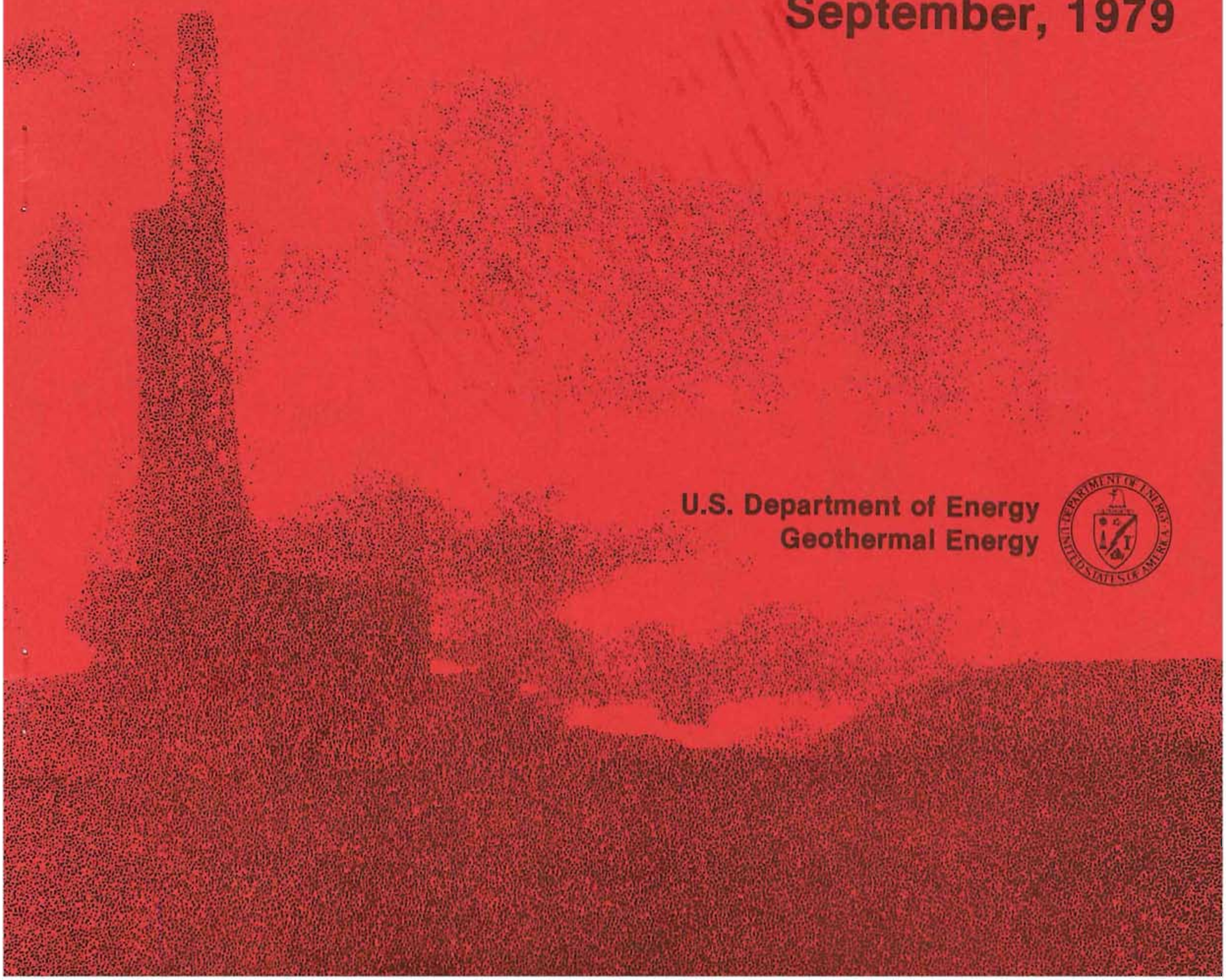
Direct Heat Application Program Summary

Presented at the Geothermal Resources Council Annual Meeting September, 1979



U.S. Department of Energy
Geothermal Energy

ACKNOWLEDGMENTS

The project descriptions contained in this pamphlet were prepared by the Project Teams of each of the twenty-two direct heat application projects currently in progress throughout the United States. The Department of Energy gratefully acknowledges their assistance in providing this information which will assist other potential users in assessing the economic and technical viability of the direct use of geothermal energy. Additional copies of this pamphlet can be obtained through the Department of Energy Offices listed on page 5.

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SPECIAL SESSION - DOE-SPONSORED DIRECT HEAT

APPLICATIONS PROJECTS

September 25, 1979

Geothermal Resources Council 1979 Annual Meeting

Session Description:

This special open session on direct heat application project experience, sponsored by the Department of Energy, will feature panel discussions on geothermal:

- Space Conditioning Systems
- Applications for Agriculture/Aquaculture
- District Heating Systems
- Applications for Industry

Panel members are individuals with a wide variety of experience, who are currently involved in demonstration projects in the direct applications field. The panelists will present brief overviews of their projects, and respond to questions from the audience. Experience in resource exploration, well drilling, design, construction, and permitting will be emphasized.

Agenda:

1:30 - 1:50 p.m.	Direct Heat Applications Program Overview: Morris Skalka, Chief, Direct Heat Applications Section, DOE-Washington
1:50 - 2:00 p.m.	Opening Remarks: Program Moderator, Bob Schultz, Manager, Hydrothermal Energy Commercialization, EG&G Idaho, Inc.
2:00 - 3:00 p.m.	Panel Discussion: Geothermal Space Conditioning Systems
	Moderator: Roland Marchand, Chief, Engineering Branch, Nevada Operations Office, DOE

Panelists	Project
Richard Berg, Project Engineer, Hengel, Berg & Associates	Haakon School, Philip, SD
Robert Sullivan, Project Engineer, Kirkham, Michael & Associates	St. Mary's Hospital, Pierre, SD
Gene McLeod, Project Manager, MERDI, Inc.	Warm Springs State Hospital, MT

Panelists	Project
Marshall Conover, Project Manager, Radian Corporation	T-H-S Hospital, Marlin, TX and Navarro College, Corsicana, TX
Brian Fitzgerald, General Director, Klamath County YMCA	Klamath County, YMCA, OR
Jack Lyman, Director, Utah Energy Office	Utah State Prison, UT
Lou Herz, Assistant City Manager, El Centro, California	El Centro, CA

3:00 - 3:45 p.m. Panel Discussion: Geothermal Application for Agriculture/Aquaculture

Moderator: Hilary Sullivan, Program Coordinator, San Francisco Operations Office, DOE

Panelists	Project
Ralph Wright, Chairman of the Board, Utah Roses, Inc.	Utah Roses, Inc., Sandy, UT
Dr. Dan Carda, Research Associate, South Dakota School of Mines and Technology	Diamond Ring Ranch, SD
Frank Metcalfe, President, Geothermal Power Corporation	Kelley Hot Springs, CA
Dr. Dov Grajcer, President, Aquafarms International, Inc.	Aquafarms International, Inc. Mecca, CA

3:45 - 4:00 p.m. BREAK

4:00 - 4:45 p.m. Panel Discussion: Geothermal District Heating Systems

Moderator: Eric Peterson, Program Manager, Division of Geothermal Resource Management, DOE-Washington

Panelists	Project
Roger Harrison, Project Engineer, Terra Tek, Inc.	Monroe City, UT
Dr. Glenn Coury, Project Manager, Coury & Associates, Inc.	Pagosa Springs, CO
Phillip Hanson, Project Director, Boise Geothermal	Boise, ID

Panelists	Project
Harrold Derrah, Assistant City Manager, Klamath Falls, OR	Klamath Falls, OR
Phillip Edwardes, Principal Investigator, Susanville, CA	Susanville, CA
David Atkinson, President, Hydrothermal Energy Corporation	Reno, NV

4:45 - 5:30 p.m. Panel Discussion: Geothermal Applications for Industry

Moderator: Robert Chappell, Project Manager
Idaho Operations Office, DOE

Panelists	Project
Dr. Jay Kunze, Vice President & General Manager, Energy Services, Inc.	Madison County, ID
Robert Rolf, Director Technical Services, Ore-Ida, Inc.	Ore-Ida, Inc., Ontario, OR
Sheldon Gordon, Project Engineer, Chilton Engineering	Elko Heat Company, Elko, NV
Lee Leventhal, Project Engineer, TRW, Inc.	Holly Sugar, Brawley, CA

DIRECT HEAT APPLICATION PROJECTS

The use of geothermal energy for direct heat purposes by the private sector within the United States has been quite limited to date, yet there is a large potential market for thermal energy in such areas as industrial processing, agribusiness, and space/water heating of commercial and residential buildings. Technical and economic information is needed to assist in identifying prospective direct heat users and to match their energy needs to specific geothermal reservoirs. Technological uncertainties and associated economic risks can influence the user's perception of profitability to the point of limiting private investment in geothermal direct heat applications.

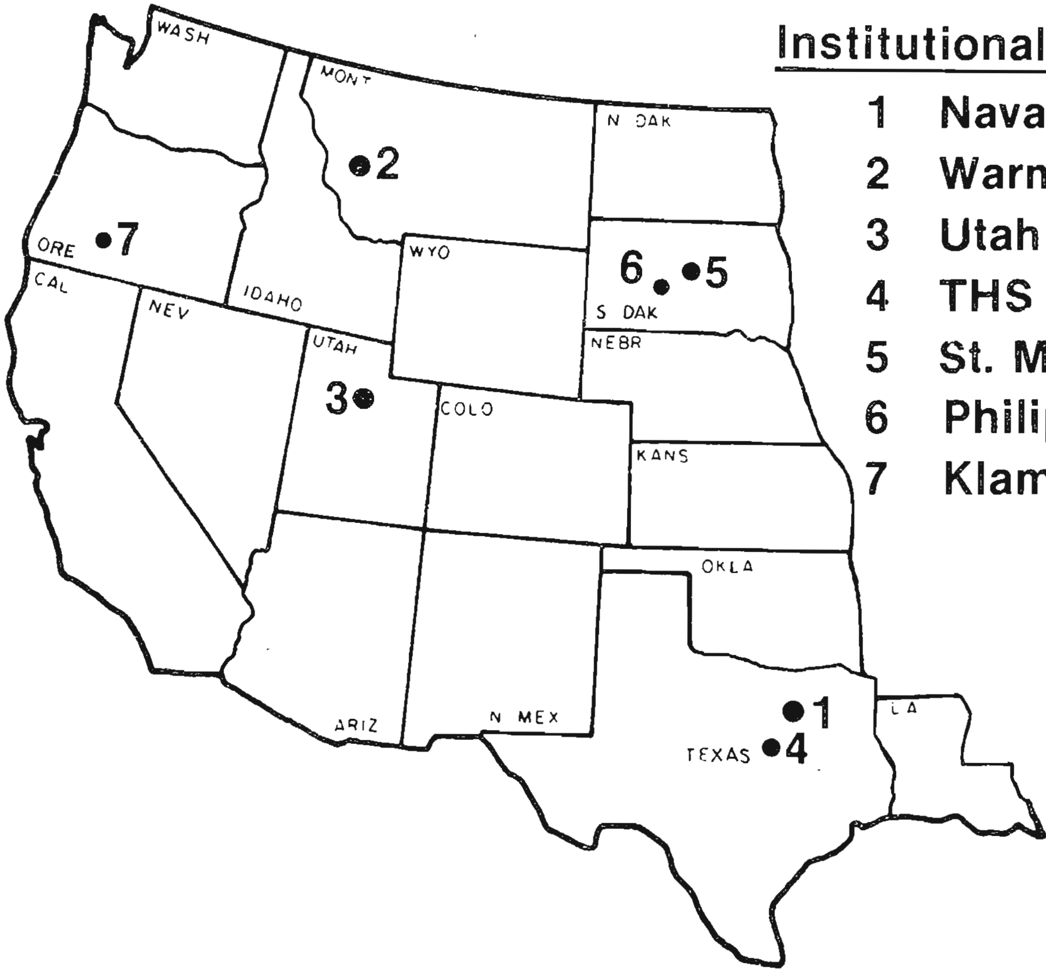
To stimulate development in the direct heat area, the Department of Energy, Division of Geothermal Energy, issued two Program Opportunity Notices. These solicitations are part of DOE's national geothermal energy program plan, which has as its goal the near-term commercialization by the private sector of hydrothermal resources. Encouragement is being given to the private sector by DOE cost sharing a portion of the front-end financial risk in a limited number of demonstration projects.

The twenty-two projects summarized in this pamphlet are a direct result of the Program Opportunity Notice solicitations. These projects will (1) provide visible evidence of the profitability of various direct heat applications in a number of geographical regions; (2) obtain technical, economic, institutional, and environmental data under field operating conditions that will facilitate decisions on the utilization of geothermal energy by prospective developers and users; and (3) demonstrate a variety of types of applications.

DOE PROJECT OFFICES

Three Department of Energy Operations Offices are responsible for the management of the direct heat application projects. The offices and their respective projects are:

	Projects
Idaho Operations Office 550 Second St. Idaho Falls, Idaho 83401 Contact: Robert Chappell Project Manager, DOE (208) 526-0035 Technical Support: EG&G Idaho, Inc. Idaho Falls, Idaho 83401	Boise Diamond Ring Ranch Elko Heat Company Haakon School Madison County Monroe City Ore-Ida, Inc. Pagosa Springs St. Mary's Hospital Utah Roses, Inc. Utah State Prison Warm Springs State Hospital
Nevada Operations Office P.O. Box 42100 Las Vegas, Nevada 89114 Contact: Roland Marchand Chief Engineering Branch, DOE (702) 734-3424	Navarro College T-H-S Hospital
San Francisco Operations Office 1333 Broadway Oakland, California 94612 Contact: Hilary Sullivan Program Coordinator, DOE (415) 273-7943 Technical Support: Energy Technology Engineering Center Canoga Park, California 91305	Aquafarms International Inc. El Centro Holly Sugar Kelley Hot Springs Klamath County YMCA Klamath Falls Reno Susanville



Institutional Heating Systems

1 Navarro College & Hospital Corsicana, Texas
2 Warm Springs Hospital, Montana
3 Utah State Prison, Utah
4 THS Hospital, Marlin, Texas
5 St. Mary's Hospital, Pierre, South Dakota
6 Philip School, South Dakota
7 Klamath Falls, Oregon, YMCA

