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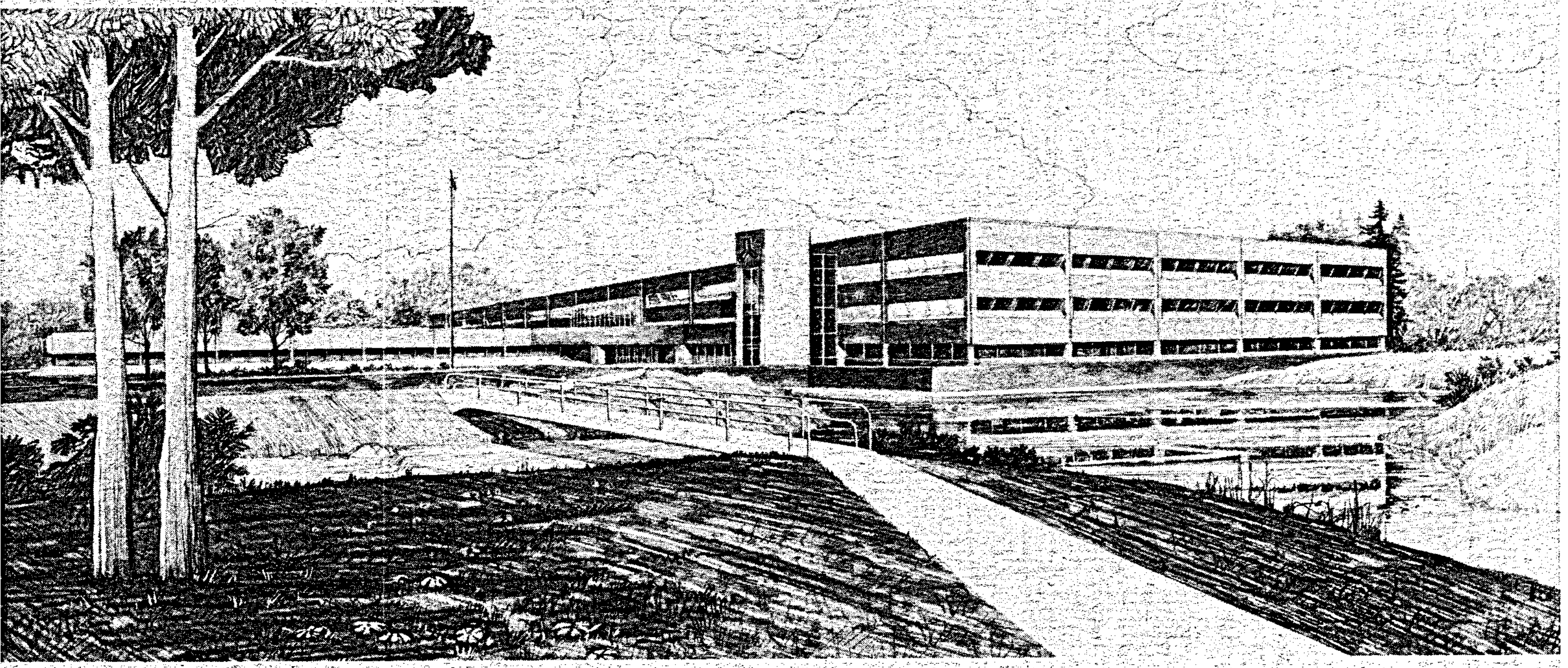

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Potential Geothermal Energy Applications For Idaho Elks Rehabilitation Hospital

John C. Austin

November 1981

Prepared for the
U.S. Department of Energy
Idaho Operations Office
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EG&G Idaho

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POTENTIAL GEOTHERMAL ENERGY APPLICATIONS FOR IDAHO ELKS REHABILITATION HOSPITAL

John C. Austin

Published November 1981

CH_2M Hill
Boise, Idaho

Prepared for EG&G Idaho, Inc.
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and the U.S. Department of Energy
Idaho Operations Office
Under DOE Contract No. DE-AC07-76IDO1570

PREFACE

This report was prepared for EG&G Idaho by CH_2M Hill on Subcontract No. K1538, Modification 1, under the Department of Energy's Outreach Program. It is now being reissued without modification as an EG&G Formal report in order to make it available to others that may be interested in this geothermal application.

ABSTRACT

Outlines several potential applications of geothermal energy for the Idaho Elks Rehabilitation Hospital. Provides a brief background on the resource and distribution system, discusses which hospital heating systems should be considered for potential geothermal retrofit, and addresses technical and economic feasibility.

