a ten-county area located in southcentral North Dakota, overlie a geothermal resource.

Most of the geothermal resources in North Dakota are also under low to moderate artesian pressure, and 40-70 pounds per square inch (psi) are common across the state. This artesian pressure, used in conjunction with low-head hydroelectric power and a geothermal groundwater heat pump, could prove quite economical to geothermal developers. This type of system is currently being proposed for the Patterson Hotel project in downtown Bismarck and may supply all of the building's electrical and heating needs.

To date, no geothermal leasing activity has occurred in North Dakota. Because the state's reservoirs are so extensive, leasing of federal or state lands is not economically practical at this time.

2.2 Area Development Plans

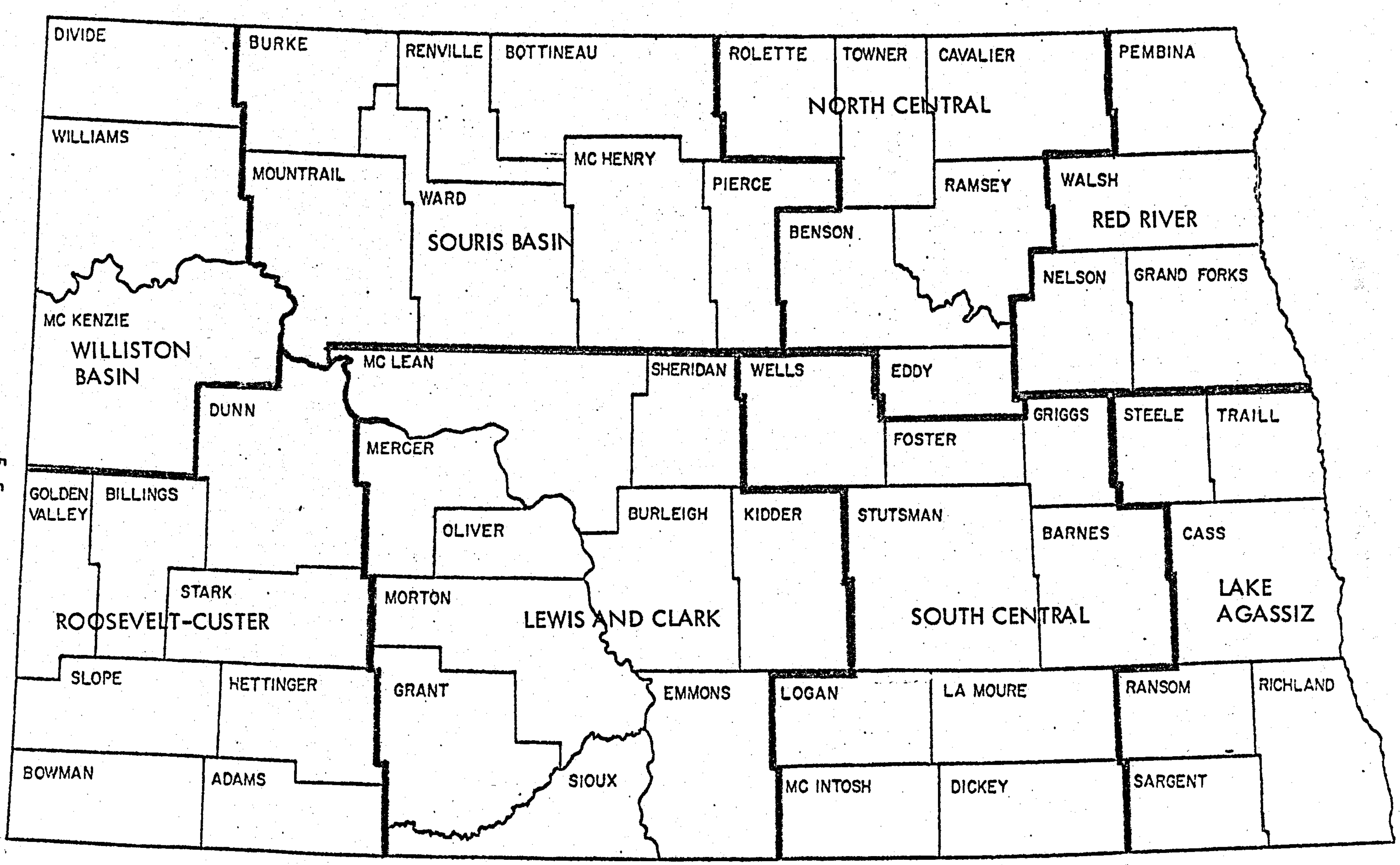
2.2.1 State Geothermal Planning Areas:

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 (Figure 1).

The area development plan for the Roosevelt-Custer Region has been completed and is awaiting publication. Priorities for area development plans for the contract year in-

FIGURE 1

NORTH DAKOTA STATE PLANNING REGIONS



clude the Lewis and Clark 1805 Region and the South Central Region; research for the Lewis and Clark 1805 Region is approximately 50 percent complete.

2.2.2 Specific ADPs - Completed or in Preparation:

The Roosevelt-Custer Region was selected as the candidate for the state's first area development plan for several reasons:

- availability of data for southwestern North Dakota
- indications that the geothermal fluids in that area are hotter than in much of the rest of the state
- the Roosevelt-Custer region shows potential as a major growth center

The Roosevelt-Custer Region is a 9,741 square mile area in southwestern North Dakota, which encompasses eight counties: Dunn, Billings, Golden Valley, Stark, Slope, Hettinger, Bowman, and Adams. Agriculture continues to be the predominant land use in the region, although the recent demand for energy self-sufficiency in the United States has led to increased exploration and production of North Dakota's mineral resources in the area, including oil, uranium, lignite coal, and natural gas.

The region's population decreased by 7.83% between 1960 and 1970. However, this trend has reversed because of the extensive energy exploration and production in the region. The Roosevelt-Custer Regional Council predicts the region's population will be 53,280 by Calendar Year 2000, compared to 42,609 in 1970.

Increased population and development will necessitate additional services and industry. There are currently several food processing plants in the region, including three cheese and one meat processing plant, and a furniture manufacturing firm. Potential for future industrial development exists in the areas of energy development, light manufacturing, and agriculturally related light industry.

Several major aquifer systems underlie the Roosevelt-Custer Region, and most of the water is under low to moderate artesian pressure. These aquifers have unlimited potential for geothermal resource development, if used in conjunction with groundwater heat pump systems. The geothermal resource characteristics of the Madison Formation, which underlies the entire region, are outlined in Table 1.

The potential for geothermal commercialization does exist in the Roosevelt-Custer Region in the form of residential, commercial, and industrial space heating. However, a number of obstacles--institutional, environmental, and economic--confront the geothermal developer.

Because little geothermal development has occurred in North Dakota, the state legislature has not passed any legislation defining geothermal resources or establishing a policy for geothermal development. As a result, several state agencies may have jurisdiction, depending on the location of the geothermal resource.

Although geothermal development does not have the adverse environmental impacts of fossil fuel or nuclear power plants, potential environmental problems do exist. These concerns will have to be addressed on a site-specific basis prior to any geothermal development.

To date, geothermal development in North Dakota is limited to individual groundwater heat pump systems. Several small communities have expressed interest in district space heating with geothermal energy, but local governments lack tax revenue sources. Such a project would be greatly accelerated by federal or other public funding sources.

2.3 Site Specific Development Plans

2.3.1 Candidate Geothermal Sites/Applications:

The specific resource sites and energy applications (residential, commercial, industrial, and agribusiness) that are candidates for site specific development plans are

TABLE I

GEOTHERMAL RESOURCE CHARACTERISTICS IN ROOSEVELT-CUSTER REGION, NORTH DAKOTA

Resource Area	Depth of Madison Formation (feet)	Thickness of Madison Formation (feet)	Subsurface Temperature °F	Gradient (Calculated at MM**)
Dickinson T139 R96	8995	1700*	174°	29.6*
Bowman T130 R102	10080	1300*	180°*	35.32*
Beach T140 R105	9450	1600*	205°	35.13
Medora T140 R102	9085	1700*	191°	33.5
Hettinger T129 R98	9300	1325*	170°*	35.1*
Mott T133 R92	9500	1400*	155°*	31.9*
New England T135 R98	8481	1400*	204°	37.9
Killdeer T144 R94	9712	2000*	174°	28.2
T145 R95	13702	2000*	180°*	29.3

* Estimated
** Calculated at Madison

GEOTHERMAL GRADIENT – The rate of increase of temperature in the earth with depth. The gradient near the surface of the earth varies from place to place depending on the heat flow in the region and on the thermal conductivity of the rock. Approximate average geothermal gradient in the earth's crust is about 25 °C/km (Geothermal Handbook, 1977).

Metric Geothermal Gradient vs. BHT (°F) and Total Depth (Feet)

$$\frac{°C}{km} = \frac{\text{BHT (°F)} - 40°\text{F (1823)}}{\text{Tot. Depth (Ft.)}}$$

Assumes 40° F Mean Annual Surface Temperature

Source: Ken Harris, North Dakota Geological Survey, Grand Forks, ND, 3 March 1980.

identified and briefly described in Table 2.

2.3.2 Site Specific Development Plans - Completed or in Preparation:

Site specific development plans are currently being prepared for three sites in the state: Patterson Hotel, Bismarck; Maryvale Convent, Valley City; and St. Mary's School, New England. These sites were chosen because of:

- high interest
- initial development activity
- attempts to obtain funding or technical assistance initiated at each site

<u>Patterson Hotel, Bismarck</u>

The Patterson Hotel is a 70-year-old historic landmark located in downtown Bismarck (Figure 2). Plans are in progress to convert the upper nine levels into elderly housing units and to retain the main floor for commercial enterprises (e.g. restaurant, lounge, etc.).

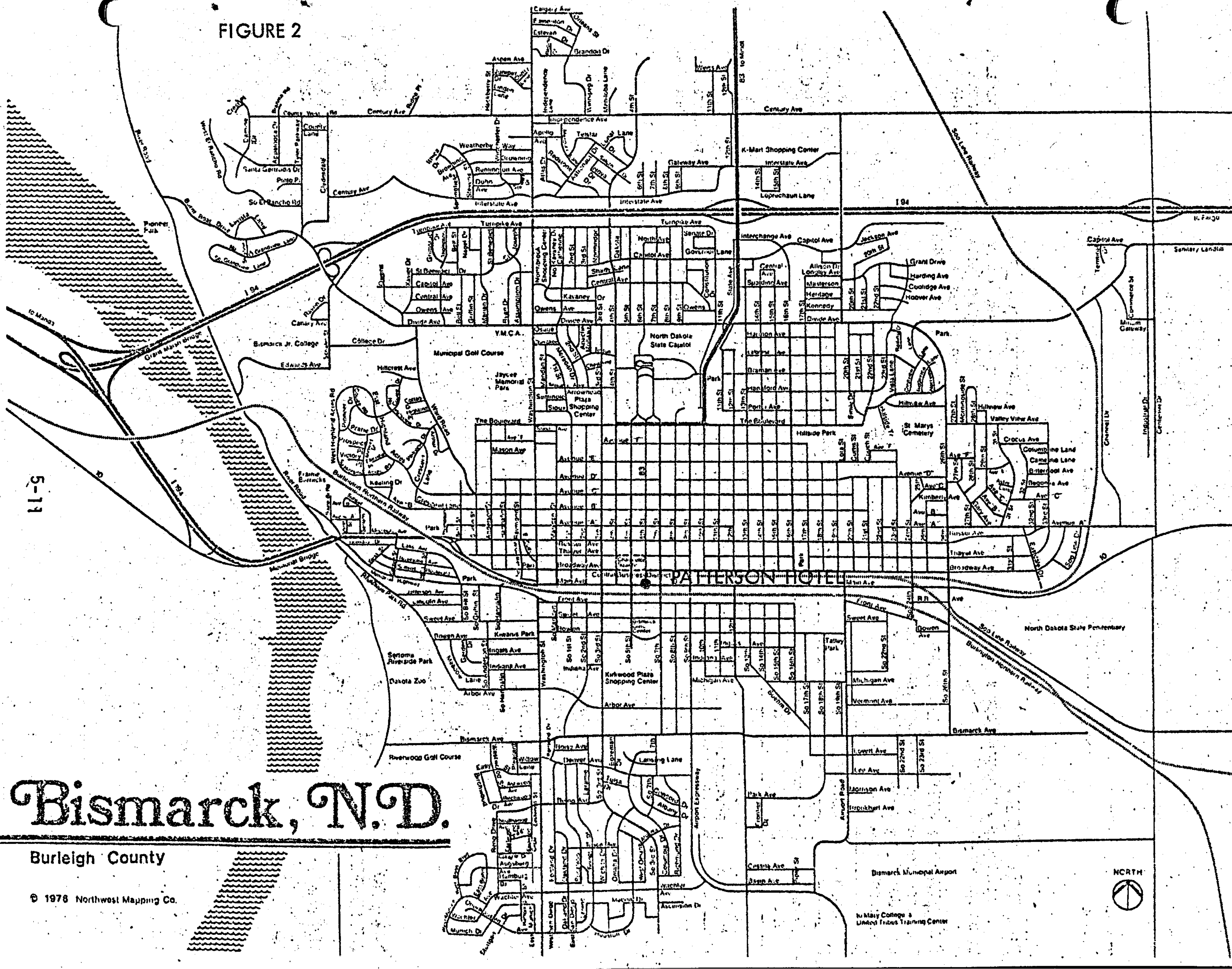
The proposed 3000 foot well will tap the Dakota Sandstone, where the resource temperature is approximately 86°F. The building owners have been granted a water use permit from the North Dakota State Water Commission for 1,200 gallons per minute from the Dakota Sandstone Formation and a conditional permit from the North Dakota State Department of Health to discharge the spent geothermal fluids into the Missouri River via the Bismarck storm drainage system.

A feasibility study of the Patterson Hotel geothermal project has been completed by a Bismarck engineering firm and is available at the N.D. Geothermal Energy Office. Initial conclusions indicate that the 12×10^9 Btu of energy currently provided to the building by natural gas will be entirely met by geothermal energy, with extra geothermal fluids available for additional downtown commercial enterprises. The geothermal fluids beneath the Patterson

TABLE 2

LOCATION	APPLICATIONS		RESOURCE DATA			
	Current	Projected	Sample Depth (ft.)	Sample Temp. (°F)	Formation	Artesian Pressure
Linton (southcentral N.D.)	Groundwater heat pump space heating of home and dairy barn	Small commercial, district, and additional residential space heating	42	47	Pierre	
			72	48	Pierre (?)	
			2490	70-90	Dakota	40-70 psi at buildings
			3187	≈100	Madison	
Badlands (southwestern N.D.)	Warm water currently used to prevent frost damage to gardens and warm soil in the spring to enable early planting	Residential space heating	250	55	Cannonball(?)	
			1100	66	Hell Creek/ Fox Hills	40-70 psi at well head
			9600	185	Madison	
Harvey (central N.D.)	None	Residential and commercial space heating	150	52	Glacial till	
			≈1500	70-90	Dakota	40-70 psi at well head
Bismarck (southcentral N.D.)	Residential space heating	Small commercial and additional residential space heating	180	≈49	Cannonball(?)	
			3057	80-100	Dakota	40-60psi at well head
			4730	109	Madison	
Mandan (southcentral N.D.)	Residential space heating	Small commercial and additional residential space heating	269	46	Hell Creek	
			740	55	Fox Hills	
			3226	80-100	Dakota	40-60 psi at well head
			4523	≈110	Madison	

FIGURE 2


Bismarck, N.D.
Burleigh County
© 1976 Northwest Mapping Co.
PATTERSON HOTEL
North Dakota State Capitol
Municipal Golf Course
Bismarck Jr. College
Jaycee Memorial Park
Arrowhead Plaza Shopping Center
K-Mart Shopping Center
Kirkwood Plaza Shopping Center
St Marys Cemetery
Hillside Park
North Dakota State Penitentiary
Bismarck Municipal Airport
Sertoma Riverside Park
Dakota Zoo
Riverwood Golf Course
Pioneer Park
Soo Line Railway
Burlington Northern Railway
Century Ave
Interstate Ave
I 94
Divide Ave
The Boulevard
Main Ave
Broadway Ave
Bismarck Ave
Memorial Bridge
Grant Marsh Bridge
Airport Road
NORTH

Hotel are also under artesian pressure of 40-60 pounds per square inch (psi) at the well head, and plans are underway to utilize this pressure in a low-head hydroelectric generator to satisfy the Hotel's electrical needs.

St. Mary's School, New England

St. Mary's School, a parochial school located in southwestern North Dakota, currently has one geothermal well that taps the Fox Hills aquifer and provides geothermal fluids in the 75°F range. The school has hired a Bismarck engineering firm to complete a study on the feasibility of utilizing geothermal space heating for the school itself and a nearby slaughter house.

Maryvale Convent, Valley City

Maryvale Convent, originally designed in 1964 to utilize geothermal fluids, has plans for converting from fuel oil heat to geothermal energy for space heating. The geothermal fluids are 75°F and flow at 114 gallons per minute under artesian pressure. Used in conjunction with a groundwater heat pump, this is more than adequate to replace the present annual consumption of 40,000 gallons of fuel oil.

2.4 Time Phased Project Plans

2.4.1 Active Demonstration/Commercialization Projects:

The University of North Dakota Experiment Station has received funding from the Old West Regional Commission for a one-year study to monitor and document results from ten residential geothermal space heating installations throughout the state (Table 3). The monitoring system is intended to procure the following information:

- Actual annual energy savings
- Operational problems or maintenance requirements for the system
- The net annual energy extracted from the groundwater supply
- Variations in system performance based on design differences and local groundwater temperatures

TABLE 3

RESIDENTIAL MONITORING INSTALLATIONS

Geothermal Users	Application	Location
Gillman Beck	Groundwater heat pump space heating	Northwood, Grand Forks County
Lee Christopherson, M.D.	Groundwater heat pump space heating	Fargo, Cass County
Art Johnson	Groundwater heat pump space heating	Larimore, Grand Forks County
Wesley D. Meland	Groundwater heat pump space heating	Northwood Grand Forks County
Oakes Electric	Groundwater heat pump space heating	Oakes, Dickey County
Mike Peterson	Groundwater heat pump space heating	Berlin, Lamoure County
Alvin Pocrice	Groundwater heat pump space heating	Sykeston, Wells County
Fred Rosenau	Groundwater heat pump space heating	Ellendale, Dickey County
Traut Wells	Groundwater heat pump space heating	Jamestown, Stutsman County
Adam and Agnes Vetter	Groundwater heat pump space heating and direct space heating	Emmons, Logan, and McIntosh Counties (Junction)

This information can then be used to predict potential effects of large scale application of this heating/cooling system with groundwater aquifers and demand loads of electric utilities. In addition, projections of energy savings by fuel oil displacement with groundwater heat pump systems can be made. The study will also serve as a reference document for future installations on the methods of groundwater handling and disposal.

2.4.2 Time Phased Project Plans-Completed or in Preparation:

No time phased project plans have been completed by the state commercialization team at this time.

2.5 State Aggregation of Prospective Geothermal Utilization

Estimates of total geothermal energy on-line for the site specific development plans are as follows:

	1981	1985
Patterson Hotel, Bismarck	Will replace 12×10^9 Btu of heat energy per year currently provided by natural gas and an undetermined quantity of electricity, which is used for air conditioning and lighting.	As an expanded project, could easily supply three to five times as much energy to additional downtown businesses.
Maryvale Convent, Valley City	Will replace 40,000 gallons of fuel oil per year.	
St. Mary's School, New England	Will replace total heat energy requirements of the school currently supplied by fuel oil.	
Roger Russell, Harvey	Will replace total heat energy requirements of an office and large shop complex currently supplied by fuel oil. Expansion plans include residential space heating.	

2.6 Institutional Analysis

To date, little geothermal development has occurred in North Dakota. Therefore, no state legislation has been aimed at defining geothermal resources or establishing a state government policy for the development of geothermal resources. Because no definitive policy exists, several state agencies may have jurisdiction over geothermal development, depending on site location, use, and developer.

Hopefully, this situation will be remedied during the 1981 state legislative session. The North Dakota Legislative Council is currently formulating legislation aimed at identifying geothermal resources and proposing economic incentives for geothermal energy users and developers.

A more detailed analysis of the institutional considerations confronting geothermal developers in North Dakota is presented in the Roosevelt-Custer Area Development Plan. Federal and state regulations remain the same for all eight planning regions. Local regulations may vary, however, and will be addressed on a site specific basis.

2.7 Public Outreach Program

2.7.1 Outreach Mechanisms:

To promote the use of geothermal energy, the state commercialization team is organizing and conducting an extensive outreach program. The program is designed primarily to inform the public about the potential and the advantages of geothermal energy in North Dakota. In addition to providing information to interested individuals and businesses upon request, the state team also actively seeks opportunities to promote the development of geothermal energy.

In order to accomplish these goals, the state commercialization team utilizes the following methods:

News Releases-

Several radio and television interviews have been conducted in recent months. A television interview conducted upon the completion of the Roosevelt-Custer Area Development Plan has generated considerable interest and promulgated requests for additional information from several individuals, businesses, and state and federal agencies. In addition, a number of articles have appeared in major newspapers throughout the state regarding proposed geothermal development plans, as well as general information on geothermal potential and applications in the state.

Brochures-

Informational brochures are distributed to all interested individuals, businesses, and government agencies. These brochures currently include the U.S. Department of Energy publication "Geothermal Energy" and a variety of materials explaining the use of groundwater heat pump systems.

Talks-

Formal talks concerning geothermal resource potential in the state were presented to the Lewis and Clark 1805 Regional Council meeting and the American Public Works Association, North Dakota Chapter. One result of these presentations has been the interest expressed by Linton's mayor in obtaining information concerning district space heating.