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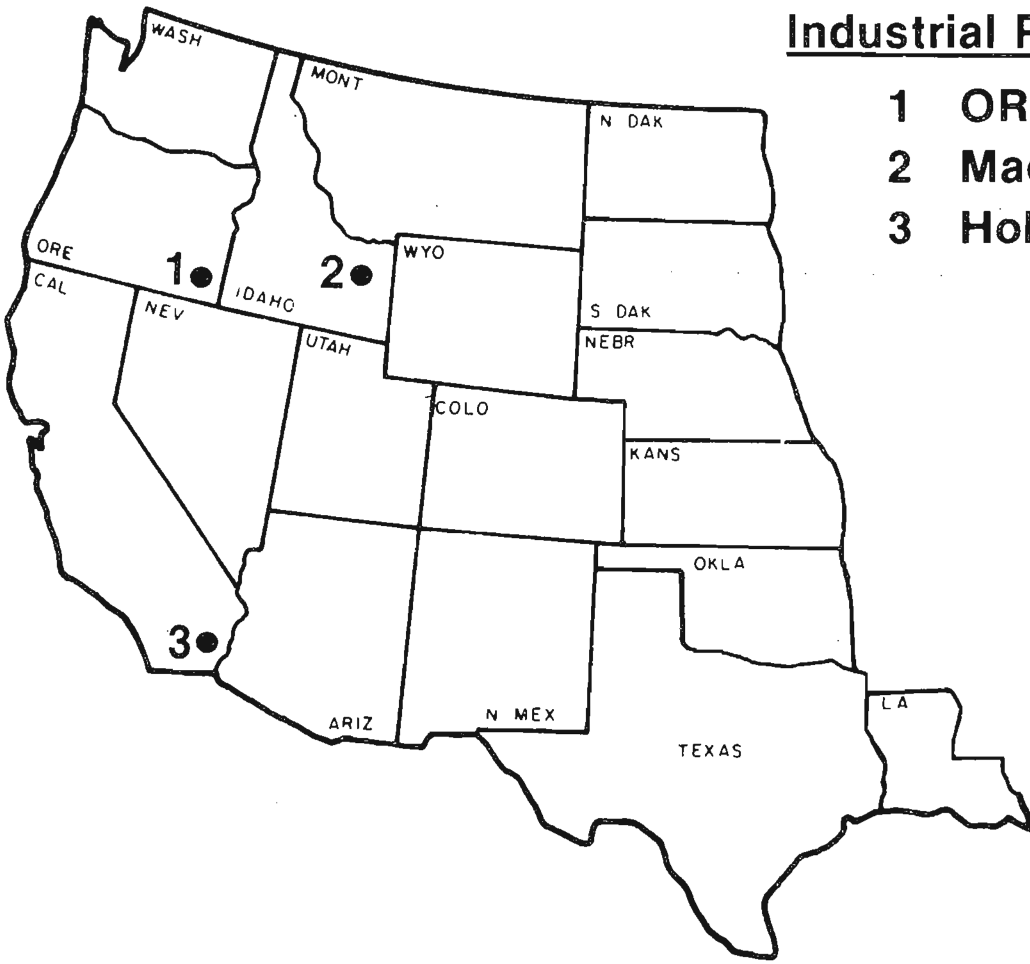

<u>**Industrial Process Sites**</u>

1 ORE-IDA — Ontario, Oregon

2 Madison County — Rexburg, Idaho

3 Holly Sugar — Brawley, California

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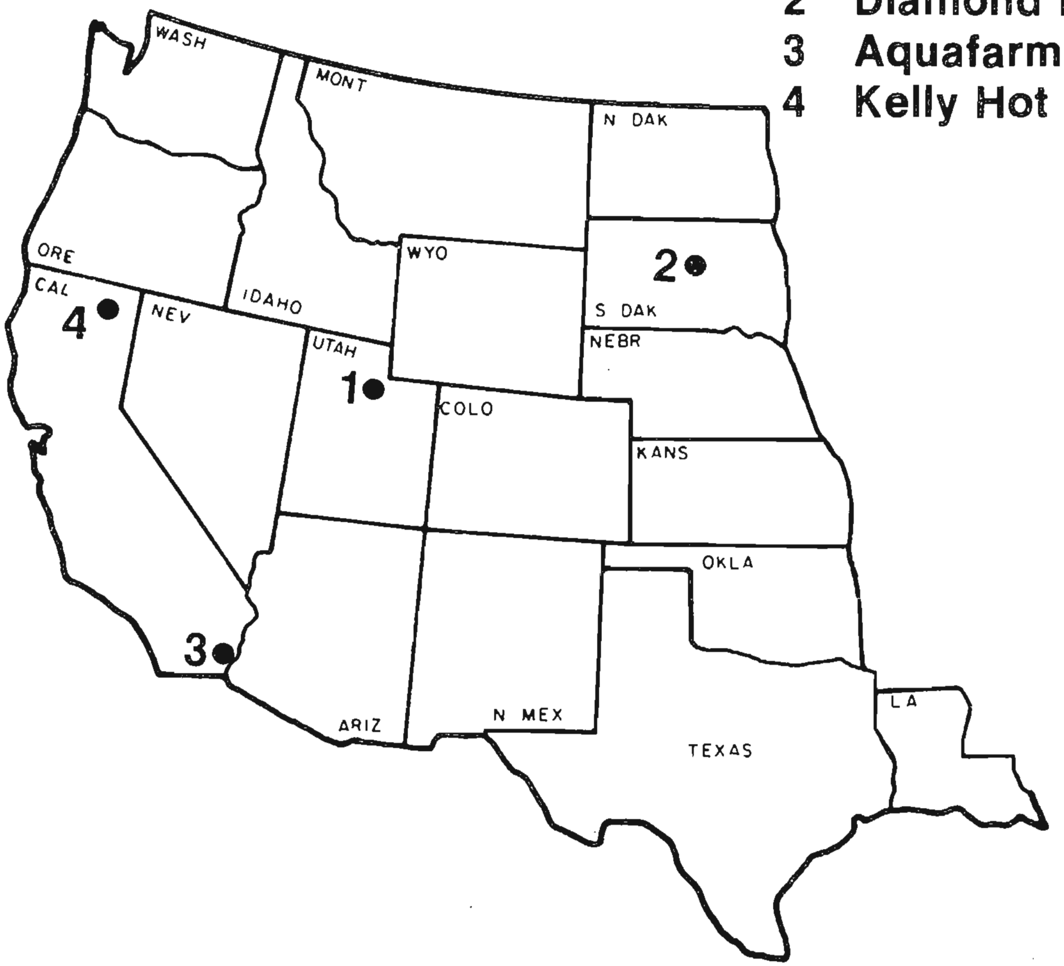
Agribusiness

1 Utah Roses — Sandy, Utah
2 Diamond Ring Ranch — South Dakota
3 Aquafarms International — Mecca, Califo
4 Kelly Hot Springs — Novato, California



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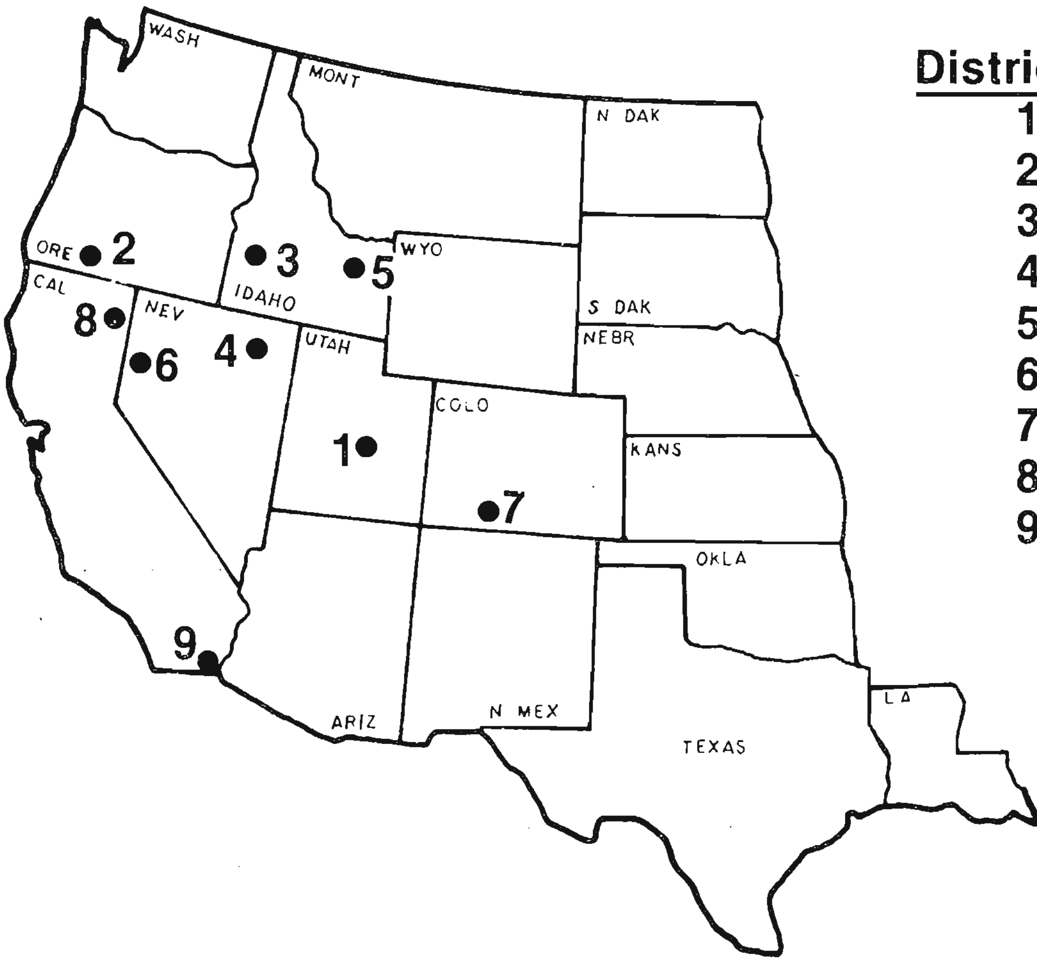

District Heating Systems

1 Monroe City, Utah
2 Klamath Falls, Oregon
3 Boise, Idaho
4 Elko, Nevada
5 Madison County, Idaho
6 Reno, Nevada
7 Pagosa Springs, Colorado
8 Susanville, California
9 El Centro, California

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DIRECT HEAT

APPLICATIONS PROJECT

DESCRIPTIONS

Project Title: Commercial Culture of *Macrobrachium Rosenbergii* on Geothermal Water

Location: Mecca, California

Principal Investigator: Dr. Dov Grajcer, President, Aquafarms International, Inc.

Project Team:

- Aquafarms International, Inc.

Project Objective:

To develop a commercial-scale prawn farm in the Coachella Valley, utilizing geothermal water as the source of constant-temperature fluid. This would permit economical, year-round prawn farming.

Resource Data:

The project is located on 246 acres of desert land in one of the most desolate parts of the Salton Trough, the area between the Coachella Canal and the Salton Sea.

Subsequent drilling has proven successful. Three wells have been drilled to a depth of about 100 ft. They are all prolific producers of warm water under thermo-artesian pressure. The estimated artesian head is about 5 psig. The total flow rate is of the order of 300 gallons per minute per well, without pumping. The quality of the water is superb: the salinity of the water is less than 600 ppm TDS, making it less saline than the Coachella canal water flowing by. The salinity of the latter is on the order of 800 to 1,000 ppm TDS. The water issues out of the 10-inch (O.D.) wells, at a temperature range of 84 to 87°F, which is ideal for shrimp farming. Detailed chemical tests of water chemistry have established that the water is of an acceptable quality for giant shrimp (or prawn) farming.

System Design Features:

The equivalent energy demand for raising shrimp or prawn in artificially heated ponds is on the order of 170 billion Btu per year for Coachella Valley groundwater and ambient air conditions for a 50-acre pond farm. The equivalent energy saving would amount to about $560,000 per year (at $2/MMBtu and 60% boiler efficiency).

The three geothermal wells on the property provide water at the required pond temperatures. Geotechnical investigations will determine if slightly higher water temperatures would be expected at a slightly greater depth. In case of discovery of hotter water, it would be possible to control pond temperature in winter with greater ease, by proper mixing of water from wells of different temperatures.

It is estimated that well pumping would require a 10-kW generator to be installed on the deep well.

Project Description:

Aquafarms International, Inc. (AII), a small California corporation, is developing a 50 acre prawn farm on its property in the Dos Palmas area, east shore of the Salton Sea, utilizing geothermally heated water. Extensive genetic and field work have already been completed by AII to achieve adaptation of the giant Malaysian prawn, Macrobrachium rosenbergii, to local water, soil, and climate conditions.

The giant Malaysian shrimp enjoys many advantages over many other crustaceans. It adapts to a relatively wide temperature range, with the optimum temperature being in the 80 to 85°F range. The female prawn is highly productive and protects her eggs, resulting in a relatively high (30 to 50%) survival rate of the larvae. The larvae metamorphose to juvenile prawns in 22 to 35 days; depending upon temperature, the juveniles reach maturity in 7 to 8 months. And, finally, the meat has excellent taste and quality, and the product is much in demand worldwide.

The project will utilize geothermal water issuing from three existing shallow wells, plus one deeper well to be drilled as part of the project, to provide enough warm water for continuous, year-round, prawn farming operation. Appropriate geotechnical studies will be carried out to determine optimal location for the new well, to test hydrologic characteristics of all wells, and to determine best methods of disposal of the water after it has been used in the prawn ponds. Studies of optimum feed, flow-through, efficient water quality control methods, and harvesting methods will also be determined.

Status:

The environmental report has been submitted for approval.

Project Title: Boise City - A Field Experiment in Space Heating

Location: Boise, Idaho

Principal Investigator: Phil Hanson, Director, Boise Geothermal (208) 384-4013

Project Team:

- Boise City
- Boise Warm Springs Water District
- CH_2M Hill Engineers

Project Objective: To develop a geothermal space heating system to serve the largest possible market in and around the Boise central business district.

Resource Data: The resource area is commonly referred to as the Boise Front. This area appears to be fault controlled, with the source of water being the annual runoff in the mountains immediately behind Boise City. There is a long history of using this resource data, dating to 1892 when the first wells were drilled to a depth of 400 feet. These wells are still productive, with water temperatures relatively invariant at 170°F. Since that date, there has been fairly continuous development of hot water wells. Records available on some 70 wells show temperature ranges of 75 to 170°F, and depths ranging up to 1,200+ feet. Production varies over the range up to 800 gpm.

System Design Features: Boise Geothermal is a joint venture of Boise City and Boise Warm Springs Water District. This joint venture will develop a space heating system consisting of two major parts. The first part is based on the Warm Springs heating district, which, in one form or another, has been operating since the 1890's. This part of the system presently serves about 220 residences, based on two 400-ft wells with temperatures of 170°F. This part of the system will be improved to provide expanded service to the residential community.

The second part of the system will draw on a separate part of the resource area to supply heat to the central business district. It is planned that the system will serve, initially, approximately 11 major buildings. These buildings range from the 270,000 square foot Idaho First National Plaza, built in 1978, to a renovated 1930's hotel that is now an office building.

The types of heat exchangers used will vary. The system capacity is a nominal 5,000 gpm, designed to take advantage of a 40 to 50°F temperature drop (170 to 120°F) to heat residential and commercial buildings. Fuel savings are expected of 230,000 barrels of oil for a system serving 500 to 1,000 residences and 11 office buildings.

Project Description: The project is managed and operated through Boise Geothermal. A Board of Directors, made up of the Boise City Council and members of the Boise Warm Springs Water District Board, provides policy direction to Boise Geothermal. An Executive Committee maintains daily involvement in project work. Overall project management is the responsibility of a Project Director, who reports to the Project Board. CH_2M Hill provides project technical direction.

Funding for the project is being supplied by the Economic Development Administration, the Department of Energy, Boise City, and Boise Warm Springs Water District. As the project develops, funding is planned from other sources. These funds will be used to prove the extent of the resource. If the resource is large enough, the first segment of the system will serve 500 residences and 11 office buildings. Service to this segment will be evaluated, to determine the technical and economic feasibility of expanding the system.

Status: Contracts with EDA and DOE were signed in July 1979. Preliminary work on geological and environmental studies actually began in March 1979. An environmental report has been completed. Geology studies are continuing, with some concurrent drilling. All wells should have been drilled and service begun between 1980 and 1982.

Project Title: Diamond Ring Ranch Geothermal Demonstration Heating Project

Location: Mid-central South Dakota, 35 miles west of the state capitol

Principal Investigator: Dr. S. M. Howard, Professor of Metallurgical Engineering, (605) 394-2341

Project Team:

- South Dakota School of Mines and Technology
- Re/Spec, Inc.
- Diamond Ring Ranch

Project Objective:

Utilize existing Madison well to provide grain drying, cattle warming, and space heating for homes.

Resource Data:

The geothermal water is coming from the Madison Limestone, which is under most of western South Dakota, at depths from 2,500 to 7,500 feet and temperatures from 100 to 195°F. The Madison is a major aquifer of South Dakota, yielding good quality drinking water. The existing well is 4,100 feet deep, flowing at approximately 152°F and 180 gpm.