CH2M
HILL
engineers
planners
economists
scientists

18 January 1980

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Idaho Elks Rehabilitation Hospital, Inc.
204 Fort Place
Boise, Idaho 83702

Attention: Mr. Richard L. Williams

Gentlemen:

Subject: Potential Geothermal Energy Applications for Idaho Elks Rehabilitation Hospital

GENERAL

We are pleased to submit this letter report which outlines several potential applications of geothermal energy for the Idaho Elks Rehabilitation Hospital. The objectives of this investigation were to provide a brief background on the resource and distribution system to determine which hospital heating systems should be considered for potential geothermal retrofit, and to address technical and economic feasibility.

GEOTHERMAL RESOURCE BACKGROUND

There is an extensive history of experience with geothermal energy in Boise. The history begins in the 1890s with the development of two geothermal production wells near the Old Penitentiary, now a part of the Boise Warm Springs Water District (BWSWD). This district is a special political subdivision of the State, created by the State Legislature. The system has continuously provided hot water for space heating since the 1890s. This long-term history provides reliable data concerning productivity of the resource wells, viability of using this resource for space heating, and operating costs of this source of energy for comparison with other sources.

More recently, a number of other resource assessment projects have been completed. Beginning in 1975, the Energy Research and Development Administration (now the Department of Energy) funded a project of resource exploration that was

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managed by Idaho National Engineering Laboratory (INEL) with work performed by Aerojet Nuclear Company and BSU, in co-operation with BWSWD. This project focused on the Military Reserve Park (also known as the Boise Barracks Property). The project entailed the drilling of two slim holes, two exploratory wells, and geophysical mapping of the resource. These exploratory wells established the presence of hot water at depths from 600 to 1,300 feet. Additional work included defining the surface geology associated with productive resource areas, gathering geophysical data, identifying other resource areas of high potential, and establishing parameters of well productivity.

The Department of Energy (DOE) and project geologists have interpreted the data to indicate the presence of a "very large" geothermal resource. This resource could be used to heat the Idaho Elks Rehabilitation Hospital, the St. Luke's Hospital Complex, the downtown Central Business District, the Veterans Administration Hospital, the Federal Building, and several schools, churches, and residential neighborhoods.

GEOTHERMAL DISTRIBUTION SYSTEM

A reliable geothermal water distribution system for Boise should be a reality in the near future. The DOE recently accepted a cost share proposal by the City of Boise and the BWSWD. DOE has agreed in principle to fund the project up to a $4.9 million maximum. A $726,000 contract has been signed between Boise City and DOE for the first phase of this project.

The long-term goal of the Boise geothermal project is to implement a complete geothermal space heating utility which will provide service to residential, commercial, and institutional customers in the area. The geothermal source should supply 170°F water in quantities sufficient to provide space heating through heat exchangers to existing commercial and institutional buildings and new home construction.

The current project is expected to include refurbishing the existing wells and transmission mains currently operated by the BWSWD. It is expected that several new production wells will be developed for the City and BWSWD.

Approximately 2 miles of new transmission main, varying in diameter from 12 to 18 inches, will be buried along public rights-of-way. The geothermal hot water will be conveyed through the transmission mains to the various buildings which will utilize the energy. Several cascading or secondary uses could be supplied in later phases (i.e., for agriculture, recreation, and horticulture).

If current planning schedules are met, well refurbishment and pipeline design for the BWSWD system will be completed by April 1980. Pipeline construction by BWSWD with service in the Idaho Elks Rehabilitation Hospital area is scheduled to be completed by the winter of 1981. The Boise City pipeline system is scheduled for completion by the winter of 1982.

The proposal to DOE identified the Idaho Elks Rehabilitation Hospital as a potential user of the geothermal water.

DESCRIPTION OF PRESENT HEATING SYSTEMS

Presently, two 60-boiler-horsepower (BHP), natural gas-fired, cast iron sectional, hot water generators (boilers), located in the 1956 Boiler Room, produce 170°F water. The 170°F boiler water is distributed through the hospital building by seven circulating pumps to four zones of space heating, two domestic hot water heaters, and one hydrotherapy hot water heater. The four zones of space heating pump 170°F boiler water directly through room cabinet convectors, room cabinet fin-tube units, room cabinet unit heaters, room cabinet fan-coil units, room cabinet unit ventilators, and heating finned coils in large central air supply units. The domestic hot water is heated in water-to-water convertors by pumping the 170°F boiler water through the convertor tube bundle and the domestic hot water through the convertor shell. The convertor shell is actually a large domestic hot water storage tank. The hydrotherapy water is heated in a water-to-water convertor by pumping the 170°F boiler water through the convertor tube bundle and the hydrotherapy water through the convertor shell. Domestic hot water for the kitchen dishwasher passes through an electric booster heater because the dishwasher requires 190°F water.