In addition to continuing the existing outreach mechanisms, several other marketing activities are proposed. These include:

Talks-

Speaking engagements will be expanded and include educational facilities and civic organizational meetings throughout the state.

Brochures–

A brochure explaining groundwater heat pump use and application in North Dakota is presently being written as a joint venture between the University of North Dakota Engineering Experiment Station and the North Dakota Geothermal Energy Office.

News Releases–

A newsletter is being developed for distribution to state legislators, local officials, building contractors, and other interested individuals.

Billboards–

Two billboards will be mounted late this fall in the Bismarck area. Bismarck was chosen the most practical site because of its importance as the state capital, its drawing potential as a major shopping area, and its apparent colocation with a geothermal resource.

2.7.2 Summary of Contacts and Results:

As Appendix C indicates, the contacts directed to and initiated by the state commercialization team are quite comprehensive. Many of the individuals and commercial enterprises that requested general information on geothermal energy potential several months ago are now making definitive plans to utilize geothermal space heating. The state commercialization team maintains frequent contact with potential users in order to provide additional information and technical assistance and to expedite state and federal regulations.

2.7.3 Overall Prospectus for Future Geothermal Commercialization:

Interest in geothermal commercialization in North Dakota from both the private and public sectors has increased substantially in recent months. This interest has generally been oriented toward residential and small commercial direct space heating applications. However, much of the state's geothermal resources are also under 40-70 pounds per square inch (psi) of artesian pressure at the well head, which can be utilized in a low-head hydroelectric power generation system. This system, used in conjunction with a geothermal groundwater heat pump, could provide a vast quantity of heat and a substantial amount of electricity. This type of system has been proposed for the Patterson Hotel in Bismarck; its success could spur further research and utilization of geothermal resources to help meet residential and commercial heating and electrical needs.

Agricultural uses in the state are limited at this time to direct space heating of homes, farm buildings, and soil warming (the low to moderate temperature geothermal water prevents frost damage to crops). However, the potential for other agriculturally related uses does exist in the state. The feasibility of using geothermal energy for greenhouse space heating and alcohol production is currently being explored.

The legislative proposals being developed by the North Dakota Legislative Council for consideration by the state legislature in 1981 are intended to define geothermal resources and provide economic incentives for geothermal development in the state. However, some institutional constraints could still prove to be major deterrents to geothermal commercialization.

Commercial developers, who intend to utilize more than one acre-foot of water annually, are required to obtain a water use permit from the State Engineer. Water use permits are issued or denied on the basis of beneficial use; that is, all water must be used in the best interest of North Dakotans. In competing applications for water use permits, domestic, municipal, and agricultural uses take precedence over industrial applications. In addition, the commercial developer must obtain a discharge permit from the State Department of Health, which requires that fluids discharged into water must either maintain or upgrade the water quality. Individuals who intend to utilize the water for personal domestic purposes are specifically exempt from these requirements.

Coal is currently the fuel most economically competitive with geothermal energy in North Dakota. However, the state's lignite coal is low-grade and will probably never become a major heat source for private or small scale commercial enterprises.

As the marketing activities of the state commercialization team increase and more North Dakotans become acquainted with the possibilities for geothermal energy in the state, development will progress rapidly. Because of the state's vast, low to moderate temperature geothermal resources, small scale geothermal utilization will proceed first. Therefore, more time and funds should be directed toward interaction with home builders and small commercial developers to interest them in the potential uses for geothermal energy in small scale housing developments and small commercial geothermal projects.

3.0 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

State commercialization team activities have concentrated on area and site specific development plans, detailed institutional analysis, updating resource data, and outreach activities. One area development plan has been completed, and work is progressing on the second. Three site specific development plans are also being formulated.

The Roosevelt-Custer Area Development Plan contains a detailed analysis of institutional considerations; further work in this area is limited to identifying local regulations on a site specific basis. North Dakota currently lacks definitive policies regarding geothermal development, but the State Legislative Council is formulating legislation aimed at defining geothermal resources and providing economic incentives for geothermal developers in the state.

The results of the state commercialization team's outreach program are very encouraging. There were no heat pump distributors operating in the state when the Geothermal Energy Office was instituted ten months ago. Now there are four distributors actively engaged in geothermal commercialization, with more interest being generated in this sector.

The state commercialization team has also stimulated several key housing developers in North Dakota to research the potential for geothermal energy. These developers are currently in the process of designing housing projects that will incorporate geothermal energy as the sole heating and cooling source.

The most effective method for promoting geothermal commercialization has been through personal contact with government officials, interested individuals, and commercial developers. Therefore, the state commercialization team plans to expand its number of speaking engagements throughout the state, as well as implement a variety of other marketing activities.

The outlook for geothermal commercialization in North Dakota is promising. However, much work remains to be done in the planning and marketing phases, as well as actual development of geothermal energy on a commercial scale. The North Dakota Geothermal Commercialization Team makes the following recommendations to expedite geothermal commercialization in the state:

- Grants should be provided for small scale geothermal development projects.
- The state teams should be delegated greater input into determining the direction of federal funding assistance for geothermal projects.
- State teams should be funded at a higher level to increase their visibility and effectiveness.

A P P E N D I C E S

APPENDIX A

GEOTHERMAL RESOURCE CHARACTERISTICS IN LEWIS AND CLARK 1805 REGION, NORTH DAKOTA

City/ County	Well Location	Sample Depth (ft.)	Sample Temp. (°F)	Formation
BURLEIGH				
Bismarck	139-80-20	180	≈49	Cannonball (?)
	140-80-19	3057	80-100	Dakota Fm.
	138-82-21	4730	109	Madison
Sterling	139-77-28	300	49	Fox Hills
	139-76-20	2670	80-100	Dakota Fm.
	140-76-10	3554	100	Madison
Wing	142-76-02	57	46	Cannonball
	142-77-04	405	51	Hell Creek (?)
	142-76-31	2893	70-90	Dakota Fm.
	142-76-31	3888	≈95	Madison
EMMONS				
Kintyre	136-74-35	100	45	Fox Hills
	136-74-10	150	48	Fox Hills
	135-73-29	2531	60-80	Dakota Fm.
	135-73-29	3148	≈100	Madison
Linton	132-76-07	42	47	Pierre
	132-76-07	72	48	Pierre (?)
	133-76-35	2490	70-90	Dakota Fm.
	133-75-35	3187	≈100	Madison
Strasburg	131-76-26	115	≈46	Fox Hills
	131-76-26	180	48	Strasburg
	131-75-21	2406	70-90	Dakota Fm.
	133-75-35	3187	≈100	Madison

APPENDIX A (cont.)

City/ County	Well Location	Sample Depth (ft.)	Sample Temp. (°F)	Formation
GRANT				
Elgin	134-90-23	242	49	Tongue River
	134-89-22	867	≈52	Hell Creek
	133-90-01	4109	110-130	Dakota Fm.
	136-92-36	6929	155	Madison
KIDDER				
Crystal Springs	138-70-06	200	44	Glacial drift undifferentiated
	139-68-05	2163	60-80	Dakota Fm.
	139-68-35	2435	≈100	Madison
Pettibone	143-69-04	2303	60-80	Dakota Fm.
	145-72-32	3310	101	Madison
MERCER				
Beulah	144-88-25	157	≈47	Tongue River
	143-90-34	880	54	Hell Creek-Fox Hills
	144-89-11	4380	110-130	Dakota Fm.
	145-88-17	7346	154	Madison
Stanton	144-85-03	452	51	Hell Creek
	144-85-10	900	≈54	Hell Creek-Fox Hills
	145-84-29	3548	100-120	Dakota Fm.
	143-83-10	5427	138	Madison
McLEAN				
Garrison	148-84-04	100	50	Fort Union
	148-84-07	258	46	Fort Union
	149-86-16	4378	100-120	Dakota Fm.
	148-84-85	5754	159	Madison

APPENDIX A (cont.)

City/ County	Well Location	Sample Depth (ft.)	Sample Temp. (°F)	Formation
McLEAN (Cont.)				
Max	150-84-26	50	45	Fort Union
	150-84-33	100	50	Fort Union
	152-82-33	3601	100-120	Dakota Fm.
	151-81-19	5217	122	Madison
Mercer	146-79-02	580	47	Fox Hills
	146-79-18	635	49	Fox Hills
	145-80-21	3330	80-100	Dakota Fm.
	148-79-16	4535	106	Madison
Washburn	144-82-02	113	47	Fort Union
	144-82-04	175	49	Fort Union
	144-81-06	3375	90-110	Dakota Fm.
	144-82-	5427	138	Madison
Wilton	143-80-15	145	47	Fort Union
	143-80-16	530	55	Fox Hills
	143-77-06	3241	80-100	Dakota Fm.
	141-80-33	4952	≈130	Madison
MORTON				
Flasher	134-84-03	140	50	Hell Creek
	134-84-03	426	51	Fox Hills
	135-83-34	3331	90-110	Dakota Fm.
	135-83-34	4737	≈120	Madison
Hebron	140-90-32	195	47	Tongue River
	140-90-33	580	61	Tongue River
	139-90-27	4526	110-130	Dakota Fm.
	139-92-16	7550	≈165	Madison
Mandan	139-81-09	269	46	Hell Creek
	139-81-16	740	55	Fox Hills
	139-82-11	3226	80-100	Dakota Fm.
	140-80-19	4523	≈110	Madison

APPENDIX A (cont.)

City/ County	Well Location	Sample Depth (ft.)	Sample Temp. (^{o}F)	Formation
OLIVER				
Center	142-84-14	118	54	Tongue River
	142-84-14	130	49	Tongue River
	143-83-10	3579	100-120	Dakota Fm.
	142-84-07	6007	141	Madison
SHERIDAN				
Goodrich	146-74-08	452-480	48	Fox Hills
	147-75-01	2541	70-90	Dakota Fm.
	145-73-28	3326	99	Madison
McClusky	146-77-11	377	46	Fox Hills
	146-77-27	2910	80-100	Dakota Fm.
	148-79-16	4535	106	Madison
SIOUX				
Fort Yates	130-80-23	40	45	Pierre
	130-80-03	190	45	Pierre
	131-80-29	2530	80-100	Dakota Fm.
	130-81-32	4016	105	Madison
Selfrige	130-84-36	417	50	Fox Hills
	130-84-31	466	56	Hell Creek
	130-81-32	2990	80-100	Dakota Fm.
	130-81-31	4016	105	Madison

APPENDIX B

SUMMARY OF CONTACTS AND RESULTS

Federal Government:

Robert Kaiser	Energy activities
Charles Mumma Soil Conservation Service	ADP Information
Joe Cullen	Geothermal Loan Guarantee Program
Ray Butler U.S. Geological Survey	Aquifer Information
Energy Management and Conservation, Federal Aid Coordinator's Office	Roosevelt-Custer ADP

State Government:

Milton Lindvig State Water Commission	Institutional Considerations
Ken Harris North Dakota Geological Survey	Resources Assessment
Dean Montieff State Planning Commission	Federal and State Land Surface Ownership
Norm Peterson State Health Department	ADP Information
Nancy Jamison State Legislative Council	Proposed Geothermal Leg- islation
Barry Zuibleman State Water Commission	Water Well Permits
Kent Conrad State Tax Department	Federal Tax Credits

State Department of Agriculture	Alcohol Production Information
Kathy Logan State Water Commission	Aquifer Information
Steve Tillotson State Soil Conservation Committee	Geothermal Development
Norm Edwards State Highway Department	Roosevelt-Custer ADP
Bob Shaver State Water Department	Roosevelt-Custer ADP

Local Government:

Rod Landblom Roosevelt-Custer Regional Coordinator	ADP Progress
John O'Leary Lewis and Clark 1805 Regional Coordinator	ADP Progress
Russ Steiger Downtown Development Association, Bismarck	Energy Consumption
Bill Sorenson Bismarck City Council	Bismarck Growth Potential and Patterson Project
Judge D. Krause Wells County Fessenden, N.D.	Roosevelt-Custer ADP
Elmer Agnew Burleigh County Board of Commissioners, Moffit	Lewis and Clark ADP
Ralph Fricke Supervisor, North Burleigh County Soil Conservation District, Baldwin	Lewis and Clark ADP

Adolph E. Miller Commissioner , Mercer County Board of Commissioners, Stanton	Lewis and Clark ADP
Marvin Faut Supervisor, Mercer County Soil Conservation District Golden Valley	Lewis and Clark ADP
O. B. Taylor President of the Pick City Council, Riverdale	Lewis and Clark ADP
H. G. VanderVorst Commissioner, Morton County Soil Conservation District, Mandan	Lewis and Clark ADP
Duane Olsen Supervisor, Morton County Board of Commissioners, Mandan	Lewis and Clark ADP
Jerry Rhone Mayor of Flasher	Lewis and Clark ADP
Raymond Ganten Commissioner, Oliver County Board of Commissioners, Center	Lewis and Clark ADP
William VanOosting Supervisor, Oliver County Soil Conservation District, Hensler	Lewis and Clark ADP
Ervin Schulte Mayor of Center	Lewis and Clark ADP
Albert Hausauer Commissioner, Sheridan County Board of Commissioners, Kief	Lewis and Clark ADP
Henry Dieterle Supervisor, Sheridan County Soil Conservation District, Kief	Lewis and Clark ADP
Alvin Berg Mayor of McClusky	Lewis and Clark ADP
Owen Gullickson Commissioner, Sioux County Board of Commissioners Cannonball	Lewis and Clark ADP

Peter J. Silbernagel Mayor of Linton	Lewis and Clark ADP
Walter Eckolm Mayor of Wing	Lewis and Clark ADP
R. D. Gaukler Commissioner, Emmons County Board of Commissioners, Linton	Lewis and Clark ADP
Eldon Beastrom Supervisor, Emmons County Soil Conservation District Hazelton	Lewis and Clark ADP
Walter Sokolofsky Chairman, Grant County Board of Commissioners, Heil	Lewis and Clark ADP
Gottlieb Weller Supervisor, Grant County Soil Conservation District New Leipzig	Lewis and Clark ADP
Ben Roth Mayor of Elgin	Lewis and Clark ADP
William Harris Adams Commissioner, Kidder County Board of Commissioners, Steele	Lewis and Clark ADP
Dick Dougherty Supervisor, Kidder County Soil Conservation District	Lewis and Clark ADP
John Lee Mayor of Dawson	Lewis and Clark ADP
Thomas W. Beierle Commissioner, McLean County Board of Commissioners, Mercer	Lewis and Clark ADP
Edwin Schmidt Supervisor, West McLean Soil Conservation District, Max	Lewis and Clark ADP
Donald Nett Mayor of Max	Lewis and Clark ADP

Russ Maher Supervisor, Cedar Soil Conservation District, Morristown, S.D.	Lewis and Clark ADP
John G. Schmidt, Sr. Mayor of Solen	Lewis and Clark ADP
B. J. Silbernagel Mandan City Commission Mandan	Lewis and Clark ADP
David Gipp Director, United Tribes Educational Technical Center Bismarck	Lewis and Clark ADP
Eugene Leary Mayor of Bismarck Bismarck	Lewis and Clark ADP

Commercial/Industry

William Guy Basin Electric Bismarck	General Information
Gerard D. Sholts Bismarck	Architect
Fenton Warner Bismarck	Architect
Loren Kopseng Vice-President Carlson Homes, Inc. Bismarck	Home Builder
125 Well Drillers	Geothermal Users Identification
270 Plumbers	Geothermal Users Identification
Warren Saterlie Montana-Dakota Utilities Bismarck	Geothermal Resource Information
Ralph Nielsen Bismarck Heating and Air Conditioning	
Joe Piesiak Traut Wells Jamestown	Geothermal Regulations
Leo Geiger Maryvale Convent Valley City	Commercial Space Heating Project
Jim Christianson Patterson Hotel Bismarck	Commercial Space Heating Project
Ed Pullen Honeywell	Heat Pump Information
Father Paluck St. Mary's School New England	District Space Heating

Radison Inn Minneapolis, Minn.	Potential Bismarck Development
Dakota Northwestern Bank Bismarck	Geothermal Development
Northwestern Bell Bismarck	Geothermal Development
Water and Power Resources Service Bismarck	Roosevelt-Custer ADP
William Clairmont Bismarck	Greenhouse

Consultants:

Harvey Schneider Toman Engineering Bismarck	Geothermal Development
Russ Harman Kohl and Schwartz Engineering Bismarck	Geothermal Development

Research:

Don Mathson University of North Dakota Engineering Experiment Station	One-year Geothermal Monitoring Study

Individuals:

Dean Kinnischke Bismarck	Residential Space Heating
Joe Mader Bismarck	Heat Pump Information
Dr. Bill McCullogh Bismarck	Residential Space Heating
Cody Bahmiller	Heat Pump Information

Bill Oliver Bismarck	Residential Space Heating
Roger Russell Harvey	Small Commercial Space Heating
Rick Nelson Mandan	Residential Space Heating; Geothermal Energy for Alcohol Production
Sam McQuade Bismarck	Residential Space Heating
Mel Brotten Bismarck	Heat Pump Availability
Toby Howell Grand Forks	Appropriate Technology Geothermal Grant Program
John Conrad Bismarck	Geothermal Development
A. L. DeKrey Lemmon, S.D.	Roosevelt-Custer ADP
Gordon Bell Bismarck	Roosevelt-Custer ADP
Robert Adams Mandan	Roosevelt-Custer ADP
John Swanson Bismarck	Roosevelt-Custer ADP
Bill Ellig Bismarck	Roosevelt-Custer ADP
Brian Giese Mandan	Roosevelt-Custer ADP
Damian Runge Bismarck	Roosevelt-Custer ADP
Greg Cleveland Bismarck	Residential Space Heating
Robert Hanson Amidon	Residential Space Heating
Robert Griffin Medora	Residential Space Heating

SOUTH DAKOTA

COMMERCIALIZATION PROGRAM

JANUARY-JUNE 1980

Prepared by

Phil Lidel

SOUTH DAKOTA OFFICE OF ENERGY POLICY
Pierre, SD 57501

Work Performed Under Contract No. DE-FC07-79ID12012
U.S. Department of Energy
Idaho Operations Office

TABLE OF CONTENTS

1.0 INTRODUCTION

Geothermal energy in South Dakota is becoming an increasingly viable energy source as petroleum based fuel prices continue to rise. Interest in hydrothermal energy is increasing in the private sector. Direct space heating, alcohol production, greenhouses and aquaculture are some of the uses that are receiving attention in areas that overlie the Madison Formation west of the Missouri River. Geothermal groundwater heat pumps are being installed east of the Missouri for space heating homes and offices.

Funding is a major problem in South Dakota as many farmers and schools are interested in an alternate energy source but do not have the "up front" money to participate in existing government guaranteed loan programs. The city of Lemmon had a Rapid City consulting firm prepare an unsolicited proposal which was sent to the South Dakota congressional delegation.

The city of Edgemont is looking for a grant to retrofit their school system.

The three P.O.N. demonstration projects are nearing completion. The Haakon County school was delayed because of a Radium 226 problem but is under construction now. The Diamond Ring Ranch is partly functional now, and the St. Mary's Hospital is going on line this winter.

2.0 SPECIFIC TASK DESCRIPTIONS

2.1 Geothermal Prospect Identification

The South Dakota Department of Water and Natural Resources and the Department of Energy are negotiating a contract for resource assessment in South Dakota. Initial ground work for a resource assessment was laid by Phil Lidel of O.E.P.; Dick Meyer, W.E.P.; Roy Mink, DOE/ID; and Duncan McGregor, South Dakota. Final negotiations are continuing between DOE/ID and the South Dakota DWNR. Dick Howard, Assistant Secretary of the DWNR is preparing the budget which has to be approved by the South Dakota Appropriations Committee.

The Stanley County Extension Agent was awarded an appropriate technology grant by D.O.E. for a resource assessment program in central South Dakota. The $6,000 program covering 6 counties will identify well use, depth, elevation, flow rate, temperature and formation. Fifty-six site visitations were made. (See Appendix A)

2.2 Specific ADP'S-Completed Or In Preparation

Areas Development Plans have not been progressing as well as expected. Obtaining data for units smaller than countywide is exceptionally difficult. The Sixth Council of Local Governments in Rapid City is collecting data on municipalities with populations of more than 500 in ADP's I and III. Preliminary site data for South Dakota is shown in Appendix B.

2.3 Site Specific Development Plans

Lemmon has completed a proposal prepared by Dunham Associates, Inc. entitled Multi-Use Demonstration of Madison Formation Geothermal Water at Lemmon, South Dakota. This proposal outlines plans for a cascading project which will provide data for a site specific development plan.

The resource, based on data from a well drilled six miles south of Lemmon in 1979, is the Madison Formation. The formation is 1,700 feet thick of a depth of 5,500 feet. The proposed project will establish a multi-tiered geothermal utility with three wells in the Madison Formation. The wells are expected to provide a total of 2,100 gmp of 88°C water. The energy will be directed through a distribution grid to supply energy for a multi-tiered geothermal utility. Anticipated utilization can extract 1.014 X 10^{12} BTU annually for beneficial use.

Industries which are possible choices and in which local Lemmon interest has been expressed include:

1. Hydroponics
2. Soil Warming
3. Aquaculture
4. Grain Drying
5. Greenhouse Heating
6. Mineral Extraction
7. Alcohol By-Product Use
8. Fertilizer Manufacturing
9. Alfalfa Pelletizing

Lemmon energy costs per million useable BTU's range from \$8.11 MM/BTU for propane to \$12.24 MM/BTU for electricity. The fossil fuel rates are subject to daily fluctuation, but the electrical rates are reasonably stable. Final geothermal energy pricing will be determined once system costs are established and operating costs are known. However, preliminary calculations indicate that a price of \$5.50 to \$6.00 per million BTU will be the initial energy cost. The rate difference will allow building owners a saving of between \$3.00 and \$6.00 per million BTU use to use toward amortization of their retrofit cost.