System Design Features:

The system is designed using PVC piping and plate-type isolation heat exchangers made of 316 stainless steel. The system is designed for a 20°F temperature drop across the isolation exchangers. The grain dryer was designed to use antifreeze in its "clean" water side, to avoid complications associated with freezing weather. The space heating provided to the homes will use existing duct work and installation of water-to-air exchangers in line with the existing heating system. This will permit the existing system to function as a backup unit, if necessary.

The system is designed for simplicity and minimal control systems, to permit economical installation and elementary operational problems.

Status:

Ground breaking ceremonies were conducted on July 19, 1979, with project completion slated for October 19, 1979. The main pipeline has been excavated and is nearly installed. The grain dryer is on-site and retrofit procedures are commencing. The retrofit for the space heating is also underway. The project will hopefully be completed to permit some grain drying operations to begin in late September.

Project Title: City of El Centro Geothermal Energy, Utility Core Field Experiment

Location: El Centro, California

Principal Investigator: Mr. G. L. Herz, Assistant City Manager of El Centro (714) 352-9440

Project Team:

- City of El Centro
- WESTEC Services, Incorporated
- Chevron Resources Company

Project Objective:

The overall objective of this field experiment is to demonstrate the engineering and economic feasibility of the utilization of moderate-temperature geothermal heat, on a pilot scale, in the City of El Centro, for space cooling, space heating and domestic hot water. This field experiment will provide visible evidence of the profitability of direct heat applications to residential/commercial space conditioning, particularly in the southwestern United States.

Resource Data:

The geothermal reservoir which is the energy source for this demonstration is embodied in a 13.5 square mile area known as the Heber Known Geothermal Resource Area in the Imperial Valley. The City of El Centro is 4-1/2 miles north of the center of the KGRA, in an area where well temperature gradients should be 2 to 4°F per 100 feet in depth.

Reservoir Characteristics (predicted) at the El Centro City Site

Total Dissolved Solids (TDS)	14,000 ppm
Brine Chemistry for Thermodynamic Calculations	14,000 ppm solution of NaCl
pH	6.2
CO_2 by weight of flashed steam	$\leq$ 0.3%
Methane and hydrogen sulfide by weight of flashed steam	trace
Maximum supply rate per well	365,000 lb/hr per well
Downhole Brine Condition at the City	Saturated 250°F at 8,500 feet
Brine return temperature at the reinjection well	$\geq$ 160°F

System Design Features:

The basic concept is to use the geothermal brine to heat clean City supply water and circulate this clean water to the Community Center for space and water heating purposes. Also, this clean, hot City supply water would be used in a lithium bromide/water absorption chiller to produce chilled water, which would be circulated to the Community Center for space cooling purposes. This design is based on the concept that the hot water/chilled water plant will be located at the proposed drill site, about 1/2 mile away from the Community Center. The reason this plant is not located at the Community Center is that the modular concept of district heating and cooling developed in the initial feasibility study will be evaluated in this demonstration. Under this concept, the area of a city to benefit from district heating and cooling would be divided into small districts in which one modular plant would serve a particular district. This demonstration plant is conceived as a modular plant serving not only the Community Center but, hopefully in the future, other consumers in the area--residential and industrial alike.

Key Design Features

Number of Production Wells	One
Number of Injection Wells	One
Type Absorption Chiller	Lithium bromide/Water
Cooling Capacity	101 tons nominal 65 tons available
Hot Water Temperature IN	235°F
Hot Water Temperature OUT	215°F
Type Heat Exchanger	Undetermined at this time
Capacity (max.)	1.2×10^6 Btu/hr
Brine Temperature IN	250°F
Brine Temperature OUT	$\geq$ 160°F
Hot Water Temperature IN	215°F cooling mode 175°F heating mode
Hot Water Temperature OUT	235°F cooling mode 195°F heating mode
Estimated Geothermal Fuel Cost/ Million Btu	$4.78 (based on fully developed district wide system, including industrial park use)
Annual Fuel Savings	4.6×10^5 cu ft/yr natural gas 1.7×10^5 kWh/yr electricity

Project Description:

The project plan calls for drilling a geothermal well within the city, building a pilot hot water/chilled water plant at the wellsite, and distributing the hot or chilled water to the El Centro Community Center (located about one-half mile away from the pilot plant). Heat from the brine will be transferred to the working fluid by way of heat exchangers located at the wellsite. City supply water has been selected as the working fluid because of its relatively low cost and availability.

The heated city water will be used in the winter to supply space heat and heat for domestic water for the Community Center. During the summer, the heated city water will be used in a lithium bromide/water absorption process to produce chilled water to be used for space cooling the Community Center. The Community Center will be retrofit with heating/cooling coils for the space conditioning requirements.

Status:

The prime contract for this project between the Department of Energy (DOE) and the City of El Centro was executed on July 11, 1979. The environmental impact report was certified by the El Centro City Council on July 5, 1979. The technical conceptual design was completed on August 3, 1979, and the detailed design phase is now in progress.

Project Title: Field Experiments for Direct Uses of Geothermal Energy: Elko Heat Company, Elko, Nevada

Location: City of Elko, Nevada

Principal Investigator: Mr. Ira S. Rackley, P.E., Project Manager
Elko Heat Company, (702) 738-3108

Project Team:

- Elko Heat Company, Elko Nevada; Mr. Jim Meeks, President
- Chilton Engineering, Elko, Nevada; Mr. Ira S. Rackley, P.E., Project Manager, and Mr. Sheldon S. Gordon, P.E., Project Engineer

Project Objectives:

This project was selected to demonstrate the technical and economic feasibility of the direct use of geothermal brines from the Elko KGRA for the purpose of providing space, water, and process heat. In a more general sense, it is the aim of the project to develop information and approaches that will enable the proposers to develop the Elko resource as a viable alternative to the consumption of primary fuels for space, water, and process heating in Elko.

Objectives related to this overall goal are:

- Develop adequate resource information to allow for the design of the geothermal process system.
- Use this resource information to generate a plan for the continued development and use of this resource after the period of government support.
- Displace a significant portion of the primary fuel consumption in Elko for identified energy markets with geothermal energy.

Resource Data

Resource Area: Adjacent to the Elko KGRA, within the city limits of Elko.

Controlling Geologic Features: Fault zone trending north-northeast through city of Elko; hot water from depth ascending along the fracture zone.

Predicted Temperature: Geothermometry-based predictions (240-670°F) (actual unknown).

Predicted Flows: Unknown

Depth of Resource: 700 to 2,000 feet, based on cold water well drilling logs (actual unknown).

System Design Features:

Production/Injection Wells: One production well (700-2,000 feet in depth), one injection well (similar depth). (Actual use is dependent on water quality considerations.)

Heat Exchangers: Use is dependent on water quality and resource temperature considerations. Design at present allows for wellhead heat exchanger and closed-loop system circulation. Heat exchanger design anticipates 10-15°F approach.

System Capacity: Present extraction permits under assumed operating ΔT of 10°F on shell side of heat exchanger provide a net capacity of 6.74×10^6 Btu/hr (actual capacity unknown).

Unique Design Considerations:

- shallow resource
- clean resource (dilute samples at 550 ppm - TDS)
- variety of applications:
    - commercial laundry
    - 400-unit motor hotel
    - office building

Project Description:

The Elko project involves the location and drilling of a production well for the purpose of extracting hydrothermal fluids from the Elko KGRA. These fluids are to be used to displace primary fuel consumption for the operation of a commercial laundry, a motor hotel, and an office building.

The Vogue Laundry and Dry Cleaners requires energy for the operation of washing equipment, dryers, and ironers. The Stockmens Motor Hotel requires energy for domestic water, space, and swimming pool heating. The Stockmens Motor Hotel also has substantial cooling requirements that may be met if the geothermal source is of sufficient temperature. The Henderson Bank Building requires energy primarily for space heating, with a small domestic hot water requirement. Thus, several different applications of the direct utilization of the Elko geothermal resource will be demonstrated and tested in this program.

Status:

The Elko project is in the resource assessment phase, with Geothermal Surveys, Inc. just completing the temperature probe survey, geologic reconnaissance, electrical resistivity soundings, sling ram soundings, and some of the geochemical sampling of city wells and the Elko Hot Springs.

The Environmental Report has been completed for this project, with no significant environmental effects expected to be caused.

Project Title: Direct Utilization of Geothermal Energy for Philip Schools

Location: Philip, South Dakota

Principal Investigator: Charles A. Maxon, Superintendent of Schools, (605) 859-2679

Project Team:

- Haakon School District 27-1
- Hengel, Berg & Associates, Rapid City, South Dakota
- Francis-Meador-Gellhaus Inc., Rapid City, South Dakota

Project Objective: To obtain water at 155°F (66°C) from the Madison Formation that can be used for space heating and domestic water heating at the Philip School buildings of the Haakon School District 27-1.

Resource Data: The Madison Formation underlies most of western South Dakota. In the Philip area, the depth to the Madison Formation is approximately 4,000 feet. The temperature of the water from the Madison Formation in this area is 155°F (66°C). The flow rate of the well drilled by the school to a depth of 4,266 feet is 300 gallons per minute, at a temperature of 155°F (66°C).

System Design Features: A 4,266-foot well, with artesian flow, has been drilled. Two stainless steel plate-type heat exchangers will be provided. One will provide 1,800,000 Btu/hr for space heating of an Armory-High School building. The other will provide 1,180,000 Btu/hr for space heating of an elementary school building, a vocational education building, and two small music buildings. Temperature of geothermal water delivered to heat exchangers is 155°F (66°C). Leaving temperature from space heating heat exchanger is not less than 130°F (54°C). Water leaving the space heating heat exchanger is piped through a domestic water heat exchanger.

The heat energy remaining after the school space heating is satisfied will be piped through part of the Philip business district. The heating district plans to utilize the low-temperature water (approximately 125 to 130°F) in a direct heat application, i.e., fan-coil type heat exchangers.

The estimated annual fuel savings for the school is 36,200 gallons of fuel oil and 107,000 kWh of electricity.

Additional savings of fuel oil will be realized from the heating district.

Project Description: A 4,266-foot well was drilled to the Madison Formation. The well will produce a sustained flow of 300 gpm of water, at 155°F (66°C). However, to utilize the well pressure to circulate the water through the heat exchangers, the heating system was designed to use 250 gallons per minute.

The water will be piped from the well that is located near the school buildings, to the Armory-High School building and to the elementary school building.

Because of the corrosive action of the Madison Formation water, the recommended materials to be used in this system are 316 stainless steel and the plastics.

The pipe from the well house to the buildings will be high-density polyethylene pipe equal to Driscopipe. Supply piping inside the buildings will be chlorinated polyvinyl chloride.

A 316 stainless steel plate-type heat exchanger will be provided in each of the buildings. The existing low pressure steam heating system will be modified to hot water systems by replacing steam coils with hot water coils in the fan coil units, by adding additional fan coil units, and by using the existing baseboard radiation. One of the boilers will be replaced because of its condition and the other boiler will be retrimmed to a hot water boiler.

The Armory-High School building is approximately 30,000 square feet. The heat exchanger in the elementary shool building will be used to heat that building, the Vocational Education building, and two small buildings used for music classrooms. These four buildings have approximately 28,000 square feet.

In addition to the space heating, the domestic hot water will be provided for the Armory-High School building and the elementary school building. A 316 stainless steel plate-type heat exchanger will be located next to the space heating heat exchangers. These heat exchangers will use either the leaving water from the space heating heat exchangers or the geothermal water, depending upon the space heating demands.

The exit temperature from the heat exchangers will be approximately 130°F (54°C). The water will be piped through a part of the Philip business district. Several building owners have indicated an interest in utilizing the remaining heat energy. They propose to use fan coil type heating units. These units are estimated to have a life of ten years before they may have to be replaced.

Because of the presence of Radium 226 in excess of the EPA allowable for domestic water, the water will be treated with barium chloride. After removal of the Radium 226, the water will be discharged into the Bad River, which flows through Philip.

The proposed barium chloride treatment plant will have two 5,000-gallon mixing tanks that will have a 10 percent aqueous solution. The solution will be added to the water. The water will pass through a static mixer. From the static mixer, the water will be piped to two detention ponds. After three days, the water will be acceptable for discharge.

Status:

The well has been drilled, cased, and flow tested.

The design of the retrofit is approximately 85 percent complete. A design review was recently completed, with some changes in the plans.

A feasibility study, financed by nine businessmen, to use the leaving water from the school to heat their buildings, has been completed. Their final decision has been delayed because the location of the final discharge point has not been established.

The most economical method of removing the Radium 226 from the water appears to be the addition of barium chloride and the precipitation of the Radium 226.

Various locations for the treatment plant are being investigated.

Bids for the heat exchangers have been received by the school. A final decision on the award of the contract will be made in the near future.

The plans and specifications will be completed and construction contracts obtained, with construction starting April 1, 1980.

Project Title: Geothermal Energy for Sugar Beet Processing

Location: Brawley, California

Principal Investigator: J. J. Seidman, Program Manager, (213) 536-1955
J. M. Kennedy, Co-Investigator, Project Manager Geothermal Resource, (213) 535-1571
E. L. Leventhal, Co-Investigator, Project Manager System Design, (213) 536-1955

Project Team:

- TRW Energy Systems Group
- Holly Sugar Corporation

Project Objective:

The objective of this project is to implement a three-phase program to replace large quantities of fossil fuels with geothermal energy for sugar processing at Brawley, California, in a technical straightforward, economically sound and environmentally acceptable manner.

Resource Data:

The Imperial Valley of southern California is within a major rift zone. Tectonic stresses, acting on valley fill sediments, have caused faulting and opened fracture, permitting the formation of geothermal convective cells. Such a convective cell is thought to exist near the termination of the Imperial Fault, in section 30 T14S, R14E SBBM. The local fault system was first mapped on the surface and later verified by geophysical surveys (seismic, resistivity, and heat flow) performed as part of this project. The fault system, which consists of four tension faults splaying off the Imperial Fault, is thought to provide permeability and the conduit for the convective cell. The geologic structure, in concert with the thermocline of other wells in the region, suggests a source of 350°F (177°C) at about 8,000 feet (2440 m). If the geothermal system is as predicted, a flow of about 1,000 gallons per minute (63 liters/sec) may be achieved.

System Design Features:

The system will replace one boiler that is presently used to supply low pressure steam (≃ 25 psig) to the evaporators and juice heaters, and will supply heat to pulp dryers. There will be about 13 heat exchangers in the system. Three of these will be used to generate 25 psig steam, and the other 10 to preheat and heat the pulp-drying air. The capacity of the system will be 75 million Btu/hr for the steam generator and 160 million Btu/hr for the air heaters, for a total of about 235 million Btu/hr. This system will be used for about four months per year during the sugar campaign.

The total cost of the system, including the study phase and the design, is expected to be about $20 million. It is estimated that the heat supplied by the geothermal resource for the 4-month campaign will save about 100,000 barrels of oil/year. At an estimated cost of $5-6/MBtu, this is equivalent to $30/barrel of oil. Based on a full year's usage, the system could replace 300,000 barrels of oil and drop the cost to about $2/MBtu; this is equivalent to $10-15/barrel.