DISCUSSION OF RETROFIT SYSTEMS

Space Heating and Hydrotherapy Hot Water Heating

The proposed geothermal system for space and hydrotherapy hot water heating would utilize a highly efficient plate-type water-to-water heat exchanger. Geothermal water at approximately 165°F entering one side of the heat exchanger will heat the existing space and hydrotherapy heating water to approximately 160°F leaving the other side of the heat exchanger (see Figure 1).

To retain the existing hot water boilers as a backup for the geothermal system, the plate heat exchanger would be installed in the existing space and hydrotherapy heating water pipe loop in series with the existing hot water boilers (see Figure 1). A three-way control valve would normally bypass the existing hot water boilers. In this mode, all of the heating would come from the geothermal source. On extremely cold days, it might be necessary to divert the flow through the existing hot water boilers to boost the space and hydrotherapy heating water temperature from 160°F to approximately 180°F.

There are several distinct advantages to this scheme:

- The existing space and hydrotherapy heating water piping loops essentially remain intact.
- The existing hot water boilers can serve to boost the space and hydrotherapy heating water temperature, as well as act as a 100 percent standby.
- The system controls require no major modifications.

Domestic Hot Water Heating

The proposed geothermal system for domestic hot water heating would use a second plate-type water-to-water heat exchanger in series with the first plate-type heat exchanger. Geothermal water at approximately 140°F leaving the first heat exchanger and entering the second heat exchanger will heat the domestic cold water supply to approximately 130°F. The 130°F water would then enter the existing combination hot water heat exchanger-storage tank where it can be utilized at its present temperature or boosted to a higher temperature by the existing space heating system, using the first plate-type heat exchanger and/or the existing hot water boilers (see Figure 1).

The advantages to this scheme are:

- The existing domestic hot water heating water piping loops essentially remain intact.

- The existing hot water boilers can serve to boost the domestic hot water temperature, as well as act as a 100 percent standby.

- The system controls require no major modifications.

EXTENT OF THE RETROFIT

Although determining the optimum extent of a geothermal retrofit at the Idaho Elks Rehabilitation Hospital is beyond the scope of this reconnaissance study, the following system appears to be viable.

- One connection would need to be made to the geothermal water main, and insulated piping would be routed underground into the 1956 Boiler Room to the plate heat exchangers and back to the disposal main.

- One plate heat exchanger would be required for the space and hydrotherapy heating system and another would be required for the domestic hot water heating system.

- Generalized schematics of how this could be accomplished are shown in Figure 1.

- Approximately 100 percent of the space heating system and the domestic and hydrotherapy hot water heating system could be provided by geothermal energy which would be fully backed up by the existing hot water boiler system.

- A valved bypass pipe around each plate heat exchanger would permit isolation of the units and enable the systems to continue to operate on the hot water boilers.

Secondary Uses of Natural Hot Water

Before disposing of the spent geothermal water which flows out of the plate heat exchangers, secondary use of the resource is possible. The 100°F water could heat outside walkways, ramps, steps, and loading docks during the winter using embedded water coils. During remodeling or new construction, these systems could be conveniently installed.

Heated walkways, kept clear of snow and ice, would reduce hazards, especially to persons in wheelchairs and others with walking disabilities.

ESTIMATED PRELIMINARY PROJECT COSTS AND BENEFITS

Potential Cost Savings

In the existing hospital, nearly all of the domestic hot water heating and 100 percent of the hydrotherapy hot water and space heating hot water is provided by natural gas-fired hot water boilers. In 1978, approximately 50,000 therms of natural gas were consumed at a cost of approximately $14,000.

The planned 1980 addition to the hospital building will double the hospital floor area. This report is assuming the annual consumption for natural gas will double with the completion of the planned 1980 hospital addition. The geothermal water retrofit is sized for the existing hospital and the planned 1980 addition.