An average small commercial building with a heat loss of 200,000 BTU per hour will save over $500 per year on energy cost. The owner could therefore pay back a probable retrofit cost of $2,000 in less than 5 years.

The buildings surveyed in Lemmon included 526 residential buildings and 101 commercial buildings. The residential area included over 675,000 square feet of space with an annual heating energy consumption of about 38×10^9 BTU. The commercial buildings encompass nearly 525,000 swuare feet with an annual heating consumption of nearly 43×10^9 BTU.

Components of the project that have already been developed are as follows:

1. Well Permits

   The City of Lemmon has made an application and has received authority from the State of South Dakota to drill three wells into the Madison Formation. Application has been made to North Dakota for a well.

2. Establishment of a Geothermal Utility

   Work has begun on the establishment of a geothermal utility which would own, control, and regulate the geothermal resource. City officials have researched the legal aspects of South Dakota law and are prepared to draft the necessary enabling ordinances to cause the utility to become a reality.

3. Community Support

   Building owners, both residential and commercial, have been contacted regarding the proposed geothermal utility.

The contact with building owners has been accomplished to develop an energy use data base for Lemmon, to inform the citizens of Lemmon on the geothermal potential, to determine the level of interest by the citizens for retrofitting their buildings for geothermal use, and to generate community support for the geothermal utility. The survey conducted by the Community Action Committee clearly demonstrated overwhelming support of the residents of Lemmon. Over 80% of the building owners responded positively to the survey. Base line data from the survey has been used to help configure the initial phase of the proposed utility piping grid.

4. Industrial Park

An industrial park has been established in close conjunction with the geothermal resource. The park is located so that industries attracted can utilize the geothermal resource. In fact, the desire of the citizens of Lemmon is to attract industry which requires and can benefit from the low cost energy resulting from the geothermal resource, and/or have need for source of water.

5. Utility Easements

Easements have already been secured for the well sites and for passage of the geothermal resource through town, to the industrial park, and to the anticipated surface disposal site. The fact that the easements have been secured will substantially reduce the time required to implement the project.

6. <u>Institutional Cooperation</u>

The citizens of Lemmon have already communicated with and elicited the support of appropriate state and federal agencies as well as asking for the support of the South Dakota Congressional Delegation. This support has been demonstrated by assistance such as the geothermal utility study accomplished by the Physical Science Laboratory of the New Mexico Energy Institute. That study was arranged by the South Dakota Office of Energy Policy.

The P.O.N. demonstration project at the Haakon County school (Philip) is a prime candidate for a site specific development plan. The project has been expanded to include providing eight downtown business places ½ of their heating needs thus saving 26,000 gallons of fuel oil per year. The local grain elevator owned by the Farmers Co-op Association is studying the possibility of constructing a grain alcohol plant. As part of their study they are considering utilizing the geothermal heat for part of their heat requirements. The elevator is also studying the possibility of utilizing part of the heat for a grain drying operation.

The resource is water from the Madison Formation flowing at 300 gpm with a temperature of 69^{o}C from a well 4,226 feet deep.

Midland is a third candidate for a SSDP.

Data from a 1977 study conducted by Dr. J. P. Gries of the South Dakota School of Mines and Technology can be used for baseline information.

The resource is a Madison Formation well that has a temperature of 71°C and a flow of 280 gpm; total depth is 3,311 feet. The Midland School System has been using this well for space heating since 1968. The Stroppel Hotel in Midland is using 41°C water for hot mineral baths from a 1,400 foot well drilled in 1977. The original hotel well drilled in 1938 was 1,880 feet in depth. Flow rate for the hotel well is approximately 50 gpm.

According to Dr. Gries, the community consists of 110 residential homes, 3 churches, and 14 commercial establishments. Based on an outside design winter temperature of -29°C it is estimated that the peak seasonal demand for Midland would be 11.3×10^6 BTU/hr.

Rushmore Electric Power Cooperative conducted a survey of all fuel suppliers for Midland to determine the amount of energy actually used in Midland during 1976. This survey indicated that 240,000 gallons of propane and 60,500 gallons of fuel oil were consumed. This consumption equates to about 30.3×10^9 BTU/yr.

2.4 Time Phased Project Plans

Has not been compiled yet.

2.5 State Aggregation of Prospective Geothermal Utilization

Has not been compiled yet.

2.6 State Government Institutional Procedures

2.6.1 General

The development of geothermal resources within South Dakota is primarily controlled by the Department of Water and Natural Resources. The Division of Water Rights within the Department regulates the development of geothermal resources under existing water statutes. The various applicable statutes will be analyzed in this document in a separate section. Existing state law dealing with water resources development is relevant, principally because (1) the geothermal resources found in South Dakota are principally hot water resources and (2) the use of water for heating and cooling purposes is deemed a "beneficial use" of the resources.

Geothermal use is classified a "beneficial use" by both the Secretary of the Department of Water and Natural Resources and the Board of Water Management. This is a citizens board, appointed by the governor, with the responsibility of establishing broad regulatory policy pertaining to water development.

Although there are numerous locations in South Dakota where geothermal resources are being utilized by private citizens and public entities, the total potential for use is relatively untapped. Because of this the Department of Water and Natural Resources strongly promotes geothermal resource development.

Another agency of state government involved in the regulation of geothermal resources is the Department of School and Public Lands. Many of the lands under which geothermal resources may lie are administered by the Department of School and Public Lands. For this reason, if one desires to develop a geothermal resource on state-owned public land, the Department of School and Public Land would be involved in the process. The state agencies responsible for geothermal regulation activities are listed in Table 6.2.

The regulatory requirements of both the Department of Water and Natural Resources and the Department of School and Public Lands will be discussed in the following sections.

The South Dakota Office of Energy Policy (OEP) is not involved in the regulation of geothermal resource development but rather serves as an information source for all citizens of the state. The Alternative Energy Technologies section of the OEP maintains current files on research, development and application of geothermal resources and would be pleased to assist any interested party.

2.6.2 Key State Government Contacts

* Department of Water & Natural Resources	
Secretary, Warren R. Neufeld	773-3151
Division of Water Quality, John Nelson	773-3351
Division of Water Rights, John Hatch, Chief Engineer	773-3352

Division of Geologic Survey (Vermillion) Duncan MacGregor	677-5227
* Department of School & Public Lands	
Commission, John Gerken	773-3303
Oil & Gas Administration, Jerry Ortbahn	773-3303
* Office of Energy Policy	
Director, Harry Christianson	773-3603
Alternative Energy Technologies, Verne Brakke	773-3603
Director, Geothermal Program, Phil Lidel	773-3603
* Department of Game, Fish and Parks	
Secretary, Jack Merwin	773-3387
Attorney, Clint Nagel	773-3484
* Public Utilities Commission	773-3202

2.6.3. State Statutes

2.6.31 Statute Analysis Section

SDCL 46-1 outlines the basic principles and definitions for water law. Of particular interest within this section is the definition of "Beneficial Use."

> 46-1-6. "Beneficial Use is the use of water is reasonable, useful and beneficial to the appropriator, and at the same time is consistent with the interests of the public in the best utilization of water supplies;"

As stated earlier the decision has been made by the Board of Water Management and the Secretary, Department of Water and Natural Resources that geothermal use is a beneficial use. This policy sets the state for the inclusion of geothermal uses into the existing processes for the obtainment of a water right.

The section entitled permitting procedures will outline the necessary steps for the obtainment of a Water Right for geothermal purposes.

Another definition found in SDCL 46-6-1 is worthy of discussion. The definition of Domestic Use is important in that if a geothermal use meets the requirements set forth in the definition, a water right need not be obtained and the developer of geothermal resource shall be afforded the full protection a law given to all other domestic water users.

> 46-6-1. "Domestic Use, is the use of water by an individual, or by a family unit or household, for drinking, washing, sanitary, culinary purposes; and irrigation of a family garden, trees, shrubbery or orchard not greater than one-half (1/2) acre. Stock watering shall be considered a domestic use;"

In making a decision as to whether or not a particular geothermal use is considered a domestic use, the Department of Water and Natural Resources will determine if the intended use can be considered an "ordinary household" use.

For example, the heating and/or cooling of a single farm dwelling and associated out-buildings such as a barn, may be considered a domestic use; but the heating and/or cooling of an individually-owned commercial livestock operation may not be domestic. Because each case must be reviewed by Department staff before a decision can be made, it is strongly recommended that each potential user of a geothermal resource contact the Department of Water and Natural Resources before beginning development. This will preclude any potential future problems concerning the necessity of a permit.

Additional statutes that pertain to obtainment of geothermal water rights include: SDCL 5-7-2 lists the minerals that are subject to the mineral leasing procedures of School and Public Lands.

> 5-7-2. Minerals subject to lease by advertising and auction or oral bids - Exemptions, "It is hereby specially provided that all leases for prospecting for, providing and marketing oil and gas, bentonite and gypsum, shall be issued after advertising and sale at public auction, to the highest bidder on oral bids. The sale of fissionable materials, feldspar, mica coal, sand, gravel, rock, stone, clay shale and any and all other minerals are specially exempted from the provisions of this section."

The above statute is one of numerous statutes which supports in whole or in part the position of the Department of School and Public Lands. All available statutes relating to mineral leasing of state lands omit water as a leaseable mineral resource.

(Additional references: see SDCL 5-7-3, 5-7-4, 5-7-5, 5-7-7-, 5-7-12.)

SDCL 5-5-3 allows the Department of School and Public Lands to designate lands which may be leased for

"Agricultural purposes". It is the judgement of the Department that instituting a well for extraction of geothermal resources for farm use in an "Agricultural purpose."

> 5-5-3. Designation of lands to be leased - Establishing of regulations - The board of school and public lands shall designate from time to time such lands as may be leased for meadow and pasturage purposes only, also such lands as may be leased for either meadow and pasturage, or for agricultural purposes. It shall establish such regulations as in its judgement shall be necessary in order that such lands may be leased most profitably for the state, and upon designation of the lands as herein provided, the commissioner shall proceed to offer the same for least.

(Additional references 5-5-1, 5-5-32.)

SDCL 5-5-22 sets forth the procedures required for gaining permission from the Department of School and Public Lands for making improvements on land leased from the State. Developing a geothermal resource on leased land is considered an improvement and a permit must be obtained.

> 5-5-22. Permit for improvements and conservation activities by lessee - Right of removal - State not liable for material or labor. - In offering any land for leasing or at any time after the lease has been made, the commissioner of school and public lands may grant to any lessee of land under the provisions of this chapter a permit to erect thereon such buildings, corrals, fences, and well apparatus as may be necessary to fully carry out the purposes of the lease, and such lessee shall have the right to remove such improvements as are capable of removal without damage to the land at

any time before the expiration of the term or upon cancellation of the lease, and during a period of sixty (60) days from the date upon which such dams thereon as may be necessary, the cost of which shall not exceed twenty-five hundred dollars. In addition, the commissioner of school and public lands shall have the authority to grant in like manner a permit to prepare the ground and to plant shelter belts on such land, and to perform government approved ripping, furrowing, contouring and reseeding. Provided that the lessee shall notify the county auditor and the commissioner of school and public lands in writing whenever any such improvements are placed upon such lands. In no event shall the state become liable for any material furnished for, nor for any labor performed on, such improvements.

(Additional references 5-5-22, 5-5-23, 5-5-29, 5-5-32.)

A statute of particular note in the instance where a potential geothermal developer wishes to buy a parcel of School and Public Land is SDCL 5-9-5.

> 5-9-5. Offer to Purchase Particular Tract - Forfeiture or Return of Deposit - Any person may file with the commissioner a written offer on any tract, which offers shall be accompanied by a cash or certified payment deposit of three dollars for each acre in the tract on which the offer is made. If said tract of land be selected for sale in the year in which the offer is made, and the offeror fails, at the time and place of sale, to appear and bid on such tract in an amount at least equal to his said written offer, said deposit shall be forfeited. If the tract be not selected for sale by the board of appraisal in the year in which the offer is made, or if the tract is sold for a price higher than the said written offer, said deposit shall be returned to the offeror, and the board of appraisal and the commissioner need not offer said tract for sale."

Although possessing a surface lease is all that is absolutely necessary before one can develop a geothermal resource on state-owned land, it may be more prudent to purchase the surface ownership to ensure long term use of the resource.

The South Dakota Legislature has also made provisions for a public entity to purchase state-owned land for public purposes.

> SDCL 5-9-34. Sale of small tract for public purposes of landing field - Maximum size and location - Air space easement. - Whenever a civil, religious or public organization shall make an application for the purchase of any common school or endowment land to be used for public purposes, not exceeding ten acres in a square form, located on a section line or on a regularly established highway at one corner of a legal subdivision, and, however, when a civil or public organization in cooperation with the department of transportation shall make an application for the purchase of land without restriction as to area or shape to be used as a landing field and provided that such land applied for shall be adjacent to a regularly established highway, or section line, and a plat and a statement of the purpose for which the land is to be used, shall have been filed in the office of the commissioner of school and public lands, the board of school and public lands is authorized to direct an appraisement of such tract, and the same may be appraised in the manner provided by law for the appraisement of school and public lands. The provisions of this section and SDCL 5-9-35 shall include and apply to the acquisition of an easement for the unrestricted passage of aircraft in the air space over state lands.

The above statute would be applicable in the case where a municipality wished to develop a large scale geothermal heating system for its members. (Additional references 5-9-1, 5-9-38.)

2.6.32 South Dakota Public Utilities Commission

SDCL 49-41B-1 states that the PUC will assume permitting authority for energy conversion facilities and transmission facilities in South Dakota. SDCL 49-41B-2 defines an energy conversion facility as:

> Any new facility expansion, designed for or capable of generation of one hundred megawatts or more of electricity.

Transmission facility is defined as:

> An electric transmission line and associated facilities with a design of two hundred fifty kilovolts or more; or (b) an electric transmission line and associated facilities with a design of one hundred fifteen to two hundred fity kilovolts, if the facility does not follow section lines, property lines, roads, highways, or railroads.

Since the low temperature geothermal resource in South Dakota does not have enough heat to generate electricity, the PUC permits are not required; furthermore, there are no direct space heating regulations in South Dakota.

2.6.4 State Legislation

The 1980 Legislature passed a bill entitled "An act to define geothermal resources and to provide for the leasing of geothermal resources on state lands." The act amends

South Dakota Compiled Laws as follows: SDCL 5-1-2

Definition of Terms.

> (3) "Geothermal resources," the use of the natural heat of the earth or the energy, in whatever form, below the surface of the earth for commercial or industrial heating or electrical generating purposes. Chapter 5-7 of SDCL "Minerals on School and Public Lands" is amended to include geothermal resources with oil and gas regulations, however, Chapter 5-7 is also amended by adding a new section to read as follows: "All leases granted by the Commissioner of School and Public Lands for the development of geothermal resources for industrial or commercial heating or production of electricity of minerals in solution, are subject to all of the provisions of Chapters 46-5 and 46-6 inclusive."

Chapter 46-5 has 46 sections pertaining to the appropriation of water and Chapter 46-6 has 23 sections pertaining to water and wells.

In addition, two other new sections were added to South Dakota Compiled Laws Chapter 5-7. Section 8 of the bill states:

> The term of all geothermal leases shall be for a period not to exceed ten years and as long as geothermal resources are produced from the leased lands.

Section 9 of the bill amends Chapter 5-7 as follows:

> All geothermal leases shall provide for the payments of royalty to the state. The royalty payments shall consist of:
>
> (1) Not less than ten percent of the gross revenue, exclusive of School and Public Lands, that were made or incurred with respect to transmission or their services or processes, received from the sale of steam, brines, from which no minerals have been extracted, and associated gases at the point of delivery to the purchaser; and

(2) A royalty of five percent of the gross revenue, exclusive of charges, approved by the commissioner of School and Public Lands, that were made or incurred with respect to transmission or other services or processes, received from the sale of mineral products from geothermal fluids or chemical compounds.

All royalties shall be subject to renegotiation after ten years from the effective date of the lease and at ten year intervals thereafter.

All geothermal leases shall provide for the payment of a reasonable annual rental, as fixed by the rules and regulations of the commissioner of School and Public Lands, but in no event to be less than one dollar per acre per year.

Apparently on School and Public Lands, geothermal resources are governed by oil and gas regulations for leasing and sale purposes and by water regulations for permitting, drilling, reporting, logging, and well construction purposes. The exception to the above is when the geothermal resource is used for domestic purposes, then it would be classified wholly as water.

2.7 Public Outreach Program

2.7.1 Introduction

The main thrust of the marketing and outreach program in South Dakota has been to inform the people of the location and potential use of geothermal energy. Due to the lack of industry in, and the agrarian background of South Dakota; space heating and agricultural uses have been stressed in the state.

Direct use of geothermal energy in South Dakota is confined to the western half of the state consisting of 17% of South Dakota's population.

Geothermal groundwater heat extractors are of intense interest in the eastern half of the state.

1. Information and Education

The primary function of the state commercialization team since its inception in July of 1979 is to provide the citizens of South Dakota with geothermal energy data that will provide the incentive for its use. The main vehicles for the dissemination of information are:

* The energy newsletter published monthly by the Office of Energy Policy has a circulation of 3,500 including financial institutions, engineers, architects, rural electric cooperatives, chambers of commerce, and educational institutions. Geothermal energy articles published in the past 15 months include (1) user-coupled program, (2) NWWA Groundwater Heat Pump Conference, (3) St. Mary's Hospital, (4) Will Lenners heat pump, (5) Geothermal Guarantee Loan Program, (6) Technical Assistance Program, and (7) UDAG.
* Public Service Announcements: Radio and newspaper PSAs include the above plus articles about Lemmon, Diamond Ring and groundwater heat pump use at Gregory and Ipswich.

* Talks: Speeches by the state commercialization team have been made to the Edgemont City Commission, the 5th and 6th District Local Council of Government, private citizens at Edgemont and Newell, VISTA Volunteers at Rapid City and other state agencies.

  These talks include slides of geothermal energy use at Philip, Midland, St. Mary's Hospital, and Diamond Ring Ranch in South Dakota plus commercial, industrial, and residential use in the western United States.

  An audio-visual show explaining the user-coupled program is available from the Office of Energy Policy. The same type show depicting the direct use of geothermal energy in South Dakota is expected shortly from Lessor Productions of Hollywood.

* Brochures: Now available from the Office of Energy Policy includes (1) "Geothermal Resources of South Dakota." This publication gives a brief, basic description of the geothermal use and some of the problems associated with that use. (2) National Water Well Associations's pamphlet "Groundwater Heat Pumps." A more comprehensive handbook on heat pump use in South Dakota is being prepared by the South Dakota Office of Water Quality and the South Dakota Office of Energy Policy. (3) The South Dakota Geothermal Handbook is at the printers. This 60 page publication gives a detailed explanation of (1) the geothermal resource in South Dakota, (2) private and agricultural uses of

geothermal energy in South Dakota, (3) materials selection and problems, (4) methods of heat extraction, (5) environmental concerns, (6) state government institutional procedures, (7) permitting requirements, (8) local government regulations, (9) federal procedures and policies and, (10) federal incentives. This handbook details all the steps necessary to get geothermal energy on line.

* Future Plans: October has been proclaimed energy month in South Dakota. Energy conservation and alternate energy use will be emphasized during this period. Twice daily during October the Public Broadcasting Service will telecast the users of geothermal energy in the state explaining their programs. This program will include the owner of the Diamond Ring Ranch explaining cascading; the Haakon County School Superintendent explaining the distribution system including secondary use of the water by businessmen after it leaves the school; the Business Administrator at St. Mary's Hospital speaking of the amount of fuel saved by his project; and a local Philip businessman speaking of energy savings in space heating by geothermal energy.

An open house and ribbon cutting ceremony is being planned by the principals of Haakon County, St. Mary's and Diamond Ring. Their efforts are being coordinated by the South Dakota Office of Energy Policy and is tentatively scheduled for October 21.

Workshops for a cross section of the business leaders of western South Dakota are being planned by the State Commercialization Team and the Stanley County Extension Agent.

2.7.2 Summary of Contacts and Results

Various state agencies have been contacted for resource information, economic data, and rules and regulations. These include the State Engineers Office, the Department of Water and Natural Resources, the South Dakota Geological Survey, the South Dakota Department of Agriculture, the South Dakota Department of Revenue, and the South Dakota Department of Economic and Tourism Development.

Information on the use of groundwater heat pumps has been conveyed to the Wessington, Orient, and Chamberlain schools and to county agents in Campbell, Spink and Stanley Counties.

The Fifth and Sixth District Local Council of Governments have been kept informed of Federal programs pertaining to geothermal energy.

Numerous requests have been answered from private individuals pertaining to groundwater heat pumps, greenhouses, aquaculture, and alcohol plants utilizing geothermal energy.

A detailed listing is contained in Appendix C.

2.7.3 Future Geothermal Commercialization

The future of geothermal energy development in South Dakota lies primarily in the agriculture and space heating sectors.

Groundwater heat pumps are becoming more popular with individuals and educational institutions.

The Polo Public School System and St. Joseph Indian School at Chamberlain plan on using existing geothermal wells (75^{o}F water) implemented with groundwater heat pumps. The Missouri Basin Power Company at Sioux Falls is having Dewild, Grant, Reckert, and Associates design an office building heated by a two well groundwater heat pump system. Requests from Rapid City, Philip, and Lemmon for information about greenhouses, alcohol plants, and aquaculture have been received by this office. With fuel oil at 95¢/gal. and LPG at 60¢/gal. geothermal energy is becoming more attractive to businesses and individuals.

3.0 Findings and Recommendations

Because of South Dakota's almost total dependence on imported petroleum products, it is imperative that South Dakota citizens learn of viable alternate energy sources.