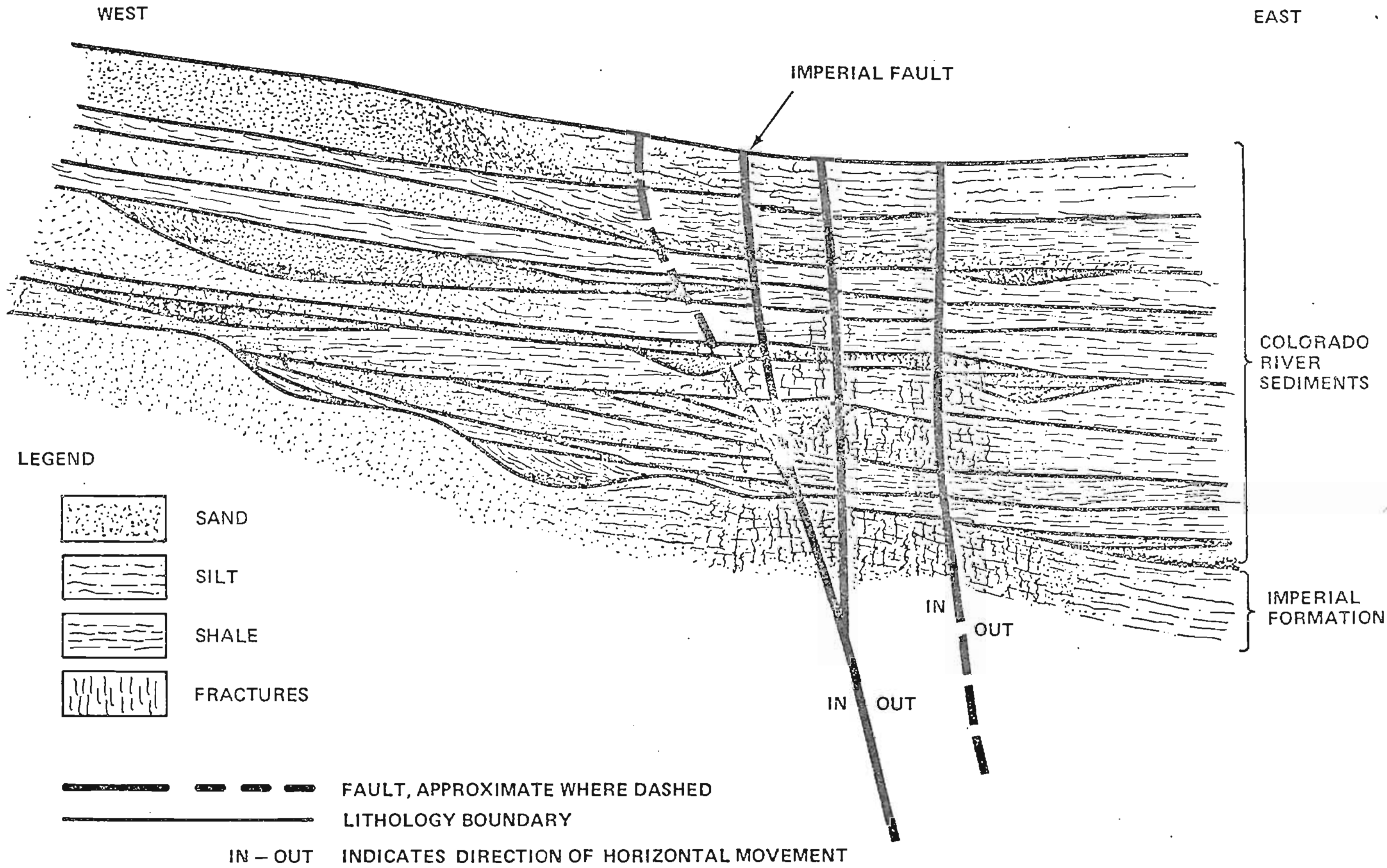
Project Description:

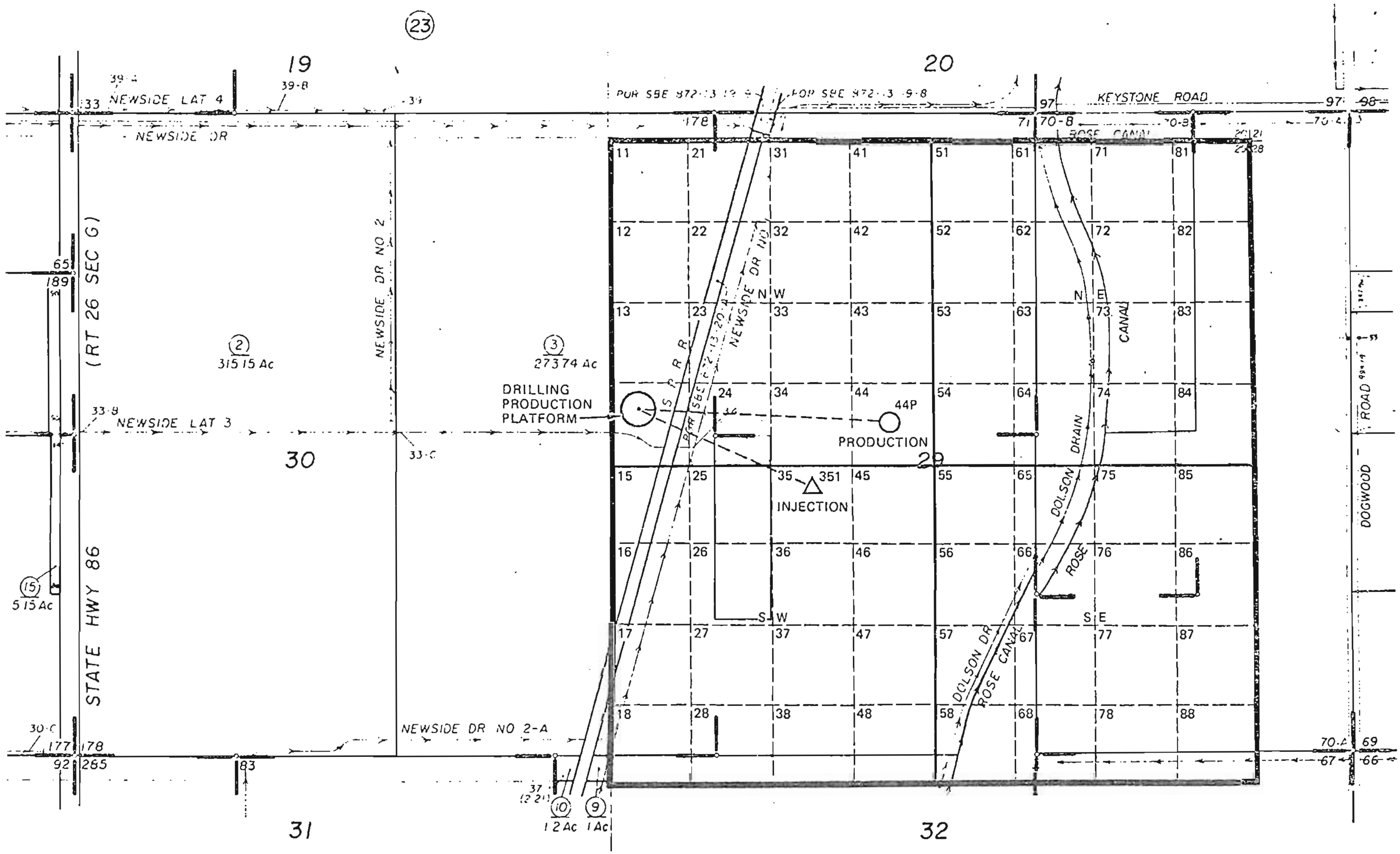
During the present phase of the contract (Phase I), the main users of geothermal heat in sugar processing have been investigated, an environmental report published, a drilling plan completed, and an application for a drilling permit submitted. An assumption was made that the well will produce water at 350°F, and, based on this assumption, low pressure steam generators and pulp dryers have undergone preliminary design. The accompanying equipment, piping, and required installation have also been identified. In Phase II, one production and one reinjection well will be drilled, and a pilot plant will be assembled. The equipment design will be based on data obtained during the drilling of the first production well.

Status:

The drilling of the first production well is scheduled to start in October 1979.

EAST - WEST DIAGRAMMATIC CROSS SECTION OF IMPERIAL VALLEY SEDIMENTARY COLUMN, SECTIONS 29 AND 30 T14S, R14E





○ – PRODUCTION

△ – INJECTION

NOTE – Assessors Block Numbers Shown in Ellipses
Assessors Parcel Numbers Shown in Circles

Assessor's Map Bk. 40 - Pg. 33
County of Imperial, Calif.

SHOOT AT 65 %

FIG 3 PAGE 14

REMARKS


AREAS FOR
NEW DRYERS
AND
STEAM
GENERATOR

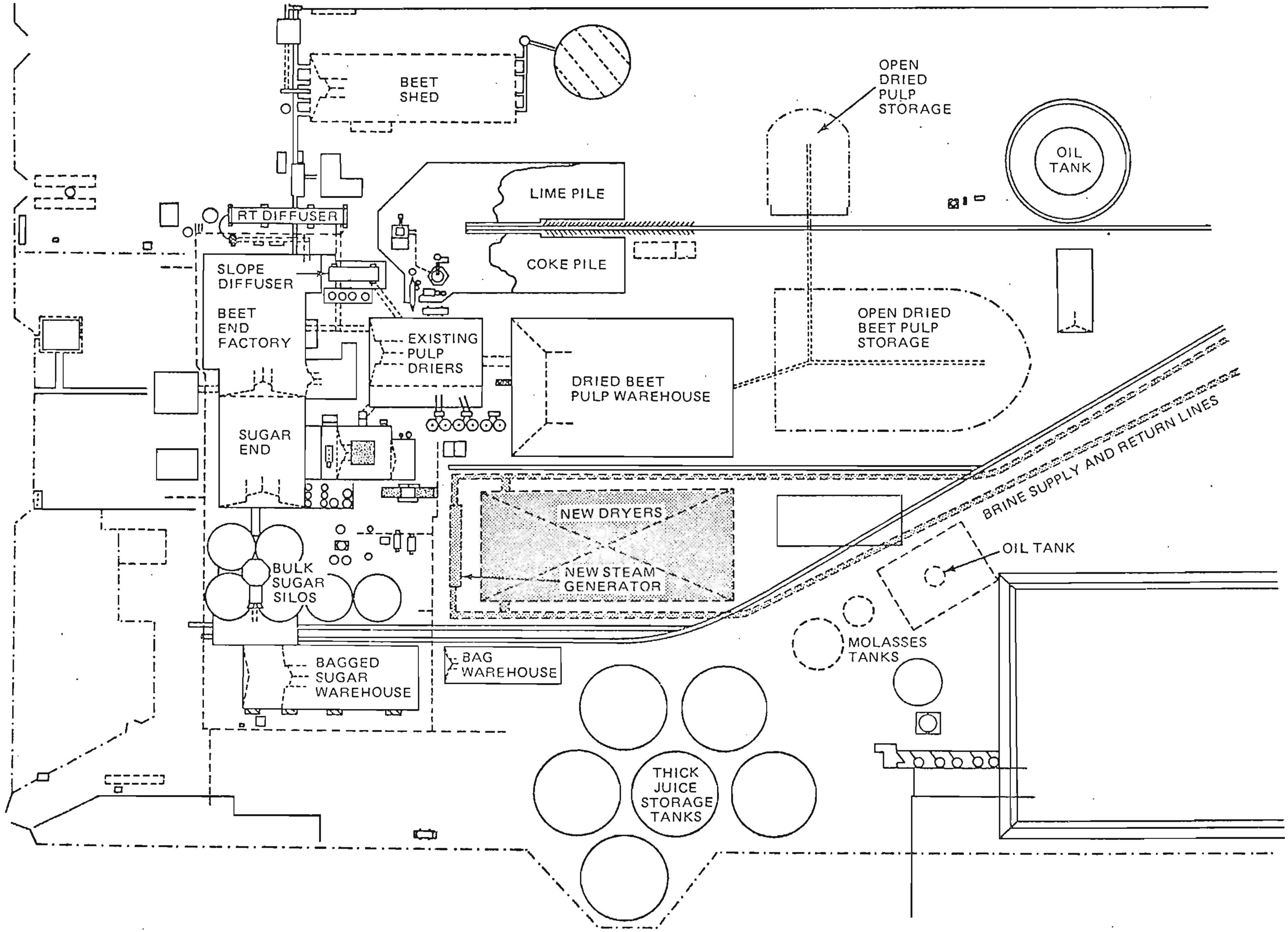


Figure 2. HOLLY SUGAR PLANT
With Geothermal Retrofit Equipment Areas

FIGURE NO. 2
PAGE NO. 13
REDUCE/~~ENLARGE~~
TO 80 %

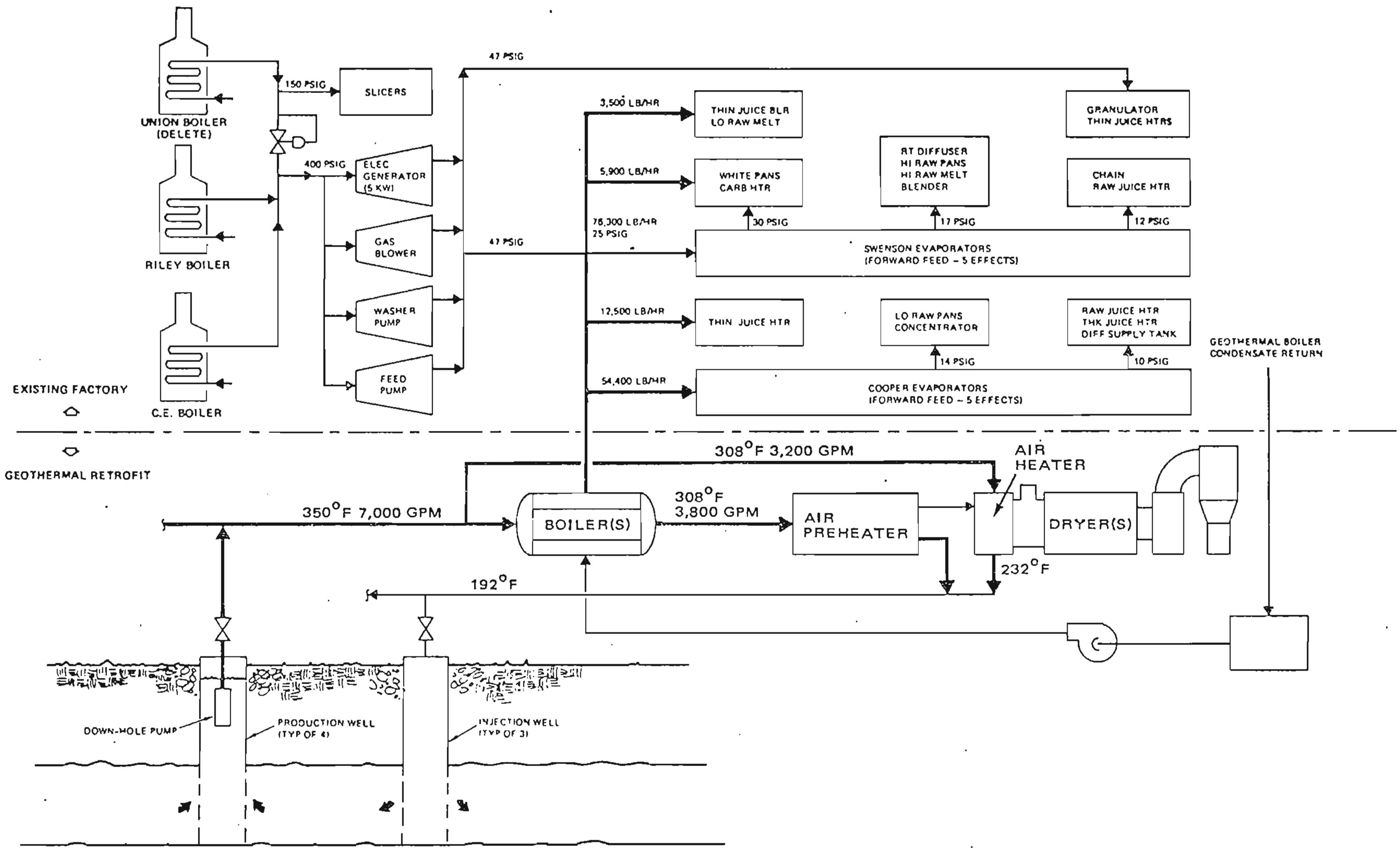


Figure 5. Geothermal Sugar Project Schematic

Project Title: Kelley Hot Springs Agricultural Center

Location: Kelley Hot Springs, Modoc County, California

Principal Investigator: Alfred B. Longyear, (916) 441-4510

Project Team:

- Geothermal Power Corp., Prime Contractor; Frank Metcalfe, Program Manager
- Agricultural Growth Industries, Inc.; Dr. Richard Matherson, Agricultural
- International Engineering Co.; Leonard A. Fisher, Civil Engineering
- Coopers & Lybrand; William R. Brink, Economics and Project Cost Management
- Ecoview; Dr. James Neilson, Environmental Report
- Carson Development Co.; Johan Otto, Construction Management

Project Objective: To demonstrate the economics and feasibility of using low-temperature geothermal energy for an integrated swine raising complex in Northern California.