Of the annual cost of $28,000 (2 x $14,000) for natural gas, an estimated $16,480 (2 x $8,240) is required for space heating. The remaining $11,520 (2 x $5,760) is for domestic and hydrotherapy hot water heating.

Potential energy cost savings exist because of the lower cost of geothermal energy in comparison with other energy sources, such as natural gas. If the average temperature drop between the geothermal supply and the spent geothermal water were 50°F, the unit of geothermal energy would be approximately $0.16 per therm*. Natural gas costs in 1978 averaged $0.28 per therm. However, heating with natural gas is only 80 percent efficient, which means that for every 10 therms of natural gas used, only 8 therms of heating was provided. Therefore, the effective cost for gas is even higher--approximately $0.34 per therm of usable energy. In other words, the geothermal water could provide 2.1 times as much heat per dollar: 2.1 x $0.16 = $0.34.

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*One therm = 100,000 BTUs of energy.
Cost of geothermal water based upon $.50 per 100 cubic feet as per the State of Idaho/BWSWD contract.

It is anticipated that the cost of natural gas will rise at least 7 percent annually. The cost of geothermal water is not expected to rise at such a rapid rate. This is another point in favor of geothermal energy.

If 80 percent of the space, domestic, and hydrotherapy hot water heating could be supplied by geothermal water, an estimated annual savings of $11,730 might be realized:

Space Heating

For gas - 80% x $16,480	=	$13,180
For geothermal water - $13,180 ÷ 2.1	=	6,280
Estimated savings -		$6,900

Domestic and Hydrotherapy Hot Water Generation

For gas - 80% x $11,520	=	$9,220
For geothermal water - $9,220 ÷ 2.1	=	4,390
Estimated savings -		$4,830

Total Estimated Savings - $6,900 + $4,830 = $11,730 annually

System Operating Costs

The geothermal retrofits previously discussed would not involve extensive maintenance because there are relatively few major components involved, primarily the plate heat exchangers and the geothermal supply pumps. The plate heat exchangers are easily disassembled and seldom require cleaning. The geothermal water supply pumps would be small centrifugal units, similar to the existing hot water circulating pumps. Power input to the geothermal water supply pumps would be relatively insignificant.

Preliminary Estimate of Retrofit Cost

Although the scope of this reconnaissance study did not permit a detailed assessment of the materials and labor involved in the retrofit, we have prepared a preliminary cost estimate. This estimate is based on the anticipated number and approximate capacity of the plate heat exchangers and geothermal supply pumps, including the associated piping, valves, and controls. Since the estimates for the retrofit were complied using cursory information in conjunction with experience in similar retrofit situations, the cost figures presented herein should be used for budgetary purposes only. During subsequent phases of the project, additional technical and economic data may become available which could affect the cost estimate.

SUMMARY OF ESTIMATED COSTS

Distribution System and Piping	$16,800
Plate Heat Exchangers and Pumps	18,000
Valves, Controls, and Instrumentation	9,000
Administration and Engineering	6,000
25 Percent Construction Contingency	11,000
TOTAL ESTIMATED COST	$60,800

ECONOMIC FEASIBILITY

In terms of 1978 energy costs, an estimated annual cost savings of $11,730 is attractive compared to an estimated project cost of approximately $60,800.

It is probable that the cost of natural gas will increase at a rate greater than the 7 percent indicated above. Intermountain Gas indicates that they expect the cost of natural gas to increase at a rate at least equal to the national inflation rate. A preliminary economic analysis for the Boise Geothermal System has been completed and is presently being reviewed. The tentative results of that study indicate that $0.16 per therm for the cost of geothermal energy is a reasonable estimate for a publically-owned geothermal system in Boise. However, these results are tentative, and considerable analysis and policy discussion must occur before a final rate estimate can be made.

A preliminary design study should be undertaken after the Boise Geothermal preliminary design report is completed. This report is scheduled for completion in April 1980. If the economics continue to appear positive, final project design for the Idaho Elks Rehabilitation Hospital retrofit should commence in October 1980. Construction would be scheduled to coincide with the completion of the BWSWD pipeline.

* * * * * * * * * * * * * *

We appreciate the opportunity to prepare this report and to work with you and your staff on this most timely endeavor. We are looking forward to assisting you in the future. If you have any questions about the report, please contact us.

Sincerely,

John C. Austin

John C. Austin, P.E.
Geothermal Projects Engineer
CH2M HILL

Roger R Bissell

Roger R. Bissell, P.E.
Division Manager
Industrial and Energy Systems
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Attachment