Hydrothermal wells in western South Dakota have been used for stock tank warming and space heating since the early 1900's. Other wells were drilled for the sole purpose of stock watering. It is the users of these wells that must be persuaded that multi-use of the water can be beneficial.

Geothermal groundwater heat pumps using water from shallow aquifers are the most viable alternate energy source for individuals and small businesses in South Dakota. The goals of the state commercialization team are to: 1) encourage owners of existing geothermal wells to develop the resource to its full potential, 2) encourage conventional fuel users to change to geothermal energy, and 3) promote the use of groundwater heat pumps in applicable areas. To achieve these goals the following recommendations are made:

* Workshops involving community business leaders should be held throughout western South Dakota. The workshops would be informative in nature stressing resource location, utilization, technical and financial aid.

* A South Dakota groundwater heat pump handbook will be developed defining the principle, hardware, and economic advantages of groundwater heat pumps.

* A list of consultants with expertise in geothermal construction will be compiled for public use.

* A list of groundwater heat pump manufacturers and South Dakota distributors will be compiled.

The end result of the State Team's effort will be BTU's on line either through direct use or complemented by groundwater heat pumps.

APPENDIX A

Geothermal Well Locations

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Onida City Wells
2. Location or legal description of well
T114N R77W S 5 Co. Sully
3. Date drilled 1976 4. Driller Ind. Drilling Co.
5. Depth 1 ?) 6. Formation of flow Dakota
7. Temperature (at well head) (Est.) 82°
8. Rate of flow ① 60 GPM ② 70 GPM ④ 100 GPM
9. Distance from dwellings or out buildings
#3 well abandoned.

10. Is well now being used for heat purposes?
no If so describe type of use, miles of pipe, effectiveness of system, ect.
Supplies city with water.

11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller (✓) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy
Date -- July 24th 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Vernon Gassett
2. Location or legal description of well
NW¼ - 19 - 114 - 80
3. Date drilled 1959 4. Driller
5. Depth 2176 6. Formation of flow Sunda
7. Temperature (at well head) 75
8. Rate of flow 80 PM
9. Distance from dwellings or out buildings
2000 ft

10. Is well now being used for heat purposes?
yes If so describe type of use, miles of pipe, effectiveness of system, ect.
shop

11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Vernon Gassett
Date -- 9-14-80

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

Well owner or user Walt & Marion Shreiber
Location or legal description of well
116N R 77 W S 6 Co. Sully
Date drilled 1985 4. Driller Huron
Depth 2100 6. Formation of flow Sundance
Temperature (at well head) 84°
Rate of flow 62GPM PRESSURE 300 (?)
Distance from dwellings or out buildings
½ mile (Walt)
1 mile (Marion)
Is well now being used for heat purposes?
no If so describe type
use, miles of pipe, effectiveness of system, ect.
ipe — 3 feet underground
opper casing. Told that water
ot fit for irrigation — waters
arden — extensively — & shelter belts
. Source of information: ( ) Well user ( ) Natural
source Agency ( ) Well driller ( ) County Agent
) Pooling use agreement member ( ) Geological surve
) Soil Conservation Service ( ) So. Dak. School of
nes ( ) Oil Exploratory Company ( ) Houston Natural
s exploratory test ( ) Personal visit to well and
asuring.

port by Bernie Duffy

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Jack Smith
2. Location or legal description of well
T 115 N R 80 W 8 7 Co. Sully
3. Date drilled 1954 4. Driller Sallnus
5. Depth ½ mile 6. Formation of flow Sundance
7. Temperature (at well head) 82°
8. Rate of flow 1954 — 120GPM — now 30GPM
9. Distance from dwellings or out buildings
200 feet
10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
problems with corrosion — replaced
casing with brass. Comment: "We
need to get control valves on these wells
or all this waters going to drain into the
draws"
11. Source of information: ( ) Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test ( ) Personal visit to well and
measuring.

Report by Bernie Duffy

6-27

STANLEY

GEO-THERMAL WELL REPORT

Well owner or user Glenn Garret

Location or legal description of well

T 113N R 80W S 29 Co. Sully

Date drilled 1978 4. Driller Huron

Depth 2170 6. Formation of flow Sundance

Temperature (at well head) ?

. Rate of flow 80 GPM

. Distance from dwellings or out buildings

200 yrds.

. Is well now being used for heat purposes?

no If so describe type

use, miles of pipe, effectiveness of system, ect.

domestic, watering livestock

– does not drink water.

1. Source of information: ( ) Well user ( ) Natural esource Agency ( ) Well driller ( ) County Agent)Pooling use agreement member ( )Geological survey)Soil Conservation Service ( )So.Dak.School of ines ( )Oil Exploratory Company ( )Houston Natural as exploratory test ( )Personal visit to well and easuring.

Report by Bernie Duffy

Date -- July 80

6-28

GEO-THERMAL WELL REPORT

1. Well owner or user Gene Stampe
2. Location or legal description of well

   T 114 N R 80W S 3 Co. Sully
3. Date drilled 1959 4. Driller Sellnus-Faulkton
5. Depth 2267 6. Formation of flow Sundance
7. Temperature (at well head) 86° – 66°
8. Rate of flow 35 GPM
9. Distance from dwellings or out buildings

   ½ mile – drinking – heating – watering livestock
10. Is well now being used for heat purposes?

    yes If so describe type of use, miles of pipe, effectiveness of system, ect.

    ½ mile pipe.

    Century heating cooling system from FRY in Pierre. $3900.00 $1000 tax break. Put in Jan. Pleased
11. Source of information: ( ) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological surve ( ) Soil Conservation Service ( ) So.Dak.School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test ( ) Personal visit to well and measuring.

Report by Bernie Duffy

Date -- July 24th 1980

6-29

GEO-THERMAL WELL REPORT

. Well owner or user Tug Bush
. Location or legal description of well
T114 N R 79 W S19 Co. Sully
. Date drilled 1965 4. Driller Huron
. Depth 2203 6. Formation of flow Sundance
. Temperature (at well head)
. Rate of flow
. Distance from dwellings or out buildings
½ mile

). Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.

1. Source of information: ( )Well user ( )Natural Resource Agency ( )Well driller ( )County Agent ( )Pooling use agreement member ( )Geological survey ( )Soil Conservation Service ( )So.Dak.School of Mines ( )Oil Exploratory Company ( )Houston Natural Gas exploratory test ( )Personal visit to well and measuring.

Report by Bernie Duffy
Date -- July 24th 1980

GEO-THERMAL WELL REPORT

1. Well owner or user Onida Pork Producers
2. Location or legal description of well
T114N R78W S12 Co. Sully
3. Date drilled 1974 4. Driller Huron
5. Depth 2071 6. Formation of flow Sundance
7. Temperature (at well head) 85°
8. Rate of flow 50 GPM
9. Distance from dwellings or out buildings
Hog building — 600 feet
dwelling — 300 feet
10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
Wanted to convert to geothermal but couldn't get a guarantee that water wouldn't corrode heat pump. Calif. Co— 1 yr. guarantee but 12,00
11. Source of information: ( )Well user ( )Naturde Resource Agency ( )Well driller ( )County Agent ( )Pooling use agreement member ( )Geological surve ( )Soil Conservation Service ( )So.Dak.School of Mines ( )Oil Exploratory Company ( )Houston Natural Gas exploratory test ( )Personal visit to well and measuring.

Report by Bernie Duffy
Date -- July 24th 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

. Well owner or user Melvin Jenson
:. Location or legal description of well
T 111 N R 78 W S 29 Co. Hughes
. Date drilled 1959 4. Driller Huron
. Depth 1860 6. Formation of flow Sundance
. Temperature (at well head) 105°
. Rate of flow 60 GPM
. Distance from dwellings or out buildings
1/2 mile
waters livestock, lawn & gardens
0. Is well now being used for heat purposes?
If so describe type
f use, miles of pipe, effectiveness of system, ect.
1959 - heating system installed
REIDRICH Cooling by Marvin Fry
PIPES HEAT BASEMENT FLOOR.
HEAT PUMP INSTALLED FEB. 80
1. Source of information: ✓ Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test ✓ Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- July 23rd 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Harold Hansen
2. Location or legal description of well
T 109 N R 75 W S 28 Co. Hughes
3. Date drilled 1975 4. Driller Huron
5. Depth 1700 6. Formation of flow Sundance
7. Temperature (at well head) —
8. Rate of flow 12 GPM
9. Distance from dwellings or out buildings
1 mile
10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
watering livestock, lawn
- domestic use.
11. Source of information: ✓ Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological surve
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test ✓ Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- July 23rd 1980

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STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

Well owner or user Richard Hart
Location or legal description of well
T 110 N R 74 W S 28 Co. Hughes
Date drilled 1960 4. Driller Huron
Depth 2080 6. Formation of flow Sundance
Temperature (at well head) 80°
Rate of flow 50 GPM
Distance from dwellings or out buildings
1½ miles

Is well now being used for heat purposes?
no If so describe type
use, miles of pipe, effectiveness of system, ect.
domestic, lawn, stock

Source of information: (✓) Well user ( ) Natural
source Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
ines ( ) Oil Exploratory Company ( ) Houston Natural
as exploratory test (✓) Personal visit to well and
easuring.

eport by Bernie Duffy
ate -- July 28th 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Paul Bonhorst
2. Location or legal description of well
T 110 N R 76 W S 28 Co. Hughes
3. Date drilled (?) 4. Driller Huron
5. Depth 1400 6. Formation of flow Dakota
7. Temperature (at well head) 70°
8. Rate of flow 40 GPM
9. Distance from dwellings or out buildings
¼ mile

10. Is well now being used for heat purposes?
yes If so describe type
of use, miles of pipe, effectiveness of system, ect.
Pipes heat shop floor.... thinking
on installing heat pump.
Domestic use - Water purifier
Waters livestock

11. Source of information: (✓) Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological surve
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test (✓) Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- July 28th 1980

STANLEY COUNTY ENERGY PROJECT
GEO-_ERMAL WELL REPORT

. Well owner or user Harold Hansen

. Location or legal description of well

T 109 N R 75 W S 28 Co. Hughes

. Date drilled — 4. Driller —

. Depth 1225 - 1240 6. Formation of flow Dakota

. Temperature (at well head) cold

. Rate of flow 2 GPM (both)

. Distance from dwellings or out buildings

1) 25 feet

2) 1½ miles

. Is well now being used for heat purposes?

no If so describe type

of use, miles of pipe, effectiveness of system, ect.

1) Waters stock

2) lawn

1. Source of information: (✓)Well user ( )Natural Resource Agency ( )Well driller ( )County Agent ( )Pooling use agreement member (_)Geological survey ( )Soil Conservation Service ( )So. Dak. School of Mines ( )Oil Exploratory Company ( )Houston Natural Gas exploratory test (✓)Personal visit to well and measuring.

Report by Bonnie Duffy

Date -- July 28, 1980

6-32

GEO-THERMAL WELL REPORT

. Well owner or user Philip Norman

. Location or legal description of well

SW 1/4 5-8-25

. Date drilled 7-1972 4. Driller Huron Drilling

. Depth 2650 6. Formation of flow [illegible]

. Temperature (at well head) 115

. Rate of flow 60 GPM

. Distance from dwellings or out buildings

1300 ft

. Is well now being used for heat purposes? [illegible] If so describe type use, miles of pipe, effectiveness of system, ect.

[illegible]

1. Source of information: (X) Well user ( ) Natural esource Agency ( ) Well driller ( ) County Agent) Pooling use agreement member ( ) Geological survey) Soil Conservation Service ( ) So. Dak. School of ines ( ) Oil Exploratory Company ( ) Houston Natural as exploratory test ( ) Personal visit to well and easuring.

eport by [illegible]

ate -- 8-14-80

6-33

STANLEY COUNTY ENERGY PROJECT

GEO-THERMAL WELL REPORT

Well owner or user Gene Stover

Location or legal description of well ~~SW~~ ~~7-6-25~~

S.W. 1/4 -7-6-25

Date drilled 5/15/75 4. Driller Huron Drilling

Depth ~~2875~~ 2780 6. Formation of flow Sandstone

Temperature (at well head) 105-100

Rate of flow 75 gal per min.

Distance from dwellings or out buildings

80 rods.

. Is well now being used for heat purposes?

Yes If so describe type use, miles of pipe, effectiveness of system, ect.

pipes flow into a room and heat is then blown up into the home. Works very well up to zero - if wind isn't too strong.

1. Source of information: (✓) Well user ( ) Natural esource Agency ( ) Well driller ( ) County Agent) Pooling use agreement member ( ) Geological survey) Soil Conservation Service ( ) So. Dak. School of ines ( ) Oil Exploratory Company ( ) Houston Natural as exploratory test ( ) Personal visit to well and easuring.

eport by Gene Stover

ate -- Aug 14-1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Ernest [illegible]
2. Location or legal description of well
S.E. 1/4 Sec. 33 Twp 3 Range 25 Stanley Co.
3. Date drilled 10/28/64 4. Driller [illegible]
5. Depth 2520 6. Formation of flow [illegible]
7. Temperature (at well head) 124 degrees
8. Rate of flow 30 gal per minute
9. Distance from dwellings or out buildings
at the barn yard.

10. Is well now being used for heat purposes?
no. If so describe type
of use, miles of pipe, effectiveness of system, ect.

11. Source of information: (X) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological surve ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Ernest [illegible]
Date -- Sept 2, 1980

STANLEY COUNTY ...

GEO-THERMAL WELL REPORT

Well owner or user Mike Norman

Location or legal description of well

T8N- R 26E - S6 Co. Stanley

Date drilled — 4. Driller Huron

Depth 2500 6. Formation of flow Sundance

Temperature (at well head) 112°

Rate of flow 40-50 GPM

Distance from dwellings or out buildings

3/8 mile

Is well now being used for heat purposes?

yes If so describe type

use, miles of pipe, effectiveness of system, ect.

Pipes run through floor of home. Washes clothes, bathes, etc. but does not drink. Waters stock

Source of information: ( )Well user ( )Natural Resource Agency ( )Well driller ( )County Agent ( )Pooling use agreement member ( )Geological survey ( )Soil Conservation Service ( )So.Dak.School of Mines ( )Oil Exploratory Company ( )Houston Natural Gas exploratory test ( )Personal visit to well and measuring.

Report by Bernie Duffy

Date -- Aug-12-80

6-35

STANLEY ...

GEO-THERMAL WELL REPORT

(T. Sheisser · J. Anderson · B. Rose M: Scarborough)

1. Well owner, or user Assosiation Well Cheyenne Group

2. Location or legal description of well

T 8N R 25E S 26 Co. Stanley

3. Date drilled 1975 4. Driller Huron

5. Depth 2540 6. Formation of flow Sundance

7. Temperature (at well head) 105°

8. Rate of flow 150 GPM

9. Distance from dwellings or out buildings

1/2 miles

(George Williams)

10. Is well now being used for heat purposes?

yes If so describe type

of use, miles of pipe, effectiveness of system, ect.

Heats shop (garage) 72° by the time water reaches. Pipes every 15". Also waters stock — Can't irrigate with it.

11. Source of information: (✓)Well user ( )Natural Resource Agency ( )Well driller ( )County Agent ( )Pooling use agreement member ( )Geological survey ( )Soil Conservation Service ( )So.Dak.School of Mines ( )Oil Exploratory Company ( )Houston Natural Gas exploratory test (✓)Personal visit to well and measuring.

Report by Bernie Duffy

Date -- Aug. 12th 1980

GEO-THERMAL WELL. REPORT

ell owner or user. Riggles

ocation or legal description of well

5N R25E S3 Co. Stanley

Date drilled 1970 4. Driller Huron

Depth 2664 6. Formation of flow

Temperature (at w l head) 128° or better

Rate of flow 100 GPM

Distance from dwellings or out buildings

60 yds.

Is well now being used for heat purposes?

yes If so describe type

use, miles of pipe, effectiveness of system, ect.

2 Homes – supplies 80% of heat – Installed in 1972. No Corrosion problems Waters stock [Domestic water] Irrigates lawn [from dam]

Source of information: (✓) Well user ( ) Natural ource Agency ( ) Well driller ( ) County Agent Pooling use agreement member ( ) Geological survey Soil Conservation Service ( ) So. Dak. School of es ( ) Oil Exploratory Company ( ) Houston Natural exploratory test (✓) Personal visit to well and suring. Also - garage heated - pipe every 18". Heated pool

ort by Bernie Duffy

te -- Aug. 12. 80

STANLEY COUNTY ENERGY PROJECT

GEO-THERMAL WELL. REPORT

Well owner or user. Gaylord Norman

Location or legal description of well

T8N R 25E S 5 Co. Stanley

Date drilled 1961 4. Driller Huron

Depth 2500 6. Formation of flow Sun.

Temperature (at well head) 112

Rate of flow 42 GPM – dropped

Distance from dwellings or out buildings

1/4 mile

Is well now being used for heat purposes?

No If so describe type

use, miles of pipe, effectiveness of system, ect.

heats pool (Corrosion problems) | waters stock

* Concerned about others digging wells.

1. Source of information: (X) Well user ( ) Natural esource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of ines ( ) Oil Exploratory Company ( ) Houston Natural as exploratory test (X) Personal visit to well and easuring.

eport by Bernie Duffy

Date -- Aug. 12th 80

6-36

STANLEY Cu....TY ENERGY PROJECT

GEO-THERMAL WELL REPORT

ll owner or user EV Sivage

cation or legal description of well

5N R 25E S 28 Co. Stanley

te drilled 1973 4. Driller Huron

pth 2250 6. Formation of flow Sundance

mperature (at well head) 112°

te of flow 60 GPM

istance from dwellings or out buildings

s well now being used for heat purposes?

No If so describe type

e, miles of pipe, effectiveness of system, ect.

Source of information: (X) Well user ( ) Natural urce Agency ( ) Well driller ( ) County Agent ooling use agreement member ( ) Geological survey oil Conservation Service ( ) So. Dak. School of s ( ) Oil Exploratory Company ( ) Houston Natural exploratory test (X) Personal visit to well and uring.

rt by Bernie Duffy

e -- Aug. 8. 80

GEO-THERMAL WELL REPORT

1. Well owner or user Arthur C. Bergeson
2. Location or legal description of well NW¼ of NW¼ - 5 - 5 - 26 Co. Stanley
3. Date drilled Oct 75 4. Driller Huron
5. Depth 2410 6. Formation of flow Sundance
7. Temperature (at well head) 125°
8. Rate of flow 60 GPM
9. Distance from dwellings or out buildings App. 200 ft. from house 50 feet from Shop.
10. Is well now being used for heat purposes? No If so describe type of use, miles of pipe, effectiveness of system, ect.
11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy

Date -- by Mail

GEO-THERMAL WELL REPORT

Well owner or user WA BIERMAN

Location or legal description of well

3N R26E S 25 Co. Stanley

Date drilled — 4. Driller Hilton

Depth 3520 6. Formation of flow Minn.

Temperature (at well head) 104°

Rate of flow 15 GPM

Distance from dwellings or out buildings

300 feet

Is well now being used for heat purposes?

no If so describe type

use, miles of pipe, effectiveness of system, ect.

. Source of information: [X] Well user [ ] Natural
source Agency [ ] Well driller [ ] County Agent
] Pooling use agreement member [ ] Geological survey
] Soil Conservation Service [ ] So. Dak. School of
nes [ ] Oil Exploratory Company [ ] Houston Natural
s exploratory test [X] Personal visit to well and
asuring.

port by Bernie Duffy

ite -- Aug. 8. 80

GEO-THERMAL WELL REPORT

1. Well owner or user SCHOFIELD
2. Location or legal description of well

T3N R 26E S 10 Co. Stanley

3. Date drilled 1920 4. Driller Hilton
5. Depth 2710 6. Formation of flow 3rd (?) (Great Falls)
7. Temperature (at well head) 132°
8. Rate of flow 80 GPM
9. Distance from dwellings or out buildings

— used to water stock & domestic drinking —

10. Is well now being used for heat purposes?

Yes If so describe type

of use, miles of pipe, effectiveness of system, ect.

pipes under basement floor

11. Source of information: [X] Well user [ ] Natural
Resource Agency [ ] Well driller [ ] County Agent
[ ] Pooling use agreement member [ ] Geological survey
[ ] Soil Conservation Service [ ] So. Dak. School of
Mines [ ] Oil Exploratory Company [ ] Houston Natural
Gas exploratory test [X] Personal visit to well and
measuring.

Report by Bernie Duffy

Date -- Aug. 8th 1980

GEO-THERMAL WELL REPORT

Well owner or user Jerome Nemec

Location or legal description of well

T 3N R 26E S1 Co. Stanley

Date drilled — 4. Driller [illegible]

Depth 2640 6. Formation of flow

Temperature (at well head) --

Rate of flow pumped

Distance from dwellings or out buildings

50 yds.

Is well now being used for heat purposes?

No If so describe type

use, miles of pipe, effectiveness of system, ect.

used domestically

waters stock

Source of information: (X) Well user ( ) Natural
ource Agency ( ) Well driller ( ) County Agent
Pooling use agreement member ( ) Geological survey
Soil Conservation Service ( ) So.Dak.School of
ies ( ) Oil Exploratory Company ( ) Houston Natural
exploratory test (X) Personal visit to well and
asuring.

ort by Bernie Duffy

te -- Aug 8th 1980

GEO-THERMAL WELL REPORT

1. Well owner or user Ralph Mathews
2. Location or legal description of well

T 3 N R 29 E S 36 Co. Stanley

3. Date drilled 68 4. Driller Aberdeen
5. Depth 2370 6. Formation of flow S
7. Temperature (at well head) 100°
8. Rate of flow 30 GPM
9. Distance from dwellings or out buildings

7,800 feet of pipe

– mile from house.

10. Is well now being used for heat purposes?

No If so describe type

of use, miles of pipe, effectiveness of system, ect.

waters stock, lawn.

domestic drinking water.

11. Source of information: ( ) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So.Dak.School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test ( ) Personal visit to well and measuring.