Resource Data: The Warm Springs Valley of the Pit River is highlighted by Kelley Hot Springs, flowing at 96°C (205°F) at 320 gpm from a single orifice. The flow is at boiling for the elevation (4,360 feet). The region is part of the Modoc Plateau province. The Pit River Valley contains a thin veneer of stream-channel alluvium, flanked by terrace deposits and older and younger fan deposits. Beneath this are sedimentary and tuffacious beds of the Alturas Formation. Overlying these on higher hills are basalt flows of Pliocene and Pleistocene age. The principal fault of the region is the northwest-trending Likely fault, which passes about one mile west of Kelley Hot Springs, and which appears to be a significant regional boundary.

Extensive exploration data include: Reconnaissance-level geologic mapping and gravity surveys, an aeromagnetic survey, at least 30 sq mi of electrical resistivity surveys, a reconnaissance-type telluric survey, a ground-noise and micro-earthquake survey, geochemical analyses, extensive temperature gradient surveys over a 15 sq mi area with 2.5-3 HFU across the area and a high of 20 HFU in certain holes.

Two exploration wells have been drilled. In 1969, Geothermal Resources International drilled to 3,200 feet, 1/4 mile south of the spring with a maximum temperature of 110°C (230°F) at bottom. In 1974, Geothermal Power Corporation drilled to 3,396 feet, approximately 1-1/2 miles due east of the GRI #1 well. The maximum bottom hole temperature of 115°C (239°F) was measured in 1977 in KHS #1. The lithology of the two wells is similar.

The proven reserve in this project is a body of hot water at over 240°F in a porous reservoir between about 1,600 to 3,400 feet depth, covering an area of several square miles. A conservative estimate of the resource, assuming an areal extent of 4 sq mi, thickness of 2,000 ft, a reservoir temperature of 240°F, a reinjection temperature of 80°F, and a porosity of 20% (KHS #1 logs), will amount to heat in the fluid of 6.73×10^{16} calories. The reservoir within the drilled depth has sufficient reserve to supply the proposed plant, plus considerable additional development.

System Design Features: The GRI #1 well will be reentered and pump tested. An additional standby and reinjection well are planned. A primary tube and shell heat exchanger will be used. The geothermal fluid will be maintained in the fluid state from supply to reinjection. Fan coils, radiant floor and possible plate-type wall heaters will be the principal sources of space heating. Absorption refrigeration for sprouted grain raising and liquid cooling in the feed processes will be evaluated. Heating coils in the methane digesters and in the treatment ponds will also be evaluated. The system will operate with 240°F nominal supply and reinjection at 80°F. The peak capacity is on the order of 64 million Btu/hr. The annual fuel savings is estimated to be 2.5 million gallons of oil.

Project Description: Based upon the characteristics of the Kelley Hot Springs resource, regional markets and raw material supplies, and a recent related DOE PRDA[1], a totally confined swine raising complex was proposed for a field experiment.

A 1,200 sow swine raising complex, utilizing geothermal direct energy, will be designed, developed, constructed, and operated as a field experiment. During subsequent operations, it is planned that the complex will be expanded to 4,800 sow capacity. The field experiment will be composed of a feed production facility, a totally confined system of swine raising buildings, employee services and maintenance facility, and a waste management system.

All commercial hardware will be utilized. Commercial swine raising facilities will be evaluated. Engineering design effort will be directed to adapt the commercial hardware and systems to geothermal applications. Engineering and economic trade studies will be conducted to determine benefit/costs and optimum design. Some of the important options are:

- A reinjection well vs. a reinjection pipeline to KHS #1 well.
- Geothermal hydroponic-sprouted grain raising as a feed constituent vs. purchase of barley sprouts from malting processes vs. no sprout content in the feed.
- Geothermal absorption refrigeration for various cooling loads, i.e., sprout raising, sprout processing, space cooling.
- Geothermal wall heaters vs. added insulation, and similar evaluations for all other space heat loads.
- Geothermal methane generation vs. protein extraction vs. conventional commercial sewage treatment facilities.

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[1] Mountain Home Geothermal Project, DOE Contract DE-AC07-78ET28442, 1978.

Final design will be based upon economic analysis, including consideration of geothermal and other tax incentives and their impact on the rate of return to the investors. Emphasis will be placed upon simplicity and a straightforward commercial approach.

Status: The project was entering contract negotiation at the time of this writing.

Project Title: Klamath Falls YMCA 1-78
Geothermal Space/Water Heating

Location: Klamath County YMCA
Klamath Falls, Oregon

Principal Investigator: Brian C. FitzGerald, General Director, YMCA

Project Team:

- Klamath County YMCA Board of Directors
- E. E. Storey & Son Well Drilling
- Balhizer & Colvin, Engineers
- Alan Lee, Attorney at Law
- O.I.T., Geo-Heat Research Consultants
- Honeywell Control Systems

Project Objective:

To demonstrate the viability of geothermal energy used in a non-profit social service corporation. The project is a direct use retrofit for space and water heating.

Resource Data:

The YMCA is located over the Klamath KGRA, with a present well drilled to 2,016 feet. The production capacity is in excess of 500 gpm, at 110°F. The well is cased to 512 feet, leaving exposed 325 feet of shale material. Consequently, it is felt that considerable cold surface water is mixing with hotter water found at lower levels, which include 850, 950, 1,150, and 1,345 feet. Static water temperature at 1,350 is 146°F. Bottom rock temperature is 176°F.

Systems Design Features:

A second production well is being drilled, with greater production anticipated (casing will exceed 950 ft, closing off cold surface water). The first well will then be used for reinjection. Should we be unable to improve upon our 110°F resource with the #2 well, the following design specifications will be used:

1. 348 gpm peak load pump, with a Nelson variable drive (110 gpm).
2. Transmission line, 5-inch ID black iron bedded in insulation.
3. In building heat exchangers, hot water boosted by gas and several multi-zoned fan-coil units.
4. The current conventional system supplies approximately 64,000 therms per year. The geothermal system should replace 44,000 therms, primarily in heating the water in the pool, boosting domestic hot water, and general space heating.

5. Project life-cycle estimates indicate 50-year term savings net of $4,950,000.

Project Description:

This straightforward application seeks to space/water heat a private recreation facility with geothermal fluid. The long-term benefits can profoundly impact the quality of recreation services available. For example, at present our swimming pool costs $1.15 per hour to heat. Conservative estimates, for 10 years hence, indicate a cost of $7.50 an hour. Since we are the only indoor teaching facility available year-round for a population of 60,000 people, this resource is critical. Future projections indicate an expense which would require this facility to be shut down. To a lesser degree, many other facilities and services could become so expensive to maintain as to be prohibitive. An alternative energy source then becomes critical to the life of our organization.

Status:

We have completed our environmental study and predesign phases. Work on our second well is in progress. It is interesting to note that our second well, drilled 520 ft from our first well, is encountering virtually the same aquifer formations found in the first. We will improve our position through more accurate use of technical information. With Department of Energy support, i.e., teaming arrangements, management plan, technical assistance, and bid specification packages, we have grown as customers and general contractors. There does exist a learning curve which can bring the process within the capability of a small private social service agency.

Although technical advances are being made, problems exist in the fields of general contracting (a scarce resource in the geothermal field), accounting, legal, and engineering. Since the field is relatively new, general business support has no precedent and little in the way of "automatic" business procedures. As potential users become more sophisticated and knowledgeable as to their needs, we are able to turn a sellers market into a buyers market--a process which must occur if geothermal energy is to be put to widespread use.

Project Title: Klamath Falls Geothermal Heating District

Location: Klamath Falls, Oregon

Principal Investigator: Mr. Harold Derrah, Assistant City Manager, (503) 884-3161

Project Team:

- City of Klamath Falls
- LLC Geothermal Consultants
- Robert E. Meyer Consultants

Project Objective:

To provide for initial setup of the geothermal heating district. Initial project will provide heating to 14 city, county, state, and federal buildings.

Resource Data:

Project is within the Klamath Falls KGRA. The geothermal description of the KGRA is as follows:

> In general, the fractured basalts and cinders are highly porous, being capped by a nearly impervious zone of fine grained, lacustrine, palogonite tuff sediments and diatomite, referred to as the "Yonna formation" and locally as "chalk rock". This formation, Tst on the geologic map, is estimated to be 30 to 150 feet thick in the urban area. It is also interbedded with sandstone or siltstone and fine cinders.

The predicted temperatures for the project range from 200°F to 240°F, and the wells will be drilled to the approximate depth of 1,000 feet. Reported temperatures within the Klamath Falls area have been as high as 250°F, with flows being produced up to 700 gpm.

System Design Features:

The project will involve two production wells, each approximately 1,000 feet deep, with temperatures ranging up from 200 to 240°F. There will also be a reinjection well for injection of geothermal fluids after passing through a central heat exchange facility. The heat exchanger facility is designed for plate exchangers, with the following specifications:

Type - Single pass with 150 316 sst plates, EPDM gaskets

Size - 9'3" long x 1'7" wide x 5' high.

Geothermal side - 219°F, inlet
176°F, outlet
4.3 psig pressure drop

350 gpm flow
(1,000 gpm maximum flow)

Secondary side - 200°F, outlet
160°F, inlet
3.7 psig pressure drop

378 gpm flow
(1,000 gpm maximum flow)

The estimated ΔT is 40°F. The estimated heating peak requirements for the initial project is 15.3×10^6 Btu/hr. The system will involve the use of concrete conduits to allow for future expansion, longer life expectancy of the distribution system, and lower maintenance costs. Again, with the use of the conduit, expansion will be greatly facilitated. The estimated annual savings for the initial heating of the 14 buildings is $262,000, current dollar value.

Project Description:

The project is initially for the establishment of a heating district that will provide geothermal heating to 14 city, state, county, and federal buildings. The intent of the project is to be the initial stage for a total urban heating district. Included within the project is the development of a master plan for the distribution lines, production sources, storage requirements, and peaking facilities. The initial project will involve two geothermal wells, a distribution line appropriately over-sized for future development, central heat exchange facilities, and domestic reheated water distribution system to the initial buildings. The geothermal distribution line will be placed in concrete conduit, which will provide for future growth, increased life expectancy, easy access for future maintenance and repairs, and also provide better assurance that groundwater will not provide a deteriorating factor to the life expectancy of the pipe. The project also envisions that after the water circulates through the plate heat exchange facility and has transferred the energy through the plate heat exchanger, the geothermal water will be reinjected to the geothermal reservoir for reheating and reuse. The initial project is to generate a peak heating load delivery of 15.3×10^6 Btu, with 756 gpm of estimated temperature of 200°F. The total estimated cost of the project is $1.4 million, with approximately 75% financed by the Department of Energy and the remaining match generated by local sources. The estimated savings in relation to natural gas costs is $262,000 per year.

Status:

At the date of this paper, the project is currently in the drilling status, with the completion of the conceptual design report and also an acceptable environmental report. As of the date of this report, the well has been drilled to 250 ft, and temperatures are at 137°F. It is envisioned that by the time this paper is presented one well will have been completed to approximately 1,000 ft, and the results of that particular well can be made available at that time. To date, the temperature gradient received in constant monitoring of the well within the range of 150 to 250 ft was approximately 1°F per 7 to 8 feet of drilling depth. From all indications at this time, the well should prove out to at least the specifications drawn for the project.

Project Title: Madison County Geothermal Project

Location: Rexburg, Idaho

Principal Investigator: Dr. J. Kent Marlor, Chairman, Madison County Energy Commission, (208) 356-3431

Project Team:

- Madison County; Kent Marlor, Program Director
- American Potato Company; Eugene F. Berry, Deputy Program Director
- Energy Services, Inc.; Dr. Jay F. Kunze, Project Manager

Project Objective:

To demonstrate the economics and feasibility of using a low-temperature geothermal resource for food processing and space heating applications.

Resource Data:

Madison County and Rexburg are at the eastern edge of the Snake River Plain, a plain that has recently been characterized as a young volcanic rift. Northeast trending faults, concentrated along the plain boundaries, are the source of many hot springs. The Snake River Plain has been the site of intense bimodal basalt-and-rhyolite for the last ten million years. The youngest eruptions (Craters of the Moon and Cedar Butte) apparently occurred as recently as 1,625 years ago.

Extensive exploration data include: reconnaissance-level geologic mapping and gravity surveys, electrical resistivity surveys, groundwater investigations, geochemical analyses of area wells, and a heat flow of 4 HFU.

Further indications of warm water not far below the surface exist in the Newdale area (9 miles northeast of Rexburg), with shallow (< 500 foot) wells producing 105°F and 97°F water. In the immediate vicinity of Rexburg there are several shallow wells, with temperatures in the 60's, the most promising of which is a 460-foot well with a surface temperature of 70°F.

In consideration of the available data, a geothermal resource of 350 to 450°F is believed to exist at a depth of 8,000 to 9,000 feet below the Snake River Plain. The target depth of the production well will be between 5,000 and 7,000 feet, to encounter a resource of at least 250°F.

Project Description:

Two 1,500-ft hydrological test wells and production wells at 3,000 and 6,000 feet are planned at this time. The deep well will supply 250°F water to American Potato Company for use in food processing.

Two major heat exchangers, using fresh water, will discharge into blanching units used for boiler makeup water and supply heat to belt dryers, secondary dryers, and heat-filtered air entering the plant. Madison County will then receive the partially spent water from the processing plant, at 190°F, and will supplement it with water from the 3,000-ft well, if required. Madison County will use the water for space heating purposes, using conventional heat exchangers. The annual savings in gas and oil would amount to an equivalent of 470 billion Btu (approximately 140 million kWh) by changing to geothermal energy.

Final design will be based upon the temperature of resource encountered, flow rate, and economic analysis of these factors.

Status:

The two 1,500-ft exploratory wells are being drilled at the time of this writing.

Project Title: Direct Utilization of Geothermal Resources Field Experiments at Monroe, Utah

Location: Monroe City, Utah

Principal Investigator: Mr. Duane Nay, Mayor, (801) 527-3511

Project Team:

- Monroe City, Utah
- Terra Tek, Inc.

Project Objective:

Utilize geothermal fluids from source of local hot springs to heat high school, city hall, and fire station. Install nucleus of district heating system for private and commercial usage.

Resource Data:

Sevier fault on Monroe-Red Hill KGRA Hot Spring, discharge 230 gpm at 148 to 165°F. Aquifer temperature is 169°F at 500 feet, increasing to 179°F at 1,400 feet.

System Design Features:

One production well	=	1,471 feet
One injection well	=	800 feet (estimate)
Geothermal fluid temperature	=	167°F
Circulating water temperature	=	155°F
Well pump capacity	=	650 gpm
Circ. pump capacity	=	650 gpm
Load	=	17×10^6 Btu/hr (with some fossil peaking assistance)
Candidate pipeline materials	=	asbestos cement and fiberglass reinforced plastic

Project Description:

Monroe City is a community of 1,500 people, located 160 miles south of Salt Lake City, Utah. The local economy is based primarily on agriculture. The geothermal demonstration project currently underway in Monroe will explore the economic and technical viability of the application of a moderate-temperature resource for a district heating system. The project will entail the drilling of one production and one injection well. Geothermal fluid from the production well will be piped through a central heat exchanger and then to the injection well. The expected production temperature is 167°F, at 650 gpm. The initial buildings to be heated will be the South Sevier High School, the Monroe City Hall, the fire station, and a number of small stores and residences. The system will be capable of being expanded to include the major areas of Monroe, and it is estimated that the total system will be capable of a load of 12,000 kW.

The principal investigator is Mr. Duane Nay, Mayor of Monroe City. Terra Tek, Inc., Salt Lake City, Utah, has responsibility for implementing the project, under the direction of Mr. Roger Harrison.

Status:

A 1,471-ft production well has been drilled and flow rates up to 370 gpm and temperatures to 167°F have been obtained during preliminary pump testing. Preliminary system design and costing and planning for injection well drilling is underway. Further pump testing of the aquifer is also planned.

Project Title: Water and Space Heating for a College and Hospital by Utilizing Geothermal Energy at Corsicana, Texas

Location: Navarro College and Navarro Memorial Hospital
Corsicana, Texas 75110

Principal Investigator: C. Paul Green, Institutional Development Director
Navarro College, (214) 874-6501

Project Team:

- Navarro College, Corsicana, Texas - Prime Contractor and User Facility
- Navarro Memorial Hospital, Corsicana, Texas - Using Facility
- Radian Corporation, Austin, Texas - Geothermal Consulting Engineers
- H. H. Hardgrave, Corsicana, Texas - Drilling Consultant
- Ham-Mer Consulting Engrs, Austin, Texas - HVAC Engineers

Project Objective:

The objective of this project is to demonstrate the economic and technical feasibility of direct utilization of geothermal energy. To meet this objective, this project is designed to decrease the dependence of Navarro College and Navarro County Memorial Hospital on fossil fuel by making maximum use of the low-temperature geothermal resource for water and space heating.

Resource Data:

Well tests have produced sustained flow rates of 315 gpm of 125°F water, at about 5,300 ppm total dissolved solids. The producing zone is 2,400 to 2,600 feet below the surface. The source of the heat is faulting associated with the Ouchita fold belt, which outcrops in Arkansas and underlies much of central Texas. The Woodbine Formation is the groundwater reservoir that makes up the aquifer. Hydraulic interconnection of deeper and shallow formations provided by the Mexia-Talco fault system is the factor responsible for the area's low-temperature geothermal value.

System Design Features:

One 2,600-ft production well provides the required flow for this project. Flat-plate heat exchangers will be used to achieve maximum geo-heat utilization and for ease of cleaning. Geothermal fluids will not be vented to the atmosphere so as to control corrosion and scaling phenomena. At peak winter heating periods, the geothermal heating system will deliver approximately one million Btu/hr to the college's Student Union Building (SUB), and about 3.5 million Btu/hr (peak) to the hospital water and space heating systems. This load is represented by a fluid temperature drop of 25°F at 315 gpm, and will reduce the college and hospital natural gas heating loads by 87 and 44 percent, respectively. The geothermal fluid will be disposed of by injection into a suitable horizon via a second well.

Project Description:

The purpose of this geothermal project is to retrofit a college SUB and county hospital space and water heating systems to use geothermal energy, thereby reducing their dependence on fossil fuels. The geothermal heating system will supply heat to the domestic water system, as well as the forced air heating and outside air preheating systems of the college SUB and hospital. At present, heat input to these systems is accomplished via steam provided by low-pressure, natural gas-fired boilers. These boilers will be maintained in place as backup and augmentation.

Readily available commercial piping, pumps, valves, controls, flat-plate heat exchangers, and insulation will be utilized. However, even though initial geochemistry has shown the Corsicana geothermal fluids to be relatively noncorrosive, a short series of field corrosion tests will reveal the most acceptable system materials.

The final phase is a one-year operational demonstration phase, during which potential geothermal users will be encouraged to visit and observe the geothermal heating system.

Status:

A submersible production pump has been set at 1,000 feet, and pumped at 315 gpm. Injection well drilling will commence in September 1979, and system preliminary design will begin in October 1979.

Project Title: Direct Utilization of Geothermal Energy for Food Processing at Ore-Ida Foods, Inc.

Location: Ore-Ida Foods Processing Plant, Ontario, Oregon

Principal Investigator: Mr. Robert W. Rolf, Director Technical Services, Ore-Idaho, Inc., (208) 336-6238

Project Team:

- Ore-Ida Foods, Inc.
- CH_2M Hill, Inc.
- GeothermEx, Inc.

Project Objective:

Locate and develop geothermal resource of 800 gpm at 320°F. Retrofit existing plant for potato processing, space heating, and hot potable water.

Resource Data:

Snake River Basin, (predicted) 320°F at 7,000 feet.

System Design Features:

Two Production Wells
One Injection Well
Central Heat Exchangers
Fluid Transmission Pipeline
Geothermal Fluid Temperature = 150°C (300°F)
Injection Fluid Temperature = 55°C (130°F)
Total Well Capacity = 800 gpm
Pipeline - Buried insulated steel
Maximum energy utilization via cascading
System Capacity $\sim 64 \times 10^6$ Btu/hr
Estimated Annual Fuel Savings - 97,200 MWh

Project Description:

Ontario, Oregon is located just across the Oregon-Idaho border, 57 miles northwest of Boise, Idaho. The existing Ore-Ida Foods, Inc. plant processes potatoes, corn, and onions. It is currently dependent on natural gas and oil for process heat. The plan for this demonstration program is to substitute geothermal energy for the potato processing heat and other heat loads of about 97,000 MWh annually (33.2×10^{10} Btu/yr).

Status:

An environmental report has been prepared which examines the impacts the project will have upon the environment and the Ontario area.

A seismic survey has been conducted to supplement existing geologic and geophysical data. Based upon all the data available, two production sites have been located on the Ore-Ida factory property. Drilling of the first production well commenced on August 19, 1979, and is expected to be at the target depth of 7,000 feet in 45 to 60 days.

The preliminary system design is underway. Equipment and material selections are being made and piping and heat exchanger locations are being laid out. Final design is expected to commence in late 1979.

Project Title: Pagosa Springs Geothermal Distribution and Heating System

Location: Pagosa Springs, Colorado

Principal Investigator: Fred A. Ebeling, Planning Administrator (303) 264-5851

Project Team:

- Town of Pagosa Springs
- Archuleta County
- School District 50 Joint
- Coury and Associates, Inc.

Project Objective: To provide the community with a means of using its natural hydrothermal resource for space heating at minimal cost to users and reduce local dependency upon fossil fuels. This project will determine the best methods of utilizing the hydrothermal resource, demonstrate the practicability of community space heating systems, and provide the basis for future expansion.

Resource Data: The geothermal resource in Pagosa Springs has been used on an individual basis since the early 1900's. Since then, nearly 30 wells have been drilled for heating and recreation purposes. These wells are drilled to depths of less than 500 feet and produce waters ranging in temperature from 130° to 170°F. The water quality of the resource is highly site specific. Some of the wells produce warm water which nearly meets the national drinking water standards. Others contain higher concentrations of dissolved solids similar to those of the production formation, the Mancos Shale.

System Design Features: Flow from several existing wells in the town can be used to supply the entire heating needs of the system. It is expected that with proper pretreatment the geothermal fluids can be pumped through the distribution system directly to the individual users. The geothermal fluid will then be collected and returned to a central location for either reinjection or surface discharge to the San Juan River, depending on the water chemistry. In the past, all geothermal fluids, including the natural hot springs, have been discharged to the San Juan River.

It is estimated that an average flow rate of 500 gpm is required for the system. A ΔT of 25° is anticipated at design conditions. The estimated annual cost for the fossil fuels to be replaced by the geothermal system is about $70,000.

Project Description: The Pagosa hot springs have been used for therapeutic purposes since prior to the coming of the white man. In this century, the underground reservoir has been tapped by wells and the hot water used for heating purposes in a relatively unsophisticated manner, which has presented corrosion and scaling problems. Characteristics of the resource have never been quantified--area, depth, source of heat, pressures, temperatures, water quantity, recharge mechanisms, specific geology, etc. The first phase of this project is to quantify characteristics of the geothermal reservoir. This provides a basis for determining its potential applications and the design of a system for practical utilization.

Actual construction and placing the system in operation is scheduled for completion by late 1980. The Town of Pagosa Springs will then operate and maintain the system. Operational data will be collected to allow ongoing evaluation of the system, to gain further knowledge concerning the resource characteristics and potential future capabilities.

At present, the project is in the early stages and specifics are not as yet determined. In general, all public buildings in the town (courthouse, Town Hall complex, schools, etc.) will be heated using geothermal energy. Location of these buildings will basically determine routing of the distribution piping. Other buildings, commercial or residential, which can logically be served from the distribution pipelines, may tap on. The piping will be located along easements, alleys, or streets provided by the town, county, or school district. User fee arrangements have yet to be determined.

Several options are available for the heat distribution medium. The hot geothermal water may be used directly from the underground reservoir or it may be chemically treated to counteract corrosive and/or scaling difficulties. Or, a closed, fresh water loop may go to the user facilities after heating by a heat exchanger, which isolates the geothermal water.

Options also exist for access to the subsurface geothermal reservoir. Existing, relatively shallow, wells, may be used. Or, new wells may be drilled to tap intermediate depths. Or, a combination of wells may be used. Final system design will involve consideration of several interdependent factors for optimum practicality.

The total cost of the project is estimated at $1,003,000, of which DOE will provide $779,000 and local community $224,000. The amount shared by the local community is comprised of in-kind contributions of wells, rights-of-way, easements, and work by local people. The Town of Pagosa Springs has been designated as the local lead entity by its partners, Archuleta County and the School District. Local control is, by agreement among the three entities, handled by an advisory committee consisting of interested and qualified citizens.

Status: The Environmental Report and the resource evaluation flow-test plan have been submitted to DOE-ID for review. Well monitoring equipment is being installed. A file of existing hydrological and geological data has been compiled. The project is coordinating with appropriate regulatory agencies and a survey of prospective users has been conducted. The conceptual design is ready for review.

Public meetings, news releases, and radio interviews have been used to keep the public informed. General public attendance at the Advisory Committee meetings is increasing.

Project Title: Multiple Use of Geothermal Energy at Moana KGRA

Location: Reno, Nevada

Principal Investigator: Dr. David J. Atkinson, President
Hydrothermal Energy Corporation
(702) 323-2306; (213) 654-6397

Project Team:

- Hydrothermal Energy Corporation, Developer and Heat Supplier
- Oak Grove Investors, Principal Heat User
- S.A.I. Engineers, Engineering Design and Construction
- W. L. McDonald & Sons, Drilling
- William E. Nork, Inc., Logging and Testing

Project Objective:

Thermal waters of the Moana KGRA in Reno have been used over several decades for heating buildings and swimming pools.

We shall use these waters for heating space and domestic hot water in the Sundance West apartment complex nearby.

To increase utilization of available heat and aid disposal of cooled geothermal fluids, we shall add whichever auxiliary uses prove most feasible after space and water heating is completed.

Resource Data:

The resource at Moana KGRA underlies part of southern Reno, though its exact limits have not been defined. Cool or cold water wells surround the general area of thermal water, but these wells are not spaced closely enough to map a boundary.

Geologic conditions are relatively simple. Valley fill in the area is generally 600 to 2,000 ft thick and consists of very young gravels, sands and clays. The hot water presently used at Moana comes mostly from shallow aquifers in this sequence, usually below a characteristic blue clay aquiclude.

Below this valley fill are Tertiary volcanics, principally andesite. Gravity data provide a straightforward indication of depth to this volcanic "basement", and, when combined with a detailed structural analysis, show that the shallow hot water reservoirs in the valley fill overlie part of a clearly defined upfaulted block.

Fault and fracture patterns show three main sets trending approximately N, N 40° E and N 35° W. The sense of relative displacement on these faults suggests they are conjugate shears (N 40° E and N 35° W), bisected by extension fracturing and normal faults that trend north.

Fracture zones and intersections in the volcanic basement may provide the best targets for high flow rates in our production wells.

Temperatures in some existing wells are close to boiling point, but more usually are in the range 140 to 190°F, with only about 1,100 ppm total dissolved solids.

System Design Features:

Two production wells about 1,000 ft deep will be drilled near the apartment complex where the heat will be used. The geothermal fluids will be piped underground to newly installed shell and tube heat exchangers in the existing boiler rooms.

The present heating system, using circulating hot water, was specifically intended by the creator and designer of the apartment complex, Mr. Larry Freels, to take advantage of the local geothermal energy. The task of retrofitting will accordingly be relatively straightforward. The existing natural gas boilers will be retained both as permanent backup and to handle peak loads.

Temperature drop in the geothermal water will be about 60°F. An average flow of about 70 gpm (180°F) will be needed to supply the major part of the heating load, which is 176,000 therms annually. Peak flow will probably be about 250 gpm.

The saving of fossil fuel energy (about 3.5×10^{11} Btu over twenty years) is quite significant, and will be increased by auxiliary uses of the heat remaining in the geothermal water after space and water heating.

Project Description:

The first stage of the project involves environmental clearances and obtaining the numerous permits that are required.

Then, by integrating data on geology, hydrogeology, geochemistry, geophysics, economics, and engineering, we shall select the first well site and design the well.

We shall drill a test production well, log it, and test selected intervals for flow rates and temperature. From the results, we shall design the well completion to maximize heat extraction.

From results of the pump tests, we shall finalize design of the production and distribution system, and the retrofit heat exchangers and related equipment.

Samples of the geothermal water will enable us to select, and obtain permits for, the most appropriate disposal method.

A second production well will next be drilled, utilizing the experience gained in the first.

Installation of the buried pipelines will follow, taking geothermal water into and out of the apartment complex boiler rooms. Heat exchangers will be installed in these, upstream of the present boilers where the cold return water enters after circulating through the buildings.

After testing and optimization and detailed analysis of the engineering results of the installation, the system will run on a routine commercial basis.

The best technically and economically feasible auxiliary applications will then be selected, and used to extract more heat from the geothermal water after the space and water heating load is handled.

An important aspect of the project is a program of public information to convey broadly how simple the concept of direct use of geothermal heat is, and exactly how this project was done, and what results we obtained.

Status:

At the time of writing, we are only four weeks into the project, and are working on the first stage. Drilling should begin before the end of this year.

Project Title: Geothermal Application of the Madison Aquifer for St. Mary's Hospital

Location: St. Mary's Hospital, Pierre, South Dakota

Principal Investigator: James Russell, St. Mary's Hospital Administrator (605) 224-5941

Project Team:

- St. Mary's Hospital
- Kirkham, Michael and Associates, Engineer
- Sherwin Artus, Reservoir Consultant
- Dr. J. P. Gries, Geologist

Project Objective:

Demonstrate that 106°F water can be used economically to heat buildings and also to preheat domestic hot water.

Resource Data:

The 2,100-ft well which taps the Madison aquifer is located on a vacant lot adjoining a residential neighborhood and across the street from the hospital complex. The site overlooks the Missouri River. Well test data indicate a static pressure of 480 psig maximum, and a flow of 375 gpm, with 27 psig, at 106°F.

System Design Features:

The system has been designed for 350 gpm flow at 105°F, producing 4,375,000 Btu/hr. The maximum supply water temperature out of the heat exchanger is expected to be 100°F. A corrosion and water quality report was completed by Dr. Howard and Dr. Carda of Rapid City, South Dakota. This report indicates that type 316 stainless steel is the recommended material for the thin wall plate fin-type heat exchangers.