Report by Bernie Duffy

Date -- Aug. 8th 1980

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STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

ell owner or us: CARLYSLE BROS.
ocation or legal description of well
1N R 31E S 18 Co. Stanley
ate drilled 1980 4. Driller Huron
epth 1970 6. Formation of flow S
emperature (at well head) 104°
ate of flow 72 GPM
istance from dwellings or out buildings

Is well now being used for heat purposes?
no If so describe type
se, miles of pipe, effectiveness of system, ect.
Water livestock.

Source of information: [X] Well user ( ) Natural
ource Agency ( ) Well driller ( ) County Agent
ooling use agreement member ( ) Geological survey
oil Conservation Service ( ) So. Dak. School of
s ( ) Oil Exploratory Company ( ) Houston Natural
exploratory test [X] Personal visit to well and
suring.

ort by Bernie Duffy
e -- Aug. 12th 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Helmet Reuer
2. Location or legal description of well
Twp. 105 Rg. 28 S 29 Co. Stanley
3. Date drilled - 4. Driller Dak/Boring
5. Depth 30 feet 6. Formation of flow -
7. Temperature (at well head) 45-50°
8. Rate of flow pumped
9. Distance from dwellings or out buildings
50 ft.

10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
waters livestock
domestic

11. Source of information: ( ) Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test ( ) Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- Aug. 1. 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user True Smith
2. Location or legal description of well
T 109N R79W S7 Co. Stanley
3. Date drilled 1964 4. Driller Sathers
5. Depth 1325 6. Formation of flow Dak.
7. Temperature (at well head) 90°
8. Rate of flow 10 GPM
9. Distance from dwellings or out buildings
1/2 mile

10. Is well now being used for heat purposes?
no If so describe type of use, miles of pipe, effectiveness of system, ect.
water livestock
domestic

11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy
Date -- Aug 1 - 80

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user TRUE Smith
2. Location or legal description of well
T 109 N R.79 W S7 Co. Stanley
3. Date drilled 1951 4. Driller Sathers
5. Depth 1325 6. Formation of flow Dakota
7. Temperature (at well head) ?
8. Rate of flow no flow
9. Distance from dwellings or out buildings
1/2 mile

10. Is well now being used for heat purposes?
no. If so describe type of use, miles of pipe, effectiveness of system, ect.
—

11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy
Date -- Aug 1 - 80

STANLEY C[illegible]NTY ENERGY PROJECT
GEO-TH[illegible]RMAL WELL REPORT

Well owner or user Bill Smith
Location or legal description of well
[T] 109 N R79W S 36 Co. Stanley
Date drilled 1908 4. Driller Norbeck Nich-olson
Depth 1500 6. Formation of flow Dak
Temperature (at well head) 50°
Rate of flow 50-60 (pumped)
Distance from dwellings or out buildings
60 yds.

Is well now being used for heat purposes?
no If so describe type
use, miles of pipe, effectiveness of system, ect.
stock watering
domestic

. Source of information: (✓) Well user ( ) Natural [Re]source Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of [Mi]nes ( ) Oil Exploratory Company ( ) Houston Natural [Ga]s exploratory test (✓) Personal visit to well and [me]asuring.

[R]eport by Bernie Duffy
[D]ate -- Aug. 1-80

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Bill Smith
2. Location or legal description of well
T 109 N R79W S 36 Co. Stanley
3. Date drilled 63 4. Driller Sather
5. Depth 1490 6. Formation of flow Dak.
7. Temperature (at well head) 70°
8. Rate of flow 50 GPM (dropped)
9. Distance from dwellings or out buildings
Waters livestock
3 MI. W 3 MI. S HOUSE.
10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
Waters stock

11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological surve[y] ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy
Date -- Aug. 1-80

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

. Well owner or user Mack Wyly
. Location or legal description of well
T 109 N R 79 W S 20 Co. Stanley
. Date drilled 1967 4. Driller Huron
. Depth 2160 6. Formation of flow Sundance
. Temperature (at well head) 108°
. Rate of flow 70 GPM
. Distance from dwellings or out buildings
1 3/4 mile

. Is well now being used for heat purposes?
no If so describe type
. use, miles of pipe, effectiveness of system, ect.
waters stock, lawns.
Domestic use.

1. Source of information: (✓) Well user ( ) Natural esource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of ines ( ) Oil Exploratory Company ( ) Houston Natural as exploratory test (✓) Personal visit to well and easuring.

eport by Bernie Duffy
Date -- Aug 8th 80

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Mack Wyly
2. Location or legal description of well
T 109 N R 79 W S 20 Co. Stanley
3. Date drilled 1974 4. Driller Huron
5. Depth 2150 6. Formation of flow Sun.
7. Temperature (at well head) 100°
8. Rate of flow 60 GPM
9. Distance from dwellings or out buildings
50 feet

10. Is well now being used for heat purposes?
yes If so describe type
of use, miles of pipe, effectiveness of system, ect.
Pipes run through basement
floor every 1 & 1/2 feet.

11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological surve ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy
Date -- Aug 1 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

...l owner or uses MikeDurkin
...ation or legal description of well
...09N R 76W S 35 Co. Stanley
...te drilled 75 4. Driller Huron
...pth 1200 6. Formation of flow Sundance
...mperature (at well head) 90°
...te of flow ?
...stance from dwellings or out buildings
3 miles

...s well now being used for heat purposes?
_____ If so describe type
...e, miles of pipe, effectiveness of system, ect.
waters stock
domestic

...ource of information: (X) Well user ( ) Natural ...rce Agency ( ) Well driller ( ) County Agent ...ooling use agreement member ( ) Geological survey ...oil Conservation Service ( ) So. Dak. School of ...s ( ) Oil Exploratory Company ( ) Houston Natural ... exploratory test (X) Personal visit to well and ...uring.

...rt by Bernie Duffy
... -- Aug. 1. 80

STANLEY COUNTY ...
GEO-THERMAL WELL REPORT

... Well owner or user. MIKE DURKIN
... Location or legal description of well
T109N R 76W S 26 Co. Stanley
... Date drilled 1960 4. Driller Sather
... Depth 1200 6. Formation of flow Dak.
... Temperature (at well head) 90°
... Rate of flow ?
... Distance from dwellings or out buildings
1/2 mile

... Is well now being used for heat purposes?
no If so describe type
... use, miles of pipe, effectiveness of system, ect.
waters stock
domestic

... Source of information: (X) Well user ( ) Natural ...esource Agency ( ) Well driller ( ) County Agent ...) Pooling use agreement member ( ) Geological survey ...) Soil Conservation Service ( ) So. Dak. School of ...ines ( ) Oil Exploratory Company ( ) Houston Natural ...as exploratory te... (X) Personal visit to well and ...easuring.

...eport by Bernie Duffy
...Date -- Aug 1-1980

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STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

well owner or user Bob Wilcox
Location or legal description of well
109N R 79W S 35 Co. Stanley
Date drilled 1967 4. Driller Huron
Depth 2100 6. Formation of flow Sundance
Temperature (at well head) 94°
Rate of flow 20 GPM
Distance from dwellings or out buildings
30 YDS.

Is well now being used for heat purposes?
Yes - If so describe type
use, miles of pipe, effectiveness of system, ect.
FREIDRICH (Heats & Cools)
Installed May of '80.
Hooked to oil furnace
Use to water stock; domestic use.

. Source of information: [✓] Well user ( ) Natural
source Agency ( ) Well driller ( ) County Agent
) Pooling use agreement member ( ) Geological survey
) Soil Conservation Service ( ) So. Dak. School of
nes ( ) Oil Exploratory Company ( ) Houston Natural
s exploratory test [✓] Personal visit to well and
asuring.

port by Bernie Duffy
ate -- Aug 1-80

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Pat DURKIN
2. Location or legal description of well
T 109N R 76W S 26 Co. Stanley
3. Date drilled 1975 4. Driller Huron
5. Depth 1856 6. Formation of flow Dakota
7. Temperature (at well head) 90°
8. Rate of flow 70 GPM
9. Distance from dwellings or out buildings
1/2 mile

10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
Waters livestock; domestic use.

11. Source of information: [✓] Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test [✓] Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- Aug 1 - 80

6-45

STANLEY COUNTY ENERGY PROJECT

GEO-THERMAL WELL REPORT

Well owner or user: Dayton Chisholm - A. Tibbs

Location or legal description of well

T9N R27 NW¼ of S 23 Stanley

Date drilled 1971 4. Driller Huron

Depth 2410 6. Formation of flow Sundance

Temperature (at well head) 97°

Rate of flow 60 GPM

Distance from dwellings or out buildings

8-9 miles of pipe-

Is well now being used for heat purposes?

no If so describe type

use, miles of pipe, effectiveness of system, ect.

Waters stock

gardens

Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So.Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy

Date -- Aug. 1980

GEO-THERMAL WELL REPORT

Well owner or user: Dan Jones

Location or legal description of well Stanley

NW¼ 20 T7N - R26E (Henderson Colo.)

Date drilled Nov. 79 4. Driller Western Well Drilling

Depth 2407 6. Formation of flow Dakota

Temperature (at well head) 95°

Rate of flow 42 GPM

1. Distance from dwellings or out buildings

¾ mile

0. Is well now being used for heat purposes?

no If so describe type

of use, miles of pipe, effectiveness of system, ect.

1. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So.Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy

Date -- Aug. 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

Jell owner or user GEORGE WELSH
.ocation or legal description of well
STANLEY COUNTY
Date drilled 1907 4. Driller UNKNOWN
Depth 1,200 FEET 6. Formation of flow DAKOTA
Temperature (at well head) 92°
Rate of flow 90 GPM
Distance from dwellings or out buildings
100 FEET (EST.)

Is well now being used for heat purposes?
YES- GAS FROM WELL If so describe type
se, miles of pipe, effectiveness of system, ect.
LTERED NAT. GAS STOVE
PIPE - 100 FEET
EFFECTIVE SYSTEM
WELL PRODUCES 270 CUBIC FEET GAS P.H.
Source of information: (✓) Well user ( ) Natural
ource Agency ( ) Well driller (✓) County Agent
Pooling use agreement member ( ) Geological survey
Soil Conservation Service ( ) So. Dak. School of
es ( ) Oil Exploratory Company (✓) Houston Natural
exploratory test (✓) Personal visit to well and
suring.

ort by Bernie Duffy
e -- July 1980

6-47

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Eldon Hawey
2. Location or legal description of well
T9N R27E S30 Co. Stanley
3. Date drilled — 4. Driller Huron
5. Depth 1800 6. Formation of flow Sundance
7. Temperature (at well head) 105
8. Rate of flow 100 GPM
9. Distance from dwellings or out buildings
about one mile-

10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
1) Waters stock
2) domestic

11. Source of information: (✓) Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test (✓) Personal visit to well and
measuring.

Report by B. Duffy
Date -- Aug - 1980

STANLEY COUNTY ENERGY PROJ...

GEO-THERMAL WELL REPORT

Barrick & Webb

1. Well owner or user Will Conners
2. Location or legal description of well
T5N R30W S23 Co. Stanley
3. Date drilled Sept. 70 4. Driller Huron
5. Depth 2075 6. Formation of flow Sundance
7. Temperature (at well head) 98.6°
8. Rate of flow 35-40 GPM
9. Distance from dwellings or out buildings
1/8 miles
Waters stock, lawn.
10. Is well now being used for heat purposes?
yes If so describe type
of use, miles of pipe, effectiveness of system, ect.
1/2 miles -
Freidrich Heating & Cooling System
11. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy Jr.

Date -- Aug- 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user City of Midland
2. Location or legal description of well Midland
3. Date drilled ______ 4. Driller ______
5. Depth ______ 6. Formation of flow ______
7. Temperature (at well head) 160°
8. Rate of flow 200 GPM
9. Distance from dwellings or out buildings 150 feet

10. Is well now being used for heat purposes? yes If so describe type of use, miles of pipe, effectiveness of system, ect.
heating School

11. Source of information: ( ) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy
Date -- July 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user City of Philip
2. Location or legal description of well Philip
3. Date drilled ______ 4. Driller ______
5. Depth 3730 6. Formation of flow ______
7. Temperature (at well head) 158°
8. Rate of flow ______
9. Distance from dwellings or out buildings 150 feet

10. Is well now being used for heat purposes? yes If so describe type of use, miles of pipe, effectiveness of system, ect.
heating [illegible]
[illegible]

11. Source of information: ( ) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological surve ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by Bernie Duffy
Date -- July 1980

STANLEY COUNTY

GEO-THERMAL WELL REPORT

Well owner or user. Charles Price

Location or legal description of well

T6N R18E S6 Haakon

Date drilled 1950 4. Driller Sellnus

Depth 2980' 6. Formation of flow Dakota

Temperature (at well head) 80°

Rate of flow 3 GPM

Distance from dwellings or out buildings

½ mile

. Is well now being used for heat purposes?

no If so describe type

use, miles of pipe, effectiveness of system, ect.

. Source of information: (✓) Well user ( ) Natural esource Agency ( ) Well driller ( ) County Agent) Pooling use agreement member ( ) Geological survey) Soil Conservation Service ( ) So. Dak. School of ines ( ) Oil Exploratory Company ( ) Houston Natural as exploratory test (✓) Personal visit to well and easuring.

eport by Bernie Duffy

Date -- Aug-1980

STANLEY COUNTY

GEO-THERMAL WELL REPORT

. Well owner or user. Charles Price

. Location or legal description of well 3 wells

T6N R18E S6 Haakon

. Date drilled 1960 4. Driller Huron

. Depth 2300-400 6. Formation of flow Dakota

. Temperature (at well head) 70°

. Rate of flow pumps all 3.

. Distance from dwellings or out buildings

Well #1 - 100 feet

#2 & 3 - ½ mile

0. Is well now being used for heat purposes?

no If so describe type

of use, miles of pipe, effectiveness of system, ect.

Wells used to water stock, lawn - & drinking water.

1. Source of information: (✓) Well user ( ) Natural Resource Agency ( ) Well driller ( ) County Agent ( ) Pooling use agreement member ( ) Geological survey ( ) Soil Conservation Service ( ) So. Dak. School of Mines ( ) Oil Exploratory Company ( ) Houston Natural Gas exploratory test (✓) Personal visit to well and measuring.

Report by B. Duffy

Date -- Aug. 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

Well owner or user Bob Schoefield
Location or legal description of well
T6N R 22 S NE 13 Co. Haakon
Date drilled 1972 4. Driller Vercamp (Newell)
Depth 2778 6. Formation of flow Fall River
Temperature (at well head) 132°
Rate of flow 200 GPM
Distance from dwellings or out buildings
300 feet

Is well now being used for heat purposes?
2 (giving system thought) If so describe type
use, miles of pipe, effectiveness of system, ect.
100 sacks cement in casing
Waters stock - gardens

. Source of information: (✓) Well user ( ) Natural
source Agency ( ) Well driller ( ) County Agent
) Pooling use agreement member ( ) Geological survey
) Soil Conservation Service ( ) So. Dak. School of
nes ( ) Oil Exploratory Company ( ) Houston Natural
s exploratory test (✓) Personal visit to well and
asuring.

port by Bernie Duffy
te -- Aug - 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user H.T. FERGUSON
2. Location or legal description of well
T 5N R 24E S 11 Co. Haakon
3. Date drilled 1961 4. Driller Star Drilling Co.
5. Depth 2653 6. Formation of flow
7. Temperature (at well head) 116°
8. Rate of flow 40 GPM
9. Distance from dwellings or out buildings
1/2 mile

10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.

11. Source of information: (✓) Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test ( ) Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- Aug - 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

ell owner or user Gene Armstrong
ocation or legal description of well
Co. Haakon

ate drilled 1957 4. Driller Huron
epth 4260 6. Formation of flow Madison
emperature (at well head) 154°
Rate of flow 200 GPM
Distance from dwellings or out buildings
1/2 mile

Is well now being used for heat purposes?
yes If so describe type
se, miles of pipe, effectiveness of system, ect.
6-7 miles of piping.
Grain drying 2) Heats Quonset floor
System installed in home -
ineffective.

Source of information: (✓) Well user ( ) Natural
ource Agency ( ) Well driller ( ) County Agent
Pooling use agreement member ( ) Geological survey
Soil Conservation Service ( ) So. Dak. School of
es ( ) Oil Exploratory Company ( ) Houston Natural
exploratory test (✓) Personal visit to well and
suring.

ort by Bernie Duffy
te -- Aug-1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Gene Armstrong
2. Location or legal description of well
Co. Haakon
3. Date drilled — 4. Driller Huron
5. Depth 2600 6. Formation of flow Dakota
7. Temperature (at well head) 130°
8. Rate of flow 250 GPM
9. Distance from dwellings or out buildings
3 miles

10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
Waters stock
Domestic

11. Source of information: (✓) Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test (✓) Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- Aug-1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

ell owner or user. Gene Armstrong
ocation or legal description of well
Co. Haakon

ate drilled — 4. Driller Huron
epth 2600 6. Formation of flow Dakota
emperature (at well head) 130°
ate of flow 200 GPM
istance from dwellings or out buildings
3 miles of pipe

Is well now being used for heat purposes?
no If so describe type
se, miles of pipe, effectiveness of system, ect.
Waters stock
Domestic

Source of information: (✓) Well user ( ) Natural
ource Agency ( ) Well driller ( ) County Agent
ooling use agreement member ( ) Geological survey
oil Conservation Service ( ) So. Dak. School of
s ( ) Oil Exploratory Company ( ) Houston Natural
exploratory test (✓) Personal visit to well and
suring.

ort by Bernie Duffy
e -- Aug. 1980

6-53

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

well owner or user Duane Fetlderson
Location or legal description of well
T105 N R 76W S 31 Co. Lyman
Date drilled 1979 4. Driller Sothek (Presho)
Depth 1690 6. Formation of flow
Temperature (at well head) 100°
Rate of flow
Distance from dwellings or out buildings
50 feet
Is well now being used for heat purposes?
yes If so describe type
use, miles of pipe, effectiveness of system, ect.
50 feet.
Owner pleased with heating system.
Charlie Beckwith (Coast to Coast) put in system
son designed the system
domestic - livestock - gardens - etc.
Source of information: ( )Well user ( )Natural
source Agency ( )Well driller ( )County Agent
)Pooling use agreement member ( )Geological survey
)Soil Conservation Service ( )So.Dak.School of
ines ( )Oil Exploratory Company ( )Houston Natural
as exploratory test ( )Personal visit to well and
easuring.

MADISON (?)

eport by Bernie Duffy
July 25th 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user Alvin Werner
2. Location or legal description of well
T 104 N R 72 W S 23 Co. Lyman
3. Date drilled 1953 4. Driller Huron
5. Depth 850 feet 6. Formation of flow (?) (PREdominant)
7. Temperature (at well head) 72°
8. Rate of flow 40-50 GPM
9. Distance from dwellings or out buildings
300 feet
10. Is well now being used for heat purposes?
no If so describe type
of use, miles of pipe, effectiveness of system, ect.
1) Waters stock
2) Domestic
3) Lawns
11. Source of information: (✓)Well user ( )Natural
Resource Agency ( )Well driller ( )County Agent
( )Pooling use agreement member ( )Geological surve
( )Soil Conservation Service ( )So.Dak.School of
Mines ( )Oil Exploratory Company ( )Houston Natural
Gas exploratory test (✓)Personal visit to well and
measuring.

Report by Bernie Duffy
Date -- July 25th 1980

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

ell owner or user. ARLEN SHELSKE
ocation or legal description of well
T 104 N R 74 W S 28 Co. Lyman
Date drilled 1968 4. Driller Hufmaker
Depth 1,200 feet 6. Formation of flow (Dacota) 1st (?)
Temperature (at well head) —
Rate of flow 5 GPM
Distance from dwellings or out buildings
500 feet

Is well now being used for heat purposes?
no If so describe type
use, miles of pipe, effectiveness of system, ect.

Source of information: ( ) Well user ( ) Natural
ource Agency ( ) Well driller ( ) County Agent
Pooling use agreement member ( ) Geological survey
Soil Conservation Service ( ) So. Dak. School of
es ( ) Oil Exploratory Company ( ) Houston Natural
s exploratory test ( ) Personal visit to well and
asuring.

port by Bern: Duffy
te -- July 25th 1980

6-55

STANLEY COUNTY ENERGY PROJECT
GEO-THERMAL WELL REPORT

1. Well owner or user. JOHN JENSEN
2. Location or legal description of well
T 105 N R 77 W S 34 Co. Lyman.
3. Date drilled 1953 4. Driller Faulkton (Sellsnus,
5. Depth 2352 6. Formation of flow Inclusd
7. Temperature (at well head) 106°
8. Rate of flow 80 (1953) 40 now
9. Distance from dwellings or out buildings
— 50 feet / Said large well to go in nearby. Disturbed about future rate of flow.
10. Is well now being used for heat purposes?
yes If so describe type
of use, miles of pipe, effectiveness of system, ect.
pipes in cement floor of garage
— put in in 1976
Hooked to oil furnace
waters gardens, livestock, domestic
11. Source of information: ( ) Well user ( ) Natural
Resource Agency ( ) Well driller ( ) County Agent
( ) Pooling use agreement member ( ) Geological survey
( ) Soil Conservation Service ( ) So. Dak. School of
Mines ( ) Oil Exploratory Company ( ) Houston Natural
Gas exploratory test ( ) Personal visit to well and
measuring. * Copper replaced iron casing
* Copper replaced plastic

Report by Bernie Duffy
Date -- July 25th 1980

APPENDIX B

Preliminary Site Data

POTENTIAL USERS

LOW INTENSITY USERS

SITE NAME	USER NAME	POPULATION	ANNHD (1E9 BTU)
Potential			
Cascade Springs	Custer	1690	118
Cascade Springs	Buffalo Gap	192	11
Draper	Draper	185	8
Dupree	Dupree	606	34
Eagle Butte	Eagle Butte	606	35
Edgemont	Edgemont	1334	139
Eureka	Eureka	1373	71
Faith	Faith	713	39
Fort Pierre	Fort Pierre	2649	181
Gettysburg	Gettysburg	1746	92
Herreid	Herreid	538	21
Hosmer	Hosmer	407	18
Hot Springs	Hot Springs	4670	269
Hoven	Hoven	742	65
Isabel	Isabel	432	23
Kadoka	Kadoka	822	38
Kadoka	Martin	1450	125
Kennebec	Chamberlain	2633	150
Kennebec	Kennebec	356	15
Winner	Winner	3755	163
Lemmon	Lemmon	1957	119
McLaughlin	McLaughlin	887	48
Midland	Midland	323	15
Mobridge	Mobridge	4679	275
Murdo	Murdo	777	32
New Underwood	New Underwood	528	23
North Eagle Butte	North Eagle Butte	1351	88
Philip Haakon School	Philip	978	54
Presho	Presho	927	45
Timberlake	Timberlake	675	36
Wall Town	Wall Town	851	41
Newell	Newell	682	82
Inferred			
Aberdeen	Groton	1105	61
Aberdeen	Webster	2298	127
Aberdeen	Bradley	206	8
Aberdeen	Bristol	483	21
Aberdeen	Conde	279	11
Aberdeen	Pierpont	221	10
Aberdeen	Roslyn	196	9
Bowdle	Bowdle	742	130

APPENDIX C

Contacts

LIST OF CONTACTS

1. STATE AGENCIES

*State Engineers Office

Terry Stofferahn - Phone: 605/773-3466

Subject: Liason officer for NMEI's economic feasibility study of State Capitol Complex.