Project Description:

(See attached well house and exchanger building schematic.) The system's three heat exchangers will provide heat for three existing hospital systems and will also serve the new hospital wing presently under construction. The existing hospital systems are: 1) space heat in existing fan coil units now used only for air conditioning; 2) space heat for the high volume of outside air (makeup air ventilation) that is required in some areas of a hospital; and 3) preheating of domestic hot water. The well is located across the street from the hospital. The heat exchangers will be located in a small building at the well site.

a) Heat Exchanger Design: Heat exchangers will be in accordance with the following design conditions:

No.	Function	Fluid		Flow gpm	Ent °F	Leav °F
1.	Building Heat	Geothermal	=	350	105	80
		Closed Loop Heating Water	=	350	75	100
2.	Preheat Dom HW utilizing geothermal discharge from exchanger #1	Geothermal	=	350	80	75
		Domestic Water	=	76	55	78
3.	Preheat dom HW (boost from #2 and full preheat when #1 is unloaded)	Geothermal	=	97	105	70
		Domestic Water	=	76	55	100

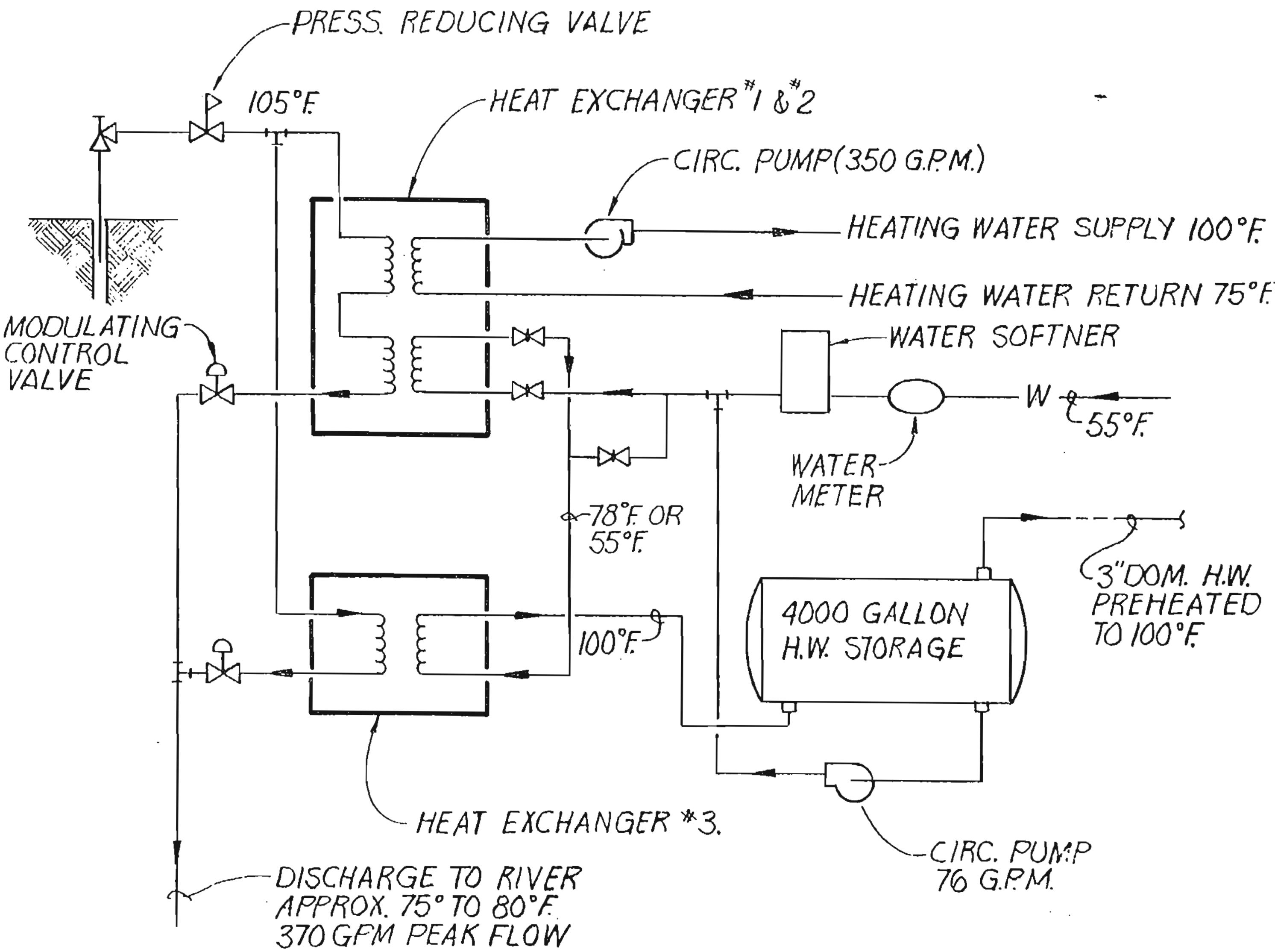
b) Makeup Air System Retrofit: A high volume of fresh air must be continuously introduced into certain areas of a hospital. This requires raising the outside air temperature to room temperature. Using the existing 6-row chilled water coil (15,650 CFM), the geothermal water supply flow would be 90 gpm at 100°F, and the leaving water temperature would be 64.5°F.

c) Fan Coil System Retrofit: The heating system in the existing hospital is basically steam perimeter radiation. The fan coil system was added to provide air conditioning. Chilled water at the average temperature of 50°F is circulated in the summer, to provide approximately 57 to 59°F supply air off the coils. In the winter time, 100°F water will be provided to these coils, to produce 87°F heated air, which is adequate to heat the spaces served during outside temperatures of approximately 2°F and above.

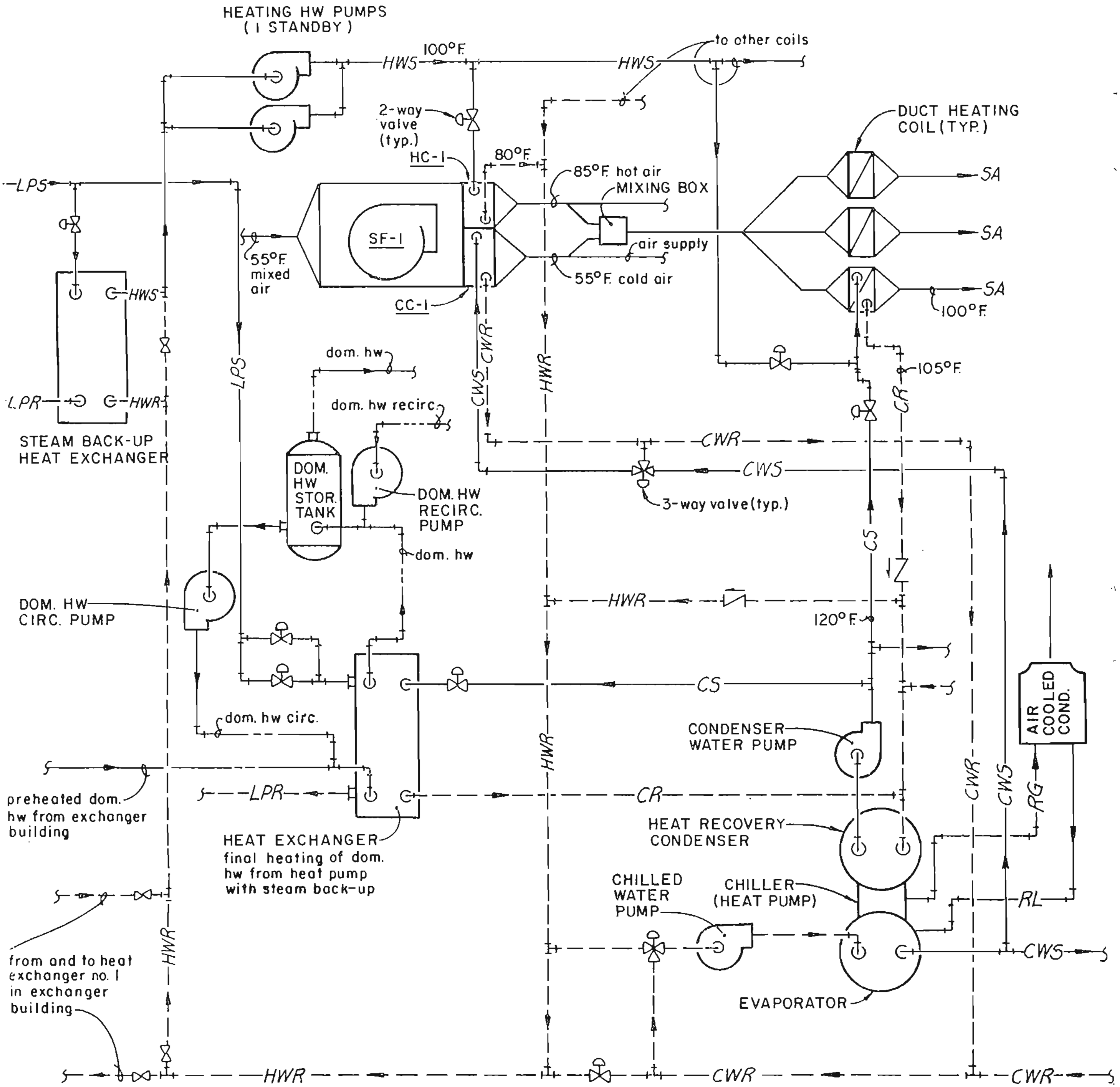
d) New Building Heating: 155 gpm from heat exchanger #1, representing 2,000,000 Btu/hr, will be available for use in the new hospital addition that is presently under construction. The new heating system is designed to utilize the geothermal heat source. (See new building heating schematic.)

Status:

The well is completed. Retrofit of the existing mechanical system will go out for bids at the end of August or early September.



3. Well House and Exchanger Building Schematic



NEW BUILDING HEATING SYSTEM SCHEMATIC

Project Title: Susanville Energy Project - Direct Utilization of Geothermal Energy

Location: North end of the Honey Lake Valley, Lassen County, California

Principal Investigator: Philip A. Edwardes
(916) 257-7259

Project Team:

- Aerojet Energy Conversion Company
- Donna Benner, Drury System Design
- Monte Koepf, Koepf and Lange, Engineering
- Fred Longyear, Lahontan, Inc., Technical Advisor
- Johan Otto, Carson Development, Management Information System/ Construction Management
- Dr. Subir Sanyal, Energetics Marketing & Management Associates, Ltd., Reservoir Evaluation/Management

Project Objective:

To displace fossil fuels and create employment. Program will heat 17 public building complexes. Effluent fluids will be cascaded through a Park of Commerce. Ultimately the heating of all commercial buildings and private homes within the City of Susanville may be feasible.

Resource Data:

Most of the temperature gradient holes developed penetrated alternating layers of basalt and mud flow (ash flow) agglomerates. Some holes encountered alluvial conglomerates. Correlation of lithological strata from one hole to another indicates faulting. This confirms the surface evidence of extensive faulting in the area. Electrical logs through the basalt layers suggest fracturing at the upper and lower limits of the layers, indicating these basalt layers, as well as the agglomerates and conglomerates, may be potential reservoir units.

Ten holes were drilled within the city boundaries and its immediate surroundings, ranging in depth from 135 m to 640 m. Six existing private wells are also within the area. Temperatures varied between 35 and 75°C. Several holes, notably in the southwest portion of the reservoir, display marked temperature reversal, with depth of 100 to 150 m in the holes with the higher temperature. In the north part of the reservoir area, reversal takes place much deeper, and the temperature zone is also thicker.

Resource data to date suggest a temperature of 75°C possible, with individual well flow between 300 and 400 gpm; a flow rate of well over 2,000 gpm is considered feasible, pending final evaluation of BuRec resource work.

System Design Features:

It is projected that there will be 3 production wells, capable of 350 gpm, pumping from a depth of 150 m x 200 m at 72°C, producing 20,000,000 Btu/hr. Two reinjection wells are planned. Water quality data to date suggests total dissolved solids of less than 1,000 PPM and pH of 7-7.5. The heat requirement of the 17 building complex (320,000 sq ft) is 12,000,000 Btu/hr; the effluent fluid reaches the park at a temperature of 110°F. A heat pump will be incorporated within the system for peaking purposes, enabling further fossil fuel displacement, and also minimizing the necessity for further wells. A relatively limited use of heat exchangers is visualized in the retrofits. Heat exchangers will be utilized only where damage to the existing hardware could be caused by the geothermal fluids. In several cases, a direct hookup will be possible; in other buildings fan coils will be used.

The economic model allows for wells to be replaced at the rate of 25% every 7 years. Initial indications are that a price to the consumer of $2.75 per million Btu could be possible. This figure could dramatically change with full utilization of the effluent fluids by the Park of Commerce.

The main transmission lines are capable of an optimum flow of 2,000 gpm; the 12-inch transmission line will be insulated, and the 12-inch return line uninsulated.

Project Description:

The Susanville project envisions in its initial phases the development of a heating district to heat 17 public building complexes and to cascade the effluent heat through a Park of Commerce.

The City of Susanville, in 1974, recognized the necessity to hold down the escalating cost of heating to the local population and to create job opportunities (the local unemployment was reaching a peak of 20% in winter months). The existence of a resource had been identified and utilized in a limited manner from the 1920's; its extent and real potential was unknown. The city believed that it was beyond the capacity of private enterprise to establish and develop the resource, so by resolution of Council, expressed its intent to develop the resource potential on behalf of the maximum number of residents for their maximum benefit. It was because of this expressed intent that Public Law 94-156 was passed, and BuRec was authorized and funded by Congress to evaluate the resource potential on behalf of the city. This extensive program is currently ongoing and is proving to be successful in its objective.

It was deemed expedient that the initial development would address publically held buildings, thus spreading the cost savings benefits to the population in general. It was also anticipated that it would be easier to attract grant funds for this objective. The Park of Commerce would be developed concurrent with the heating district.

The potential for replicating the program in many western rural areas was identified, and this formed part of the basis of justification of the project.

In January 1978, a proposal was submitted to DOE which projected a DOE contribution of $2.4 million and a City share of $1.9 million. The program was expected to extend over a 33-month period. Phase I, the design and engineering effort, is currently under contract, with Phase II, the construction phase, hopefully under contract in time to develop the first production well in December 1979. The City and its team members believe they have the capacity to have fluid flow and utilization by December 1980.

The Park of Commerce is being promoted and developed independently of DOE, but, at the same time, the City is under contractural obligation to DOE to do so if deemed feasible. Currently the City is negotiating for land suitable for such a park (200 to 300 acres). It is the City's intent to secure options on behalf of its nominees (identified industry) but not to be involved in land purchases itself. The City will and has successfully identified potential long-term loan sources for the development of streets, utility reticulation, and sewerage system for the park; the repayment will come from the developers and operators within the park.

The City intends that the Park of Commerce will have an agricultural bias, feed mill, greenhouses, and confined animal raising units. Some heat augmentation of the residual effluent from the heating district will be necessary for refrigeration, air conditioning, and sterilization of wool, etc. Various alternate energy sources are being investigated (wood waste, city refuse, and methane from the animal fattening units) to accomplish this.