*Department of water and Natural Resources

Dick Howard, Assistant Secretary - Phone: 605/773-3151
John Hatch, Water Rights Specialist - Phone: 605/773-3151
Steve Pirner, Natural Resource Administrator - Phone: 605/773-3351

Subject: State rules and regulations pertaining to geothermal energy including groundwater heat pump use.

*South Dakota Geological Survey

Duncan McGregor, State Geologist - Phone: 605/677-5227
Bob Schoon, Subsurface Geologist - Phone: 605/677-5227
Fred Steece, Assistant State Geologist - Phone: 605/394-2229

Subject: Geothermal resource information.

*Department of Agriculture

Angus Anson, Director - Phone: 605/773-3375

Subject: Use of conventional fuel in agricultural sector; result - no data available.

*Department of Revenue

Dennis Hanson, Property Tax Division - Phone: 605/773-3311

Subject: Tax credit for water source heat pumps.

2. 5TH DISTRICT LOCAL COUNCIL OF GOVERNMENTS

Greg Hoover, Planner - Phone: 605/224-1623

Subject: Coordination of different types of federal funding.

3. 6TH DISTRICT LOCAL COUNCIL OF GOVERNMENTS

Brian Shorten, Planner - Phone: 605/394-2681

Subject: Coordination of federal programs and funding.

4. EDGEMONT CITY PLANNER

John Kruger - Phone: 605/662-7285

Subject: Federal funding to retrofit city hall and school.

5. EDGEMONT CITY COMMISSION

Subject: Technical assistance for subject above; referral to Ivar Engen, EG&G.

6. STANLEY COUNTY EXTENSION AGENT

Delwin Jensen - Phone: 605/223-2812

Subject: Delwin inventoried 56 geothermal wells in central South Dakota; also very interested in groundwater heat pumps.

7. CAMPBELL COUNTY EXTENSION AGENT

Jim Knoeble - Phone: 605/955-3305

Subject: Jim has an appropriate technology grant monitoring the economic feasibility of groundwater heat pumps.

8. SPINK COUNTY EXTENSION HOME ECONOMIST

Diann Steinheuser - Phone: 605/472-2023

Subject: Fulfilled request for information on geothermal heating.

9. BUTTE RURAL ELECTRIC COOPERATIVE

Ken Wetz - Phone: 605/456-2494

Subject: Public talk at Newell, SD presenting information on geothermal energy.

10. BLACK HILLS ELECTRIC COOPERATIVE

Harlan Borszich - Phone: 605/673-4461

Subject: Public meeting at Edgemont, SD explaining geothermal energy use in South Dakota.

11. POLO SCHOOL DISTRICT #29-2

John Biegler - Phone: 392-2345

Subject: Request for technical assistance on how to use existing well with 75°F temperature.

12. WESSINGTON, SOUTH DAKOTA SCHOOL

Delmer Wolkow - Phone: 605/458-2248

Subject: Superintendent requested and received information about geothermal heating.

13. ST. JOSEPH INDIAN SCHOOL, CHAMBERLAIN, SD

Father Cassedy - Lowell Thomas

Subject: Funding to use existing artesian well with 80°F for space heating in conjunction with groundwater heat pumps.

Prime Contractor for the school is:

Roby, Quintal, and Everson
321 W. 6th, Mitchell, SD 57301
Phone: 605/996-7543

14. MISSOURI BASIN MUNICIPAL POWER

Vic Simmons - Phone: 605/338-4042

Subject: Company is building office building heated by two-well geothermal heat system in Sioux Falls. Design consultant is DeWild, Grant, Reckert and Associates, 1113 E. 14th St., Sioux Falls, SD 57104.

15. ROB WHEELER

P.O. Box 629, Lemmon, SD 57638

Subject: Principal investigator for Lemmon geothermal project. State Team helped Mr. Wheeler obtain water right permits; obtained economic data for Lemmon from NMEI and advised of GLGP and WDAG programs. Lemmon decided to submit unsolicited proposal to DOE that was turned down.

16. ENERGY AGE

Marketing and Management Corporation
902 Mt. Rushmore Rd., Rapid City, SD 57701
Fred Hendrickson

Subject: Mr. Hendrickson requested and received information about the GLGP and User-coupled programs.

17. ROBERT PATTERSON

Philip, SD

Subject: Requested and received information about geothermal energy's role in a small alcohol plant operation.

UTAH GEOTHERMAL COMMERCIALIZATION PROJECT

SEMI-ANNUAL PROGRESS REPORT

JANUARY - JUNE 1980

Prepared by

Stanley Green

L. Ward Wagstaff

Douglas Nielsen

UTAH DIVISION OF WATER RIGHTS

Work Performed Under Contract No. DE-FC07-791012

U. S. Department of Energy

Idaho Operations Office

TABLE OF CONTENTS

Utah Geothermal Commercialization Project

Semi-annual Progress Report
July, 1980

1.0 Introduction

The Utah Geothermal Commercialization Project is part of a regional program funded primarily by the U.S. Department of Energy to provide support and planning information about geothermal development, and to perform outreach or marketing activities for geothermal use. In 1977, the Utah Division of Water Rights contracted with the DOE to perform these functions for Utah. Personnel working on the Utah project are Stanley Green, project supervisor; L. Ward Wagstaff, planning and technical analysis; and Douglas Nielsen, information and marketing specialist.

2.0 Specific Task Descriptions and Products

2.1 Geothermal Prospect Identification

During the first half of 1980, little new exploration for geothermal resources occurred. Several temperature gradient surveys in the southwest part of the state were planned by major exploration firms. No new production wells, either for electrical or direct use, were drilled in Utah during this period. Most of the activity has been associated with project development rather than exploration. Updated data on electrical prospects are presented in Table 1, and data on direct use projects are presented in Tables 2, 3, and 4.

Table 1

Geothermal Electrical Prospects

Prospect	Measured Temp. ^{o}C	Well Depth	Estimated Power Capacity	Notes
Roosevelt Hot Springs (proven)	265	365-2130 m (1200-7000 ft.)	300-500 MWe	20 MWe planned for about 1983, followed by 55 MWe plants. Phillips and UP&L in exclusive negotiations.
Thermo (potential)	177-205	2225 m (7300 ft.)	-	Well drilled by Republic in 1977. May be suitable for binary power system.

Table 2

Proven Direct Use Geothermal Prospects

(Verified by Drilling)

Prospect	Location	Temp °C	Well Depth, m.	TDS ppm	Notes
Monroe Hot Springs	Sec. 15, T25S, R3E; Sevier Co.	74	457	2800	Well drilled; project not commercial
Crystal Hot Springs	Sec. 11, T4S, R1W; Salt Lake Co.	93(1)	125(2)	1665(3)	Production well drilled by Utah Roses; Geological investigations planned by the State of Utah
Sandy City	Sec. 1, T3S, R1W; Salt Lake Co.		1527(4)	1120	Work proceeding to increase temperature and flow
Newcastle	Sec. 20, T36S, R15W; Iron Co.	96(5)	153		Two production wells drilled; in use this year
Beryl	Sec. 18, T34S, R16W; Iron Co.	149(6)	2134	low	Deep well reportedly producibly, but it is not currently in use
Cove Fort	Sec. 7, T25S, R6W; Sec. 33, T25S, R6W; Beaver and Millard Counties	173(7) 130(7)	2358 1691	9405(8) 10,000(8)	Two well, planned to be used for alcohol plant

(1) Reported temperature in Utah Roses production well.
(2) Depth of production well drilled by Utah Roses.
(3) TDS in spring (surface discharge).
(4) Deep well drilled by Utah Roses to 1527 m (5009 ft.)
(5) Temperature, depth of first well, and TDS from Goode, 1978.
(6) Temperature and depth of Beryl well from Goode, 1978. TDS reportedly low.
(7) Data on Union Wells #42-7 and #31-33 released through UURI.
(8) TDS data for Cove Fort well shows wide range of variation. Well #42-7: 4775 and 9405 ppm: Well #31-33 1320 and 10,000 ppm.

Table 3

Potential Prospects For Direct Utilization of Geothermal Resources[1]

Prospect	Location	Maximum Measured Temperature, °C
Wasatch Hot Springs	Sec. 25, T1N, R1W Salt Lake County	40[2]
Beck's Hot Springs	Sec. 14, T1N, R1W Salt Lake County	55[2]
Midway	T3S, R4E Wasatch County	46[3]
Udy (Belmont) Hot Springs	Sec. 23, T13N, R3W Box Elder County	45[2]
Crystal (Madsen's) Hot Springs	Sec. 29, T11N, R2W Box Elder County	60[2]
Utah Hot Springs	Sec. 14, T7N, R2W Weber County	59[2]
Ogden Hot Springs	Sec. 23, T6N, R1W Weber County	57[2]
Abraham (Baker) Hot Springs	Sec. 23, T6N, R1W Juab County	82[4]

1. Sites investigated by UGMS, including temperature gradient surveys.
2. Peter J. Murphy, UGMS
3. Kohler, 1979
4. Goode, 1978

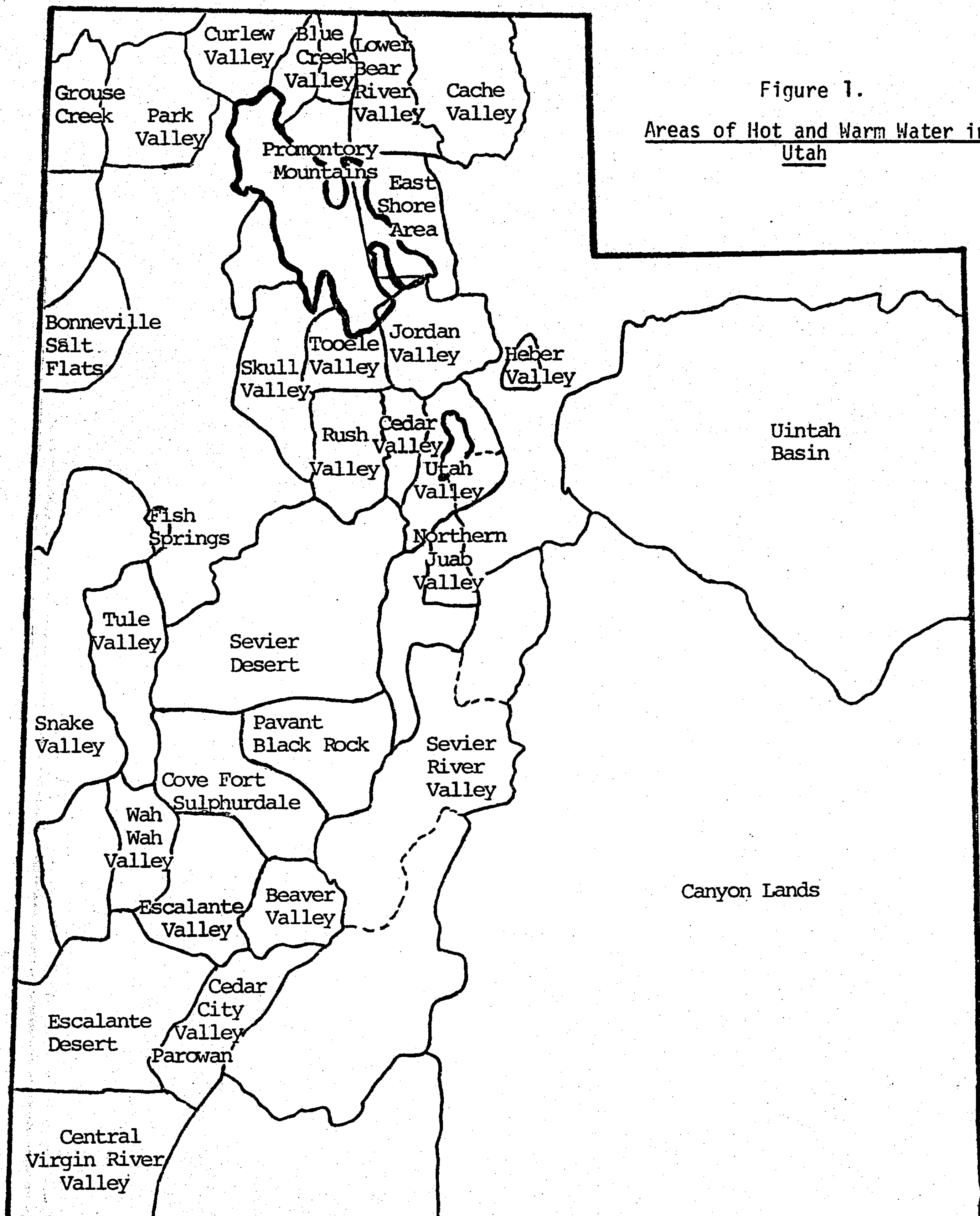
Development of Roosevelt Hot Springs has centered primarily around the signing of an agreement for exclusive negotiation between Phillips Petroleum Company and Utah Power & Light. The agreement does not mean that a contract has been signed, but does indicate serious interest in the project by the utility.

The Utah Roses well at Crystal Hot Springs was tested during the early part of the year. The well was pumped at 200 gpm and produced water at about 93° C.; recovery of the well back to artesian flow after pumping was about 90 seconds. The well will be in use during the coming heating season.

The Utah Roses well at Sandy has experienced difficulty in producing fluids at flows and temperatures sufficient to economically heat the greenhouse. Work on the well is continuing in efforts to produce adequate fluids and temperatures.

Figure 1.

Areas of Hot and Warm Water in Utah



From Goode, 1978.

Table 4

Areas of Inferred Direct Thermal Resources

Prospect	Maximum Recorded Water Temperature (°C)
Lower Bear River Area	105
Bonneville Salt Flats	88
Cove Fort - Sulphurdale	165
Curlew Valley	43
East Shore Area	62
Escalante Desert	149
Escalante Valley	85
Fish Springs	61
Grouse Creek	42
Heber Valley	44
Jordan Valley	93
Pavant Valley/Black Rock Desert	67
Sevier Desert	82
Sevier Valley	77
Utah Valley	46
Central Virgin River Basin	42
Uintah Basin	55
Beaver Valley	24
Blue Creek Valley	28
Cache Valley	49
Canyonlands	28
Cedar City and Parowan Valley	21
Cedar Valley	27
Northern Juab Valley	20
Park Valley	23
Promontory Mountains Area	25
Rush Valley	27
Skull Valley	24
Snake Valley	27
Tooele Valley	32
Tule Valley	28
Wah Wah Valley	29
Castilla Hot Springs	40
Como Warm Springs	25
Diamond Fork Warm Springs	20

Union well 42-7 at Cove Fort may be used as a production well for an alcohol plant by R&R Energies and Forminco Inc. Work was done on the well to plug back and perforate at about 1300 feet, a level at which the well produced an artesian flow. Results of the workover should soon be available. If the plugging and perforation operation is successful, the well would produce heat for a cascaded alcohol distillation/sulfur drying project.

A hot well drilled late in 1979 at Newcastle, Iron County, was used to heat greenhouses during the latter part of the 1979-80 heating season. The well produces exceptionally good quality water at boiling temperatures from shallow aquifers.

Several state geothermal leases were issued in the first part of 1980. Table 5 lists new state geothermal leases issued during this period.

2.2 Area Development Plans

2.2.1 State Geothermal Planning Areas

Area Development Plans (ADP's) are intended to match projected energy demand for a given area with the geothermal energy potential for that area. This matching of the resource with demand would give an estimate of the portion of energy demand which might be supplied by the geothermal resource. This information would then form the basis for further planning, indicate the sites which are the best candidates for development, and provide a marketing tool for county and regional agencies.

Table 5
New State Geothermal Leases
January - June 1980

COUNTY	SIZE, ACRES (No. of Leases)	LOCATION	DATE ISSUED
MILLARD			
Atlantic Richfield Co.	1275 (2)	T20S, R9W T21S, R9W	1/2/80
Jack J. Grynberg	160 (1)	T23S, R7W	1/2/80
IRON			
Technology International, Inc.	1448 (3)	T33S, R15W T34S, R17W	1/2/80

Table 6

Area Development Plans

Area	Counties
Jordan Valley	Salt Lake
Southwest Utah	Beaver, Iron, Washington
Sevier Valley	Piute, Sanpete, Sevier, Wayne
Northern Wasatch Front	Davis, Morgan, Weber
Utah Valley	Utah
West Central Utah	Juab, Millard
Northern Utah	Box Elder, Cache, Rich
Northern Mountainlands	Summit, Wasatch
Great Salt Lake Desert	Tooele

The first step in the ADP process was to divide the state into areas suitable for analysis. County lines were used as area boundaries, and counties were grouped according to existing multi-county planning districts. They were then further subdivided according to geographic and social characteristics, the size and nature of their economic base, and the nature of their geothermal resources. The planning areas for the ADP's are shown in Figure 2 and listed in Table 6.

2.2.2 Specific ADP's

Completed work on the Area Development Plans is summarized in Table 7. It shows projected residential energy demand for each area (for a breakdown of this data to single counties, see the Utah Semi-annual Progress Report for January, 1980). In the table, equivalent natural gas is the estimated amount of natural gas which would be consumed if natural gas were used in the home (some areas of Utah do not have natural gas service). Space and water heating data are derived from equivalent natural gas projections. Electricity projections are based on existing records for Utah; the assumption is implied that the dwellings are serviced by both electricity and natural gas. Industrial energy demand data was projected by the New

Figure 2
Substate Areas To Be Considered
In Area Development Plans
Utah

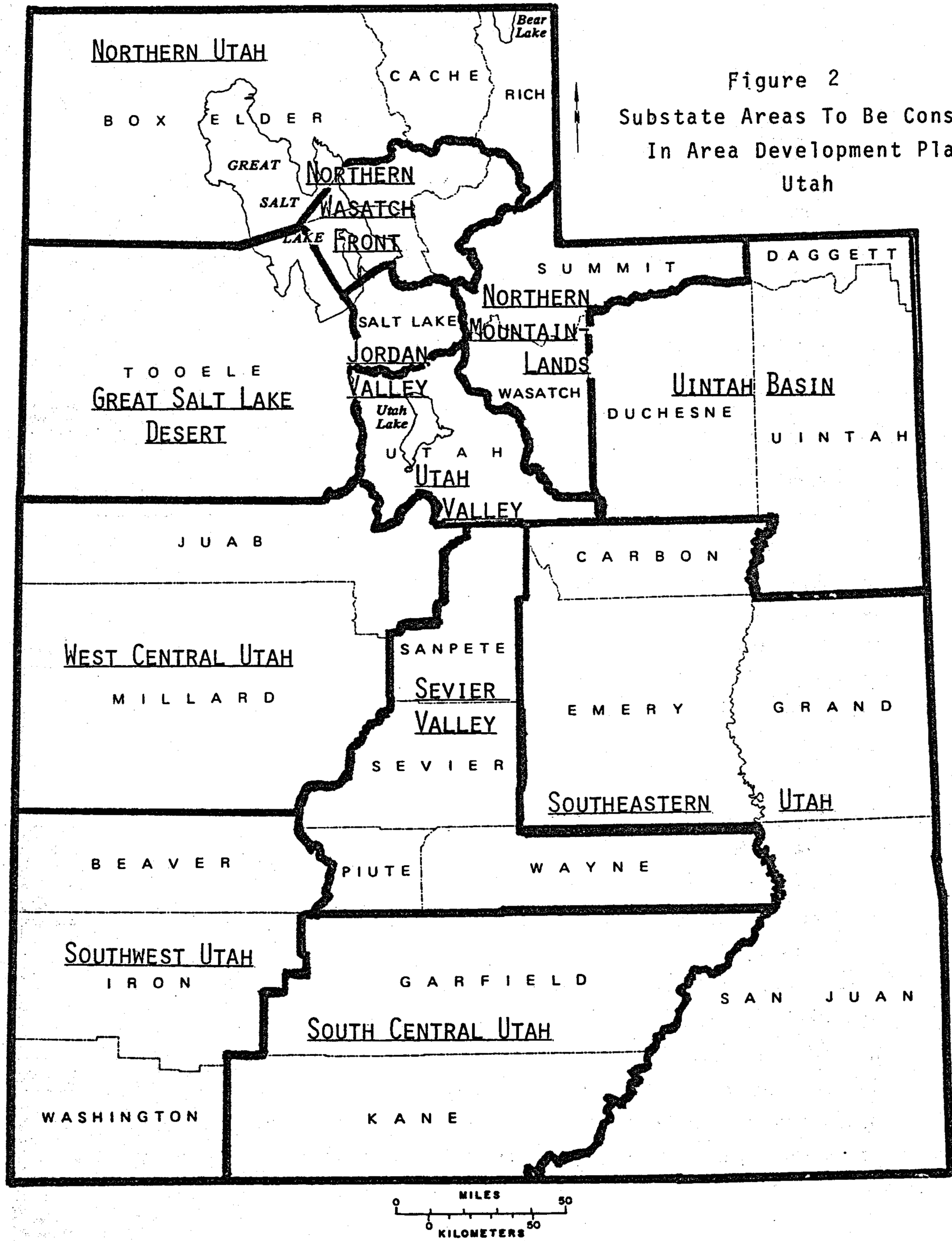


Table 7

Results of Area Development Plans
Projected Energy Use

Area	Residential Equivalent Natural Gas (10^3 Mcf)			Residential Electricity (Mkwh)			Industrial Energy Demand (10^{10} Btu's/year)	
	1980	2000	2020	1980	2000	2020	1979	2020
Jordan Valley	30,700	53,700	78,000	123,000	216,000	313,000	1017	1560
Southwest Utah	2,190	3,960	6,630	12,330	24,070	40,790	10.8	16.6
Sevier Valley	1,760	2,800	3,870	9,560	16,400	22,620	123.2	189.0
Northern Wester Front	13,900	24,300	35,300	45,300	80,000	116,300	407.8	625.6
Utah Valley	9,100	15,800	24,000	33,100	58,300	88,000	169.1	259.4
West Central Utah	800	1,300	1,800	4,100	7,000	9,600	39.9	61.3
Northern Utah	4,600	7,600	10,300	16,400	27,600	37,900	181.1	283.2
Northern Mountainlands	900	1,600	2,400	3,200	3,400	5,200	2.4	3.5
Great Salt Lake Desert	1,100	1,900	2,700	5,000	8,700	12,000	357.5	548.4

Natural Gas and Electricity data from utility records and population projections;
Industrial Energy from NMEI.

Mexico Energy Institute based on the 1979 Directory of Utah Manfacturing. The data generated for the ADP's should be considered more in a qualitative than a quantitative sense because of uncertainty in the data used to make the projections.

A number of occurences could vastly change the applicability of these projections. Massive energy projects, including the IPP project in Millard County, and other projects such as the MX system might drastically affect the distribution of population and industry within the state and especially within a given region.

2.3 Site Specific Development Analysis

Site Specific Development Analyses (SSDA's) are intended to portray various aspects of the development of a particular application at a specific geothermal resource site. In general, an analysis would consist of a step-by-step outline of development procedures, time frame estimates for expediential development, a preliminary analysis of the technical and economic feasibility of the project, and the identification of specific factors which might hinder or prohibit the successful completion of the project. SSDA's are more detailed and technical in nature than the Area Development Plans, and offer more insight into the real development potential and problems at a given site.

2.3.1 Candidate Geothermal Sites and Applications

Proven or potential resource sites may be candidates for SSDA's. These are sites where test drilling to confirm the resource has taken place ("proven" sites), or where some subsurface data are available ("potential" sites). Candidate sites for SSDA's are listed in Table 8. Two categories are listed - - sites where specific projects are already underway, and sites which appear to be good prospects for development but for which no specific plans have been announced.

2.3.2 Site Specific Development Plans: Completed and in Preparation

During the first half of 1980 two types of site-specific analyses were done. One was preliminary run of several Utah sites using the BTHERM model at New Mexico State University, and the other was a cooperative study with Salt Lake City on the use of heat pumps for a large redevelopment project in downtown Salt Lake City.

Table 8

Candidate Sites for
Site Specific Development Analyses

Planned Developments	Other Promising Sites
Crystal Springs - Space Heating	Beck's Hot Springs
Crystal Springs - Greenhouses	Wasatch Hot Springs
Udy Hot Springs - District Heating	Utah Hot Springs
Cove Fort - Alcohol Plant	Ogden Hot Springs
Newcastle - Greenhouses	Hooper Hot Springs
Abraham Hot Springs - Recreation & Aquaculture	Midway
	Beryl
	Thermo

BTHERM Models for Selected Utah Geothermal Sites

The following site analyses were run using the BTHERM direct use computer model developed by the Physical Science Lab at New Mexico State University. The model is very complex, and in general the results of each analysis are heavily dependent on certain of the input assumptions. Because a tabulation of the result data would be quite extensive, the results are summarized below; tabulated lists of the complete input assumptions are found in the Appendix.

Subdivision in Sandy, Utah: Following the drilling of the 5009 ft. well at Sandy City by the DOE and Utah Roses, Inc., owners of a large parcel of land adjacent to the Utah Roses property approached the State commercialization team about the feasibility of drilling wells similar to the Utah Roses well to be used for district heating. The Utah Roses well originally cost \$300,000. The BTHERM analysis showed that if a well, drilled for \$300,000, could produce 70° C (158° F) water at 500 gpm, the cost of the geothermal heat would be less than that of natural gas (\$2.45/MBtu for geothermal, \$2.56 for natural gas). If the well cost were \$500,000, the cost of the geothermal heat would be \$3.49/MBtu; if the well cost were \$400,000, it would be \$2.96/MBtu. The analysis showed almost immediate feasibility under ideal conditions. However, later tests of the Utah Roses well have shown that it is probably not capable of producing the assumed flows and temperatures.

Logan and North Logan, Utah: Water wells in the city of North Logan and in the northern part of Logan City have shown indications of elevated temperatures at depth. A preliminary analysis using the BTHERM model assumed temperatures of 60° C (140° F) were attainable at depths of 610 m (2000 ft.). For a private development, the geothermal heat was projected to cost $2.43/MBtu, less than the $2.56/MBtu of natural gas. For a municipal development, the cost was projected to be $3.30/MBtu, the higher cost for a municipalities apparently are due to management costs, inability to utilize tax credits, and similar constraints peculiar to municipalities. If the private developer could obtain 25% funding from outside sources, the cost of geothermal heat would be $1.98/MBtu; if the city obtained 25% outside funding, the cost would be $2.83/MBtu, with an economical on-line date of 1984 (including 3 years of development). If the temperature at 2000 ft. were only 45° C (113° F), the cost of geothermal heat would be raised considerably, to $4.29/MBtu.

Beryl/Escalante Desert: A hypothetical case of a geothermal development in southern Utah was run using well characteristics similar to an existing well drilled by McCulloch in 1977. Temperatures of 150° C (302° F) at depths of 2134 m. (7000 ft.) and flows of 1000 gpm were inputted assumptions. A price of alternative fuel of $6.30 for electricity was assumed. The results of the modeling indicated a cost of geothermal energy of $9.08/MBtu, compared with a price of alternative fuel of $6.03; the model indicated that the development would be economical almost immediately. Why the project was economical even though the price of geothermal energy was higher than the alternative energy is not clear, but it is probably due to complex interactions between the variables within the model. More complete data on the BTHERM models, including tabulation of the input assumptions, are found in the Appendices.

Block 53 Redevelopment: Heat Pump Analysis

Block 53 is located in downtown Salt Lake City near the south end of the main commercial district. Presently the block is occupied by several businesses, with most of the block used as parking space. The planned redevelopment of the block would include a state office building, a city office building, several private and commercial office buildings, and eventually a set of high-rise condominiums. The state geothermal commercialization staff agreed to assist the city with an analysis of a geothermal heat pump district heating system. The focus of the analysis was the projected economic feasibility of the heat pump system as compared with a conventional natural gas/chiller system.

The approach used by the state team was to analyze the proposed buildings to determine a projected heating and cooling loads; to estimate, using local cost information, the cost of wells, heat pumps, and the associated operating costs for the heat pump system; to estimate the cost of boilers, chillers, and the associated natural gas and electricity for the conventional system; and to compare costs on an annual basis over the projected life of the project.

Table 9 summarizes the important input assumptions for the analysis. Table 10 summarizes the results of the economic analysis. As can be seen, the heat pump system is only marginally competitive with natural gas over the estimated life of the equipment (20 years). A major factor is apparently the low cost of natural gas in northern Utah. A graphic comparison is made with natural gas prices from Idaho, which are approximately 2 1/2 times the Utah prices; under such circumstances, the heat pump system is very economical. A lower bond rate or a two well system would accelerate the payback on the system, but not significantly. On the other hand, if existing wells or other ground-water sources were used, the heat pump system would be economical from the start.

Although the results of this analysis are heavily dependent on the specific assumptions used, the results obtained here do indicate a slight economic advantage to the heat pump system, even with the low natural gas prices in Utah. They also indicate a strong economic advantage in areas outside natural gas service areas or where existing wells may be used.

2.4 Time Phased Project Plans

Time Phased Project Plans (TPPP's) are intended to be a detailed analysis of a specific development at a particular site, with emphasis on the specific development steps, the sequence in which they occur, and estimates of when each step will begin and end. The project is followed through all stages of development, including pre-lease activities, leasing, exploration, reservoir testing and development, developer and market negotiations, permitting, plant construction, and distribution system construction. The TPPP should provide a basis for recommendations of actions which would facilitate the development.

2.4.1 Active Demonstration/Commercialization Projects

Active geothermal projects in Utah are candidates for TPPP's and are

Table 9

Basic Assumptions
Block 53 Heat Pump Analysis

Total Floor Space		732,000 ft^2
Design Heating Load		8.09×10^6 Btuh
Design Cooling Load		14.94×10^6 Btuh
Annual Heating Load		14.52×10^9 Btu
Annual Cooling Load		19.54×10^9 Btu
Design Temperatures:	Summer, inside	78^o F
	Summer, outside	95^o F
	Winter, inside	65^o F
	Winter, outside	5^o F

Costs:	
Heat Pumps	$376,200
Heat Pumps, Annual Operation (cooling)	78,700
Heat Pumps, Annual Operation (heating)	49,100
Wells and Piping plus 30%	396,300
Annual Pumping Cost	17,400
Boilers	72,200
Chillers	311,400
Cooling Towers	41,400
Annual Cooling Cost (electricity)	104,200
Annual Heating Cost (natural gas)	42,400

Summary:	
Heat Pump System, Capital Cost	$772,800
Heat Pump System, Operating Cost	145,200
Conventional System, Capital Cost	424,900
Conventional System, Operating Cost	146,600

Wells: 4 wells, 700 ft. deep, 20 in. diameter, at $90/ft.

Table 10

Summary of Results

Block 53 Heat Pump Heating District

Description	Initial Cost Difference	Net Present Value (20 Year)	Payback (Prior to Year)	Benefit/Cost Ratio (20 Year)
Basic Case	347,900	-60,100	23	0.83
Natural gas at Idaho prices	347,900	1,313,700	5	4.78
Bond Rate of 8%	347,900	17,900	20	1.05
No Condominiums, 2 well system	176,500	-11,300	21	0.94
No Initial Well Cost	-48,700	336,500	From Start	----

described in Table 11. Although few new projects have actually gotten under way during the first part of 1980, significant progress has been made on several of the projects. The initial set of Utah Roses greenhouses at Crystal Hot Springs are constructed and under cultivation; greenhouses at Newcastle were heated from a geothermal well by early this spring. Crystal Springs at Honeyville is actively advertising their new swimming pools and resort facilities.

One unfortunate development during this time was the suspension of the Monroe City district heating project. When the production well was drilled, the fluids encountered were at lower temperatures and substantially lower quantities than had been expected. Part of the reason for the misleading energy estimates has been cited by David S. Chapman as being convective heat transfer, which caused heat flow calculations based on a conductive model to be misleading. DOE and Monroe City officials agreed to suspend the project because the operating costs of the geothermal heating system would be higher than those for a coal heating system. Other areas of difficulty for the project were inadequate fluid production from the well, rising construction and equipment costs, and an expensive disposal system. Other uses for the geothermal well are being investigated.

2.4.2 Time Phased Project Plans

A Time Phased Project Plan for Roosevelt Hot Springs was completed by the Utah geothermal commercialization project in July, 1979. During the latter

Table 11

Active Geothermal Projects

Site (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 234×10^9 Btu's/yr.	A hot and a cold (irrigation) well have been drilled, 70,000 ft^2 of greenhouses have been constructed and planted, with more to be constructed later.
Crystal Hot Springs (State of Utah)	Space Heating	Probably similar to Utah Roses well	Initial phase, minimum security building, 10.9×10^9 Btu's/yr. Possible eventual development to 55.7×10^9 Btu's/yr.	Geophysical studies have been completed and analysed. Bids for drilling of two deep observation holes are out.
Sandy City (Utah Roses)	Greenhouses	1527 m well with slight flow; bottom hole temp. 75° C, temp. at surface around 50° C.	Greenhouse conversion from natural gas, about 70.0×10^9 Btu's/yr.	Deep production well drilled. Difficulties in producing required amounts at higher temperatures.
Newcastle (Christensen Bros.)	Greenhouses	Two wells: 152 m well producing at 96° D, 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, 4.5×10^9 Btu's/yr.	Flow and temperatures were much lower than expected; project has been suspended.

Table 11

Active Geothermal Projects

Page 2

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 are planned.	The resort is undergoing major renovations; work is scheduled to continue several years.
Midway (Several Individuals)	Space Heating (Homes)	Maximum measured temp. 46° C. Generalized 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 x 10^6 gal alcohol production.	

part of 1979, a unit agreement was signed between Phillips Petroleum Co. and the ATO Consortium (AMAX Exploration, Inc., Thermal Power Company, and O'Brien Resources Corp). During the early part of 1980, Phillips submitted proposals to a number of potential plant operators and power customers. At present, Phillips and Utah Power and Light have signed an agreement for exclusive negotiations, and are rumored to be very close to a contract agreement. Development plans still include a 20 MWe pilot plant, probably on-line about 1983.

2.5 State Aggregations of Prospective Geothermal Aggregations

Using information supplied by the Utah team, the Physical Science Lab at New Mexico State University made projections for economical geothermal energy use to the year 2020. These data are summarized in Table 12 and Figure 3. More complete data are found in the Appendices.

The results indicate the year in which geothermal energy at a specific site becomes price competitive with the specified cheapest alternative fuel for the area, and do not account for institutional, social, or economic factors which might arise (most of which are impossible to predict). Updated information on resources and development in Utah was given to the Physical Science Lab during on interactive session with state team personnel in February, but those data have not yet been incorporated into new aggregations.

2.6 Institutional Analysis

Geothermal legislation is badly needed in Utah. The existing law simply assigns regulatory authority for geothermal development to the Division of Water Rights. The legislation is lacking a definition of the resource, clarification of the water/mineral conflict, definition of ownership, and guidelines for regulation, particularly in unitization.

Legislation designed to meet these needs was submitted late in the 1979 session, but was not passed. The legislation was reintroduced into the 1980 session, where it met with stiff opposition from Utah Power & Light, and was again not passed. The legislation will probably be reintroduced to the 1981 session; it is hoped that the opposition to the bill will be reduced by UP&L's agreement with Phillips.

Other areas which should be addressed by legislation are the authority of municipalities and counties to form heating districts or power distribution

Table 12

Aggregated Geothermal Energy
(10^{10} Btu)

With Private Developer	1980	1990	2000	2010	2020
Residential (total)	0.15	11.0	32.8	48.8	64.1
Industrial (total)	0.15	7.79	19.2	26.7	33.2
Combined (potential)	0.00	4.6	9.6	12.7	14.9
Combined (inferred)	0.00	13.9	42.1	62.5	82.1
Combined (total)	0.15	18.7	51.8	75.3	96.2
With City Utility					
Residential (total)	0.15	22.7	42.2	59.5	72.6
Industrial (total)	0.15	15.9	23.9	32.5	35.6
Combined (potential)	0.00	7.3	11.3	14.0	15.4
Combined (inferred)	0.00	31.1	54.5	77.7	92.5
Combined (total)	0.15	38.5	65.9	91.8	107.9

Note: "Potential" and "inferred" refer to classification of the resource (see text). "Total" includes potential and inferred sites plus assumed 1.54×10^{10} Btu already on-line.

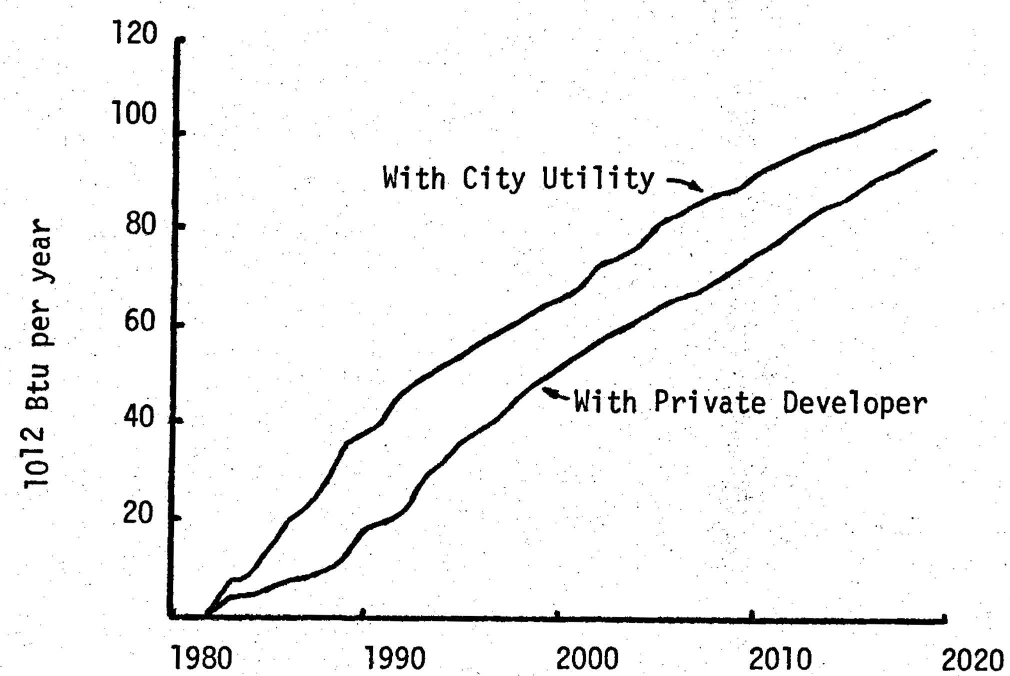


Figure 3. Projected economic geothermal energy for combined residential and industrial uses, including proven, potential, and inferred resources. From New Mexico Energy Institute, December, 1979.

districts, and tax incentives for geothermal developers (particularly direct users).

The institutional handbook is at present partially complete and should be complete by early fall.

Several institutional issues have arisen the last few months which should be mentioned. One is the problem of disposal, either by surface discharge or reinjection. Because of stringent EPA standards, surface disposal, even for short-term tests, will or nearly be impossible. Reinjection also will probably be restricted to specific sites approved by the state Division of Environmental Health and the Division of Water Rights. In some cases the reinjection restrictions will pose no problem to the developer, but in some cases, such as at Monroe City, it could have a major impact on the economics of the project.

2.7 Public Outreach Program

2.7.1 Outreach Mechanisms

The Outreach program consists of several component activites. One of these is basic public education; another would be more specific information service in response to requests from individuals, governmental agencies, researchers, geothermal companies, and government contractors; a third would be technical assistance to prospective users; a fourth would be marketing, an active effort to reach prospective industrial, private, and public users, both directly and through appropriate state and local agencies; and a fifth would be assistance in preparing proposed geothermal legislation.

The Utah Outreach program has been directed and coordinated by Douglas Nielsen. Specifically, some of the Outreach activities of the first part of 1980 included the following:

- Legislation: Stanley Green, the State team leader, acted in an advisory and coordinating role in drafting and submitting geothermal legislation.

- Newsletter: Under the direction of Douglas Nielsen, the project has established a monthly newsletter, the "Utah Water/Geothermal Report" which contains items pertaining to both water and geothermal resources in the state.

- Display: Also under the direction of Mr. Nielsen, the project contracted with a private firm to fabricate a geothermal display. The display, entitled "Utah's Geothermal Energy", briefly acquaints the viewer with geothermal resources and development in the state.

- Information Sheets and Pamphlets: The project has put together several brief information sheets dealing with subjects such as heat pumps and geothermal use, which are for distribution at displays, energy fairs, etc..

- Energy Fairs: The state team has participated in several energy fairs in Utah during this period, using photos, pamphlets and slide shows.

Plans for upcoming activities include the following:

- County Fairs: The state team has arranged for display space at several county fairs during the month of August. The display, slide presentations, and hand-out pamphlets will be used.

- Local and Industrial Contacts: In conjunction with the county fairs, state team members plan to meet with local officials and appropriate industry representatives to discuss the potential of geothermal resource use.

- New Industry Contacts: The state team has initiated contacts with some state and local industrial promotion agencies, and plans to expand the contacts in order to make new industries aware of the geothermal potential in Utah.

- Pamphlets: Pamphlets are in preparation which will deal with several subjects pertinent to geothermal development.

- Use of Site Specific Studies: The state team plans to increase the use of results of site specific studies in contacts with industrial and public officials. It is hoped that the state team can make use of the results of computer modeling by NMEI to demonstrate the potential of specific geothermal sites for development to those directly involved.

2.7.2 Summary of Contacts and Results

A detailed description of outreach activities by the Utah Geothermal Commercialization Project is beyond the scope of this report. Contacts listed in previous reports will also not be repeated in this report. A few significant project contacts will be summarized however.