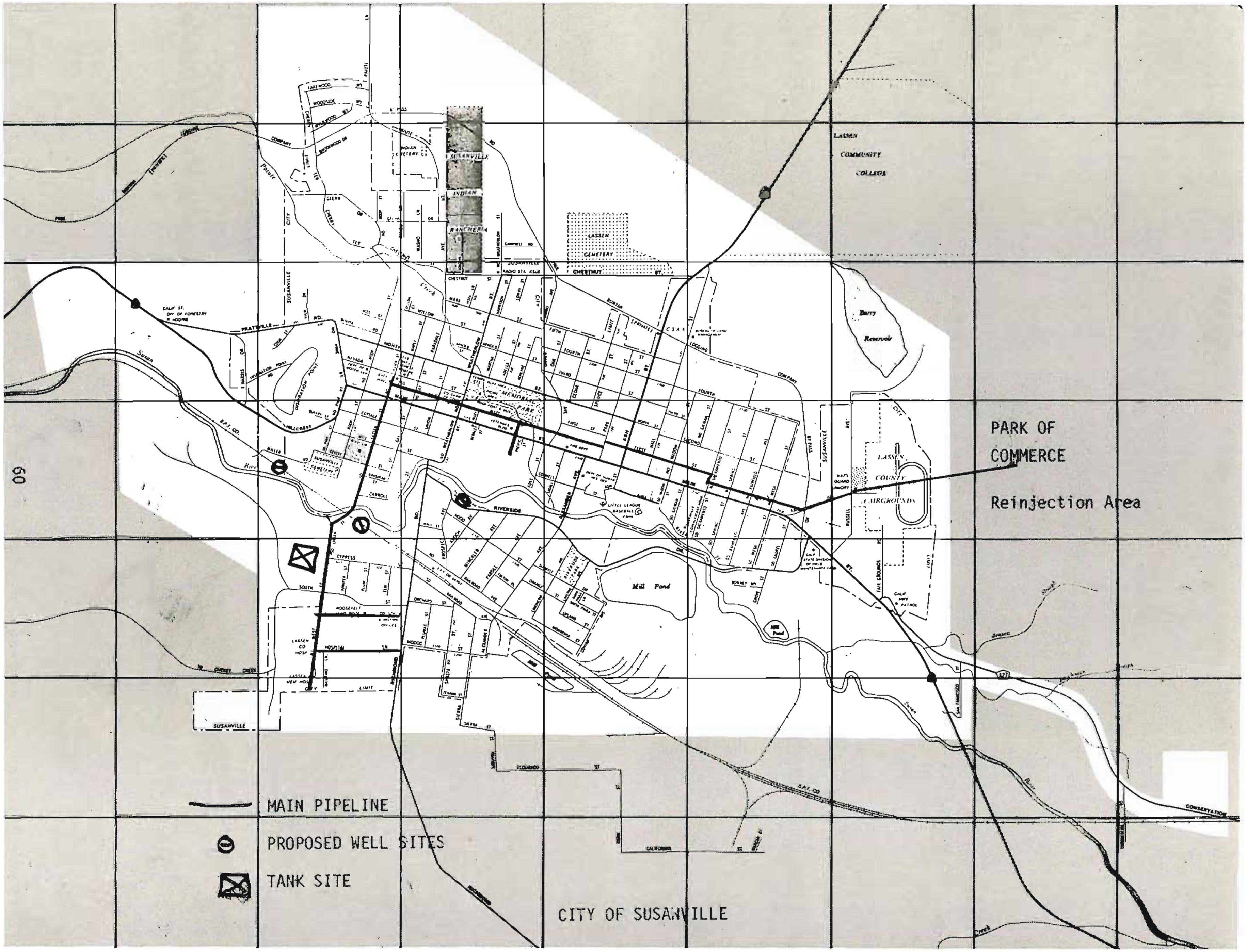
The intent of the City of Susanville is that eventually it will develop a heating district encompassing all buildings within the city. It is likely that a high percentage of Main Street commercial buildings could be heated by December 1981; progress to encompass single family homes could be considerably slower. It is recognized that the geothermal resource in itself may be insufficient for this ambitious program; however, the City believes that the cost effectiveness of utilizing wood waste from the nearby forest areas will allow it to continue in its objective of being self-sufficient in energy for heating purposes. Importantly, the City has unanimous support in its endeavor from the local population.

In recognition of the fact that a geothermal resource is finite by definition, the City introduced an ordinance to insure orderly and efficient utilization of the resource for the maximum benefit of the residents of the city. It is the declared intent of Council to make geothermal energy available to private enterprise at the lowest cost possible. The City's ownership of the total supply and distribution system will enhance this position.

Status:

Phase I: Under DOE contract since March 1, 1979 for design, engineering, and resource evaluation. Major permitting has been completed. Initial design criteria has been transmitted to engineers. Program to date on schedule.

Phase II: Construction period, hopefully, will commence in December 1979, with development of the first production well. Pipeline and storage tank construction is anticipated to commence in May 1980, concurrent with retrofit. First flow to part of the system is anticipated by December 1980. Completion and checkout is anticipated by June 1981.


PARK OF
COMMERCE
Reinjection Area
MAIN PIPELINE
PROPOSED WELL SITES
TANK SITE
CITY OF SUSANVILLE

Project Title: Direct Utilization of Geothermal Energy for Space and Water Heating at Marlin, Texas

Location: Torbett-Hutchings-Smith (THS) Memorial Hospital
Marlin, Texas 76661

Principal Investigator: J. D. Norris, Jr., Administrator
THS Memorial Hospital, (817) 883-3561

Project Team:

- THS Hospital, Marlin, Texas - Prime Contractor and User Facility
- Radian Corporation, Austin, Texas - Geothermal Consulting Engineer
- Ham-Mer Consulting Engineers, Austin, Texas - Economic Evaluation, Operation and Maintenance
- Layne Texas Company, Dallas, Texas - Well Drilling
- Spencer Associates, Austin, Texas - Architectural

Project Objective:

The objective of this project is to demonstrate the economic and technical feasibility of direct utilization of geothermal energy. To meet this objective, this project is to augment the space and water heating requirements of the THS Memorial Hospital in Marlin, Texas, with geothermal energy.

Resource Data:

Well tests have produced flow rates of over 300 gpm of 153°F water, at about 4,000 ppm total dissolved solids. The producing zone is 3,615 to 3,885 feet below the surface. The source of the heat is faulting associated with the Ouchita fold belt, which outcrops in Arkansas and underlies much of central Texas. The coarser-grained sandstones (especially the Houston member of the Travis Peak Foundation) are the groundwater reservoir that defines the aquifer. The factor which is responsible for the area's geothermal value is the hydraulic interconnection of deeper and shallow sandstones provided by the Mexia-Talco fault system.

System Design Features:

One 3,885-foot production well will provide more than the required flow for this project. Flat-plate heat exchangers will be used to achieve maximum geoheat utilization and for ease of cleaning. Geothermal fluids will not be vented to the atmosphere so as to control corrosion and scaling phenomena. At peak winter heating periods, the geothermal heating system will deliver approximately 2.5 million Btu/hr to the hospital heating load. This load is represented by a fluid temperature drop of 45°F at 110 gpm, and will reduce the THS Hospital natural gas consumption by 85 percent. The geothermal fluid disposal system design is yet to be defined.

Project Description:

The purpose of this geothermal project is to retrofit the 130-bed hospital space and water heating systems to use geothermal energy, thereby reducing its dependence on fossil fuels. The geothermal heating system will supply heat to the hospital domestic water system, as well as to the 130°F space heating and outside air preheating systems. At present, heat input to these systems is accomplished via steam provided by a low-pressure, natural gas-fired boiler. This boiler system will remain in place as backup and augmentation.

Readily available commercial piping, pumps, valves, controls, flat-plate heat exchangers, and insulation will be utilized. However, even though initial geochemistry has shown the Marlin geothermal fluids to be relatively noncorrosive, a short series of field corrosion tests will reveal the most acceptable system materials.

The final phase is a one-year operational demonstration phase, during which potential geothermal users will be encouraged to visit and observe the geothermal heating system.

Status:

A 3,885-foot deep production well was completed and tested in July 1979. Preliminary heating system design is underway, and the Preliminary Design Review is anticipated to be held in November 1979.

Project Title: Floral Greenhouse Industry Geothermal Energy Demonstration Project

Location: 567 West 90th South, Sandy, Utah (15 miles south of Salt Lake City center)

Principal Investigator: Ralph M. Wright, Chairman of the Board
Utah Roses, Inc. (801) 295-2023

Project Team:

- Utah Roses, Inc., Sandy, Utah
- Energy Services, Inc., Idaho Falls, Idaho

Project Objective:

To demonstrate to the public the potential offered by geothermal space heating in a highly populated area, by using geothermal heating in a commercial application.

Resource Data:

A large area of the southeast portion of the Salt Lake Valley appears to be underlaid by a source of warm water. Crystal Hot Springs, approximately 6 miles south, flows hot water at 180°. Several wells in the area of Utah Roses have shows of warm water, including one within 100 yards of the proposed site, which has 93°F water at 875 feet. There is evidence of a fault running east-west at our location. These indications, plus the normal temperature gradient, lead to an expectation of water at 150 to 180°F at 3,000 to 4,000 feet. Since no drilling below 1,000 feet has occurred in our area, flow rates and actual temperatures are difficult to project until actual drilling can take place.

System Design Features:

One well is projected to a 4,000-ft depth, with possibly a second well for reinjection. However, the primary plan is to discharge the water into a nearby irrigation canal, if water quality is high enough. Heat exchange will be dependent on water quality and temperature. Plans are to keep the water under pressure and run it through water/air heat exchangers in the greenhouse, with the air being distributed through polyethelene tubes located near ground level throughout the greenhouse. If sufficient flow and temperature are achieved, the entire heat load of the greenhouse will be taken over by geothermal, with an annual saving of $100,000.

Project Description:

A 4,000-ft well is to be drilled at the present site of Utah Roses, Inc., a 250,000 sq ft greenhouse which is producing cut roses for the national floral market. If water of sufficient temperature and quantity is developed, the water will be used to heat the greenhouse, replacing the current natural gas/oil usage. Since Utah Roses is well-known in the floral industry, with two of its officers serving as officers in national floral trade associations, a considerable amount of publicity has been and will be generated for geothermal energy in an industry that has a high potential for using geothermal energy.

Status:

The Environmental Report has been prepared and approved, the well design is completed, and the bid package has been sent to prospective drilling contractors. It is planned to begin drilling during September.

Project Title: Direct Utilization of Geothermal Resources, Field Experiment at the Utah State Prison

Location: Draper, Utah; approximately 22.5 km (14 miles) south of Salt Lake City.

Principal Investigator: Jack Lyman, Director, Utah Energy Office, (801) 533-5424

Project Team:

- Utah Energy Office
- Utah Department of Social Services
- Utah State Building Board
- Utah Geological and Mineral Survey
- Terra Tek, Inc.

Project Objective:

To demonstrate the economic and technical viability of using a low-temperature geothermal resource in a variety of direct applications at the Utah State Prison.

Resource Data:

The site of the Utah State Prison PON is located in the southern portion of Salt Lake County, near Draper, Utah. Located just west of the Wasatch Range, the resource is within the Basin and Range physiographic province. The surface expression of the resource is known as Crystal Hot Springs, and is located on the northern flank of the East Traverse Mountains; a horst that is intermediate in elevation, between the Wasatch range to the east and the valley grabens to the north and south. The northern flank of the Traverse Range is bound by a series of northeast striking normal range front faults, having a combined displacement of at least 900 m (3,000 ft). The thermal springs are located between two of the range front faults that are intersected by a north-northeast striking fault. Only 25 meters (80 ft) of basin alluvial material covers the bedrock surface in the immediate vicinity of the springs. The maximum measured temperature of the resource is 86°C, and total surface discharge is approximately 35 l/sec. (1.25 ft^3/sec). The total dissolved solids content of the spring water is on the order of 1,500 mg/l.

System Design Features:

The preliminary system design for the Utah State Prison minimum security block includes plans for a space heating system, with a design load of 750 kW and a culinary water heating system with a design load of 500 kW. The inlet temperature for both systems is 90°C; the outlet temperature is 75°C (T = 15°C) for the space heating system and 65°C (T = 25°C) for the water heating system. Together, these systems will require a design flow rate of 17 kilograms per second (270 gpm) and an average requirement of 5 kilograms per second (80 gpm).

One production well and one injection well (if needed) are anticipated. Siting of the production hole will be based on the results of a detail gravity survey and thermal test hole drilling program. The injection well will be drilled in the event that water quality parameters preclude surface disposal, in which case the water could be disposed of in near surface alluvial aquifers.

The conversion of the minimum security block to a geothermal heat source will result in a 10 to 25% reduction in the prison's use of natural gas and fuel oil.

Project Description:

The project is designed to provide geothermal space and water heating systems for the minimum security block of the Utah State Prison. Future expansion of the project may include the extension of these services to other buildings, as well as the use of the thermal water for a variety of other direct applications at the prison dairy and slaughterhouse. Where possible, the geothermal fluids may be used to heat greenhouses and irrigate crops.

Status:

The first phase of the project has just begun. The detailed gravity survey is in progress and plans are being made for a test hole drilling program.

Project Title: Geothermal Heating of Warm Springs State Hospital, Montana

Location: Warm Springs State Mental Hospital, Deer Lodge County, Montana

Principal Investigator: M. Eugene McLeod, Project Manager (406) 494-6420; FTS-587-6402

Project Team:

- MERDI, Inc.
- Energy Services, Inc.
- CH_2M Hill, Inc.
- State of Montana

Project Objective:

The objective of this program is to develop the geothermal resource at Warm Springs for domestic water and space heating.

Resource Data:

The Deer Lodge Valley is within the Northern Rocky Mountains physiographic province and is bordered on the east by low (generally below 8,000 ft), rolling hills known locally as the Deer Lodge Mountains. The western boundary consists of the rugged, glaciated Flint Creek Range, with elevations up to 10,171 feet (Mount Powell). The Anaconda Range encloses the valley on the south and the Garnet Range is located to the north. The valley consists of high terraces that slope downward from the mountain peaks and terminate above low terraces that grade into the Clark Fork flood plain, which forms the valley floor. This basic topography has been modified by the formation of coalescent fans and glacial moraines at the mouths of the tributary valleys and canyons. This modification is especially evident on the west side of the valley.

The valley is predominately filled with Tertiary sedimentary strata derived from the surrounding mountains. This strata has a diverse lithology composed primarily of interbedded limestone, shale, sandstone, volcanic debris, and sand. It appears to be at least 1,600 feet thick northwest of Deer Lodge and is overlain by 300 feet of Pliocene channel sand and gravel. The strata also contains bentonitic clay beds, pebble conglomerate, cobbles, and granitic debris. The maximum thickness of the valley fill may be as much as 5,500 feet east of Anaconda. The Tertiary valley fill is estimated to be approximately 2,200 feet thick in the area of Warm Springs.

The valley is a closed structural basin produced by faulting along the boundaries. The sedimentary beds in the mountains surrounding the valley have been folded and faulted. Extensive thrusting has occurred within the Flint Creek Range and several northeast-southwest trending anticlines and synclines are evident. Several faults within the mountains to the south and west are traceable into the valley, although direct evidence such as faultline scarps are lacking. The spring currently discharges water at 171°F, with a dissolved solid content of 1,250 mg/l. The source of the geothermal water is attributed to deep circulation in fault zones with a probable limestone matrix.

System Design Features:

The present drilling plan calls for drilling one production well to a depth of 1,250 ± 250 feet. Disposal of the spent geothermal water will be utilized for the creation of a wetlands for waterfowl, eliminating the need for an injection well.

The engineering design will accomplish two well-defined tasks at Warm Springs, depending upon the well flow.

1. Heating of domestic hot water; and
2. Space heating of at least two buildings.

Both heating tasks will be accomplished independently by using plate-type counterflow heat exchangers, each task having its own exchanger. The domestic hot water heating requirements are estimated to be 100 gal/min of 170°F geothermal fluid, with a ΔT of 60°F; the space heating requirements are estimated to be 200 gal/min at the same ΔT.

Project Description:

The geothermal demonstration plan includes drilling one production well to a depth of approximately 1,250 feet. The expected production temperature is 170°F, at 300 gpm. The plan is to substitute geothermal energy for domestic hot water requirements and partial space heating of the Warm Springs facility, which is currently dependent upon natural gas. The water will be pumped through plate-type heat exchangers, with approximately 490 Btu per gallon of useful energy extracted in the process. The water will be discharged at 110°F into Montana Department of Fish, Wildlife, and Park's ponds adjacent to the hospital, for the creation of wetlands for migratory waterfowl.

Status:

The Environmental Report has been prepared and reviewed by DOE. The geophysical survey conducted by the Montana College of Mineral Science consisted of gravity and resistivity surveys. The geophysical survey was supplemented by a review and interpretation of existing geologic and geophysical literature by Roger Stoker. The well site has been determined and well drilling is scheduled in September 1979.

The legal review of state regulations for geothermal exploration and drilling has been completed. Applicable permits have been acquired. MERDI is presently working with various state and federal agencies for the creation of waterfowl wetlands, using the disposed geothermal water.