The State team has continued to interact with ongoing projects, such as the Monroe City Project, the State Prison project, the Utah Roses projects, and the alcohol plant at Cove Fort Sulphurdale. The state team has also been contacted by several new users, including developers of a recreation/greenhouse/agriculture project at Abraham Hot Springs. Contacts have also been established with geothermal projects already in operation, such as resorts at Veyo, LaVerkin, Honeyville, and Belmont, greenhouses at Arrowhead (Utah Valley) and Newcastle, and space heating projects in Heber Valley. A number of local and state agencies have also been contacted, and plans have been made to meet with several groups of officials in the Fall.

2.7.3 Overall Prospectus for Future Geothermal Commercialization

The electrical project at Roosevelt Hot Springs is probably closer to real development than at any other time. The negotiation agreement between Phillips and Utah Power & Light indicates definite progress towards a contractual agreement for power plant construction and the sale of the power. If Phillips and Utah Power & Light can come to a timely agreement, the initial 20 MWe plant may still be on-line by 1982 or 1983.

As mentioned earlier, the projects at Crystal Hot Springs (Utah Roses) and Newcastle (Christensen Brothers) are both ready to put geothermal energy on-line. The alcohol distillation plant at Cove Fort - Sulphurdale moved closer to reality with financial negotiations and the testing of the well.

A number of other projects appear to be getting underway. Even though there have been some setbacks, such as the suspension of the Monroe City Project, Union Oil's withdrawal from Cove Fort, and disappointing exploration results at Hill Air Force Base, the successes of the various other geothermal projects make for a development outlook that is definitely positive.

3.0 Summary of Major Findings and Recommendations

Some of the recommendations of the Utah Geothermal Commercialization Project have not changed from previous reports. Summaries of some of the more important recommendations are included here.

- Geothermal Legislation for Utah should be passed. The legislation should define geothermal resources in terms compatible with nature and with other standard definitions (such as the federal definition) and such that electrical and direct use development will be facilitated; it should clarify ownership of the resource; it should clarify regulatory authority of the State Engineer and provide guidelines where necessary; it should clarify the relationship between geothermal resources and water in such a way as to facilitate development of both high and low temperature resources; it should define and clarify the relationship between geothermal rights, water rights, and correlative (property) rights; and it should clarify and specify the authority of the State Engineer to unitize. Legislation is also needed which would specifically authorize local government to establish geothermal or other district heating systems, remove small distributors of direct heat resources from regulation by the Public Service Commission, and provide proper tax incentives for direct users.

- The state should carefully consider guidelines for disposal of spent fluids, both by surface discharge and by reinjection. Such guidelines should apply to direct use and heat pump applications. The guidelines should reconcile environmental, hydrologic, and statutory requirements in a reasonable and economic way. A number of policy issues need to be resolved, particularly certain ones associated with direct use and heat pump application. Some of these guidelines will be the results of the experience with specific cases, but it would be unfortunate if unnecessarily restrictive disposal requirements were applied to future projects.

- The Utah Geothermal Commercialization program should be continued at a level of activity and funding at least as high as at present. The program provides important services and information which are not available from any other source. If federal funding were cut completely, it is very unlikely that the State would pick up the program to the extent of keeping these services and information available.

WYOMING GEOTHERMAL COMMERCIALIZATION OFFICE

SEMI-ANNUAL PROGRESS REPORT

January 1 to June 30, 1980

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1.0 INTRODUCTION

The University of Wyoming in cooperative agreement with the United States Department of Energy began the Wyoming Geothermal Commercialization and Utilization Program in December of 1978. The program evolved to become the Wyoming Geothermal Commercialization Program which is administered by the Wyoming Geothermal Commercialization Office (GCO). The GCO is located on the campus of the University of Wyoming in Laramie.

The purpose of the Wyoming Geothermal Commercialization Program is to match geothermal resources with potential users and applications. The program also is a clearing house of geothermal development information and a link to Wyoming geothermal resource data.

The objectives of the GCO are: (1) To bring about a general understanding and use of geothermal energy in Wyoming. (2) To create a working relationship with other agencies involved in geothermal development; both state and federal and contribute to the accomplishment of national geothermal energy goals of the United States Department of Energy. (3) To develop usable plans to predict and encourage geothermal development over the next 40 years. (4) To maintain regional ties with other states. (5) To assess the institutional barriers and intentions to development of geothermal energy.

The GCO approach is primarily a planning and advocacy effort. The office in cooperation with state agencies, businesses and concerned citizen groups uses a variety of publications and information sources to develop an awareness of geothermal energy. Additionally the specific development plans provide a general view of the future for geothermal energy in Wyoming

2.0 SPECIFIC TASK DESCRIPTIONS AND PRODUCTS

2.1 Prospect Identification

A preliminary report (supported by this office) on "Hydrothermal Resources in Wyoming" (Decker 1980), involved studies of indicated low-temperature resource areas, compilations of regional geothermal data, and synthesis of pertinent geology and geophysics. Compilations of geothermal data directly followed bottom hole temperatures in oil wells and measurements of temperatures in more than 100 drill holes.

Areas investigated with indicated low-temperature resources were Thermopolis, the Cody Horse-Center Anticline System, the Casper-Midwest area, the Gas Hills area, the Saratoga Valley system, the Big Horn Basin, the Wyoming Basin, and the Powder River Basin.

In addition, hydrothermal resource information was supplied by Amoco Oil for some of its wells in the Midwest area which are currently being utilized for oil extraction.

Table 2.1

Proven Resources	Temperature (C°)	Depth (meters)
Midwest	49°-77°	300-1400
Casper area		
Emmigrant Gap	32°-47°	410-470
Airport	95°	885
Thermopolis	32°-70°	600
Cody	38°-48°	185-500
Potential Resources	Temperature (C°)	Depth (meters)
Thermopolis	60°	1150
Countryman Well	50°	1500
Saratoga Hot Spring	85°	910
Auburn Hot Spring	130°	1500
Little Sheep	85°	1200
Fort Washakie	100°	760
Astoria Spring	70°	600
Inferred Resources		
Red Springs Anticline	60°	1200-1300
Rattlesnake Anticline	60°	300

2.2 Specific ADP's

Converse/Natrona (in press)

The Converse-Natrona region is characterized by a vast source of potential geothermal waters in the Madison Limestone, which underlies much of the region. Use of these waters is restricted however, due to factors of temperature and depth. Temperature of underground waters in this area is not hot enough for electrical development and is consequently restricted to low-temperature utilization such as commercial space heating, aquaculture, greenhouse or residential heating. Cost of development will be influenced by depth to the Madison Formation, which in some locations is as much as 4850 meters below the ground surface. In other locations, such as the Midwest-Edgerton and Douglas-Glenrock areas, the resource is close enough to the surface to make its utilization economically feasible. Drilling costs in the Midwest area were recently estimated to be $432,000 for a well with casing to reach the top of the Madison formation at 1450 meters.

Midwest Area

The Midwest area probably has the greatest potential for immediate and successful development due to proven resource information and interest on the part of local concerns to make use of the geothermal sources. Wells in the immediate vicinity have recorded temperatures of 49° to 78° C at 300 to 1300 meters, with maximum calculated gradients between 4° and 38° per 300 meters. Water injection wells that penetrate the Madison Formation produce 71° to 80° waters that flow to the surface at rates exceeding 7000 gpm (Decker 1980).

Due mainly to restrictions caused by relatively low temperatures and the economics of the region, one of the most effective uses of the geothermal waters would be in the space heating of buildings, which would include residential, commercial and industrial applications. Large amounts of hot water issuing from the Madison are presently being used in secondary oil recovery operations at the Salt Creek Oil Field. Three wells with a combined flow of 7800 gpm, at temperatures of 81°C are being used. The hot Madison wells are approximately 1360 meters deep.

Other direct uses are being planned for development in the area of Midwest and Edgerton. A private developer is planning a small greenhouse complex cascading to an aquacultural facility 3 miles from Midwest using 85° C waters. In addition, another developer is planning to build a small industrial park in conjunction with the town of Midwest which owns a well producing 71°C water at 500 gpm. District heating systems for the towns of Midwest and Edgerton have also been proposed with a great deal of public interest. Major impedences to development may be the percent relative cost of hydrocarbon versus geothermal resources, possible high concentrations of solids, and questions of ownership rights in regard to the geothermal water. (Commercial development is presently stalled until ownership rights are settled. Amoco Oil claims prior use rights to the water as groundwater, however there is some question within Wyoming Statutes whether geothermal waters are groundwater or a mineral. As a consequence of this situation, cooperation of Amoco officials seems to be waning while local interest in development is maintained.)

2.3 Site Specific Development Plans

2.3.1 Candidate Geothermal Sites/Applications

None

2.3.2 Site Specific Development Plans - Completed or in Preparation

A. Midwest/Edgerton (inpreparation)

A Site Specific Development Plan for the Midwest region will be completed within 6 months. This SSDP will also include the neighboring town of Edgerton, as well as some industrial park applications for the resource. Specific data will be provided by the GCO to various organizations specializing in geothermal economic analysis. It is hoped that cost studies will then be generated that more accurately describe the physical and economic realities of the Midwest region.

Preliminary economic analysis has been conducted for the proposed geothermal district heating system for Midwest by the Physical Science Laboratory of the New Mexico Energy Institute (PSL-MNEI) and by EG & G Idaho.

INSTALLATION OF SUPPLY, DISTRIBUTION AND DISPOSAL SYSTEMS TO PROVIDE GEOTHERMAL SPACE HEATING IN MIDWEST AND EDGERTON, WYOMING (A PRELIMINARY COST ESTIMATE)

ASSUMPTIONS FOR PRELIMINARY COST ESTIMATES

ITEM	MIDWEST	EDGERTON
Population	750	600
Single Family Residences (1000 ft^2)	340	270
Businesses (2000 ft2)	10	5
Residential Design Heat Load	65,000 BTU/HR	65,000 BTU/HR
Business Design Heat Load	160,000 BTU/HR	160,000 BTU/HR
Total Design Heat Load	2.37×10^7 BTU/HR	1.835×10^7 BTU/HR
Annual Heat Load	5.25×10^{10} BTU	4.125×10^{10} BTU
Peak Geothermal Flow	1,860 gpm	1,460 gpm
Present Annual Fuel Cost		
Each Residence	$700	$700
Each Business	$1200	$1200
Estimated Annual Fuel Savings (Natural Gas @ $3.40/MMBTU)	$250,000	$195,000

PRELIMINARY COST ESTIMATES

Cost Element ($)	Midwest Steel Supply	Midwest ASM-CEM	Edgerton Steel Supply	Edgerton ASM-CEM
Supply	246,000	110,000	234,000	105,000
Distribution ($1,000/unit)	350,000	350,000	275,000	275,000
Sub Total	596,000	460,000	509,000	380,000
Disposal	200,000	200,000	200,000	200,000
Sub Total	796,000	660,000	709,000	580,000
Retrofit ($2,000/unit)	700,000	700,000	550,000	550,000
Project Total	$1,496,000	$1,360,000	$1,259,000	$1,130,000
Annual Costs ($)				
O&M, Supply, Distribution	19,000	16,000	16,000	14,000
O&M, Disposal	7,000	7,000	7,000	7,000
Amortization of Capital Costs				
Supply Distribution:				
1. 10%, 20 yrs (.1175)	70,000	54,050	59,808	44,650
2. 16%, 20 yrs. (.1687)	100,000	77,602	85,868	64,106
Disposal:				
1. 10%, 20 yrs (.1175)	23,600			
2. 16%, 20 yrs (.1687)	33,800			
Retrofit:				
1. 10%, 20 yrs (.1175)	82,250	82,250	64,625	64,625
2. 16%, 20 yrs (.1687)	118,090	118,090	92,785	92,785

Using data from the table above, and assuming the "worst-case" costs (disposal by injection well, steel supply pipe, 16% interest on borrowed money), the total capital and annual costs are about:

	Midwest	Edgerton	Total
Capital	$1,500,000	$1,260,000	$2,760,000
Annual	278,000	235,000	513,000

Assuming the "best-case" costs (0 disposal cost, asbestos-cement supply pipe, 10% interest), capital and annual costs are approximately:

	Midwest	Edgerton	Total
Capital	$1,160,000	930,000	$2,090,000
Annual	175,000	130,000	305,000

Comparison of these annual costs with the estimated annual fuel cost savings ($445,000) show the "worst-case" estimate to exceed annual fuel savings by about 12%; the "best-case" estimate is less than the savings by about 30%. In view of rapidly escalating fossil fuel costs, this preliminary analysis indicates a high probability that a more detailed assessment will also show geothermal space heating can be an economically attractive alternative to the present use of natural gas.

The foregoing development of costs is based on minimal information and should be viewed as a preliminary estimate only. A more detailed development may alter the results significantly, however, based on available information the estimated costs are believed to be reasonable by the author of the above tables.

Source: I. A. Engen, Marketing assistance, EG&G of Idaho, Ind., March, 1980.

MIDWEST DISTRICT HEATING SYSTEM (CASE 1)

INVESTMENT COSTS

CATEGORY	NET PRESENT VALUE (1980-2010) DISCOUNTED AT COST OF CAPITAL
Research Investment	$ 71,413
Design	115,589
Management Fee	0
Wells	5,112
Transmission	149,709
Distribution:	
Residential Retrofit	383,726
Residential Hookup	133,328
Commercial Conversion	27,023
Industrial Conversion	0
Heat Exchangers	50,825
Central Systems	621,382
Total	$1,558,109

Price per MMBTU: $4.08

Year on line: 1982

MIDWEST DISTRICT HEATING SYSTEM (CASE 2)

INVESTMENT COSTS

CATEGORY	NET PRESENT VALUE (1980-]010) DISCOUNTED AT COST OF CAPITAL
Research Investment	$ 79,200
Design	131,268
Management Fee	0
Wells	14,500
Transmission	143,866
Distribution:	
Residential Retrofit	368,750
Residential Hookup	128,125
Commercial Conversion	25,969
Industrial Conversion	0
Heat Exchangers	48,842
Central System	597,131
Total	$1,537,651

Price per MMBTU: $4.22

Year on Line: 1982

Source: NMEI printout from BTHERM computer model, May 1980.

COST AND BENEFIT SUMMARY (1980-2010), DISCOUNTED

Federal Factors:	Fed. Tax	Tax Credit	Royalty
	$125,929	$308,390	$179,611
State Factors:	State Tax	Sales Tax	Property Tax
	$0	$29,125	$135,086
Net Savings Through Year:	1990	2000	2010
	$357,000	$1,041,000	$1,641,000

EVALUATION OF INVESTMENT (NET PRESENT VALUE)

Investors Return on Investment:	$586,319
Equity Investment:	$366,238
Equipty Portion:	0.3
Economic Judgement:	$220,081
Ration of Rate of Return to Investment:	1.6
Investors Break-Even Year:	1990
Total Project Break-Even Year:	2000

Price of Geothermal: $4.08MMBTU

Price of Natural Gas: $3.80/MMBTU

Year on Line: 1982

Required Flow Rate

Available Flow	5000 gpm
Required Flow Rate:	359 gpm
Spare Flow Rate:	4641 gpm

Source: NMEI printout from BTHERM Computer Model, May 1980.

B. East Thermopolis (in preparation)

Proposed uses of geothermal waters in the Thermopolis area include:

--a commercial greenhouse for one of the private wells; tomatoes would be the major crop; an Appropriate Technology Small Grant has been applied for to pay for developmental investment costs

--a small scale ethanol production plant for an existing well and an Appropriate Technology Grant applied for; this plant would use geothermal water, heat pumps and passive solar as the energy source; river moss from the bottom of the Big Horn River is the proposed raw material; a water-powered paddlewheel would be utilized to acquire the moss

--a geothermally heated fish farm for the region is in the early stages of the planning process

--a district heating system; the major factor holding this development back is the uncertainties remaining in regard to the reservoir characteristics; thus far, no one has been able to predict with any certainty what effect well drilling and large scale development would have on the temperature and flow rates of the springs in the State Park; preliminary marketing estimates by the NMEI indicate that geothermal energy would be cost effective in this region by 1983.

2.4 Time Phased Project Plans

None

2.5 State Aggregation of Prospective Geothermal Utilization

ADPS	1980 Bil BTU/yr	1985 Bil BTU/yr	2000 Bil BTU/yr	2020 Bil BTU/yr
Big Horn Basin	10	50	100	165
Fremont County	20	35	60	100
Conserse/Natrona	0	2250	3000	5000
Carbon Albany	0	15	45	60
Powder River Basin	15	25	60	88
Western	15	25	50	75
South Eastern	0	5	10	10
North Eastern	10	25	40	60
South Western	0	0	5	10
TOTAL ADPs	70	2430	3420	5568
SSDPs				
Thermop. Dist. Heat	0	25	45	75
Midwest Dist. Heat	0	50	70	100
Midwest Ind. Pk.	0	1300	2930	4900
Countryman Well	0	20	40	40
Saratoga Dist. Heat	0	15	45	60
Auburn Agribusiness	0	10	60	75
TOTAL SSDPs	0	1420	3190	5250

2.6 Institutional Analysis

Development of geothermal resources in Wyoming is regulated by federal and state regulations and agencies. Because approximately half of Wyoming's lands are federally managed, federal leasing agencies play an important role in geothermal development. Primarily concerned are the BLM, the USFS, and the Park Service. The USGS processes all applications. The developer leases geothermal rights from the federal government but is additionally regulated by state and local agencies. Estimated time involved with obtaining permits from federal agencies range from 30 days to as as much as eight years.

Most of the Wyoming laws which affect geothermal development apply only broadly to the developer. The Department of Environmental Quality regulates all environmentally affected activities in Wyoming. The State Engineer issues permits to drill all water wells and also has the responsibility to shut down drilling operations which may endager thermal features in the state.

Few Wyoming laws deal directly with geothermal development. Wyoming Statute 41-3-901, Definition of Undergroundwater states, "underground water means any water, including hot water or geothermal steam, under the surface of the land or the bed of any stream, lake, reservoir, or other body of surface water...". The State Board of Land Commissioners, however, leases geothermal as a mineral on state lands, thus causing some confusion in identifying the source. In July, the joint Mines, Minerals and Industrial Development Interim Committee of the Wyoming Legislature held a hearing on potential geothermal legislation. At that time, attention was addressed to the definition of geothermal resources but no conclusions were reached.

Proposed legislation has been developed by the Wyoming Geothermal Commercialization Office for introduction in the 1981 session of the legislature. Primary focus is in six areas: definitions of geothermal, regulatory agencies, grandfather clause, delineation of small use or large use, bonding and taxation powers, and quality and quantity protection of Wyoming waters (Wyoming Geothermal Institutional Handbook 1980).

Local agencies and regulations in Wyoming become involved in development of geothermal resources according to local and use controls. Primarily involved are County Commissioners and City Councils.

2.7 Outreach

2.7.1 Mechanisms

Existing

1-Regular contact with state and federal lawmakers

2-Wyoming Energy Extension Service (WEES) contacts through the seven regional directors

3-Incoming toll-free telephone on which anyone in the state can call GCO free of charge

4-University of Wyoming Communications Services which provides news coverage of all pertinent issues and arranges interviews on radio and television

5-A monthly newsletter circulated to interested parties in the state, concerning recent geothermal legislation, funding sources, and applications

2.7.2 Summary of Contacts and Results

The Wyoming GCO has maintained continued contacts with elected officials during the period January 1, 1980 to June 30, 1980. These officeholders include Senators Alan Simpson and Malcolm Wallop; Representative Dick Cheney, Governor Ed Hershler, and state legislators.

Many contacts with other state officials and offices were initiated or continued including the Wyoming Energy Conservation Office, the State Planning Coordinator, the Wyoming Department of Economic Planning and Development, The Wyoming Department of Environmental Quality, the Governor's Office, the Public Utilities Commission and the State Engineer. Contact was also maintained on a regular basis with DOE in Washington, D.C., Idaho Falls, San Francisco and Denver.

A good deal of correspondence took place with the New Mexico State University Physical Science Lab, EG & G Idaho and Western Energy Planners. University of Wyomings contacts included Ed Decker and Hank Heasler of the Geology Department, Charles Folkner and Don Tiernan from Computer Services, Don Stinson, Paul Biggs, and H. L. Hutchinson from the Department of Mineral Engineering.

County Planning offices in Fremont, Hot Springs, and Converse counties have been consulted concerning possible geothermal resource development in their areas. Correspondence has been on-going with members of the Hot Springs Community Energy Conservation Board in Thermopolis concerning possible development of the resource in that county. Contact is also maintained with public and private concerns in the Midwest/Edgerton area in anticipation of early development of their geothermal resources.

Major contacts on a personal basis were:

- -Television interview of Rick James by KYCU-Cheyenne
- -Radio interview of Karen Marcotte by KUWR-Laramie
- -Newspaper interview of Rick James by Casper Star-Tribune
- -Platte County Energy Fair
- -Hot Springs County field assessment and presentation to the Thermopolis Chamber of Commerce
- -Presentation to the Wyoming Outdoor Council in Casper

In addition to the above contacts the Wyoming Geothermal Institutional Handbook was completed and distributed to interested parties.

2.7.3 Overall Prospects for Future Geothermal Activity

Awareness of geothermal energy and its potential has increased dramatically in Wyoming, as evidenced by the increase in inquiries received by this office. State support is continuing from the Mineral Division of the Dept. of Economic Planning and Development and from the State Planning Coordinator.

Geothermal development presents good opportunities in some areas of Wyoming, especially in Thermopolis and Midwest where proven resources have been identified. Exploitation of the Madison Formation in the Powder River Basin offers possibilities, but because of the depth involved, will require larger investment capital than the above areas. Wyoming will probably never utilize geothermal waters as a sole energy source entensively since other sources of alternative energy are so abundant in the forms of solar or wind power. However, with continued efforts by this office at dissemination of information to the public, more small-scale uses of the low-temperature resource are likely, particularly for space-heating. There is also a good possibility for joint use of geothermal and solar/wind sources in combination in Wyoming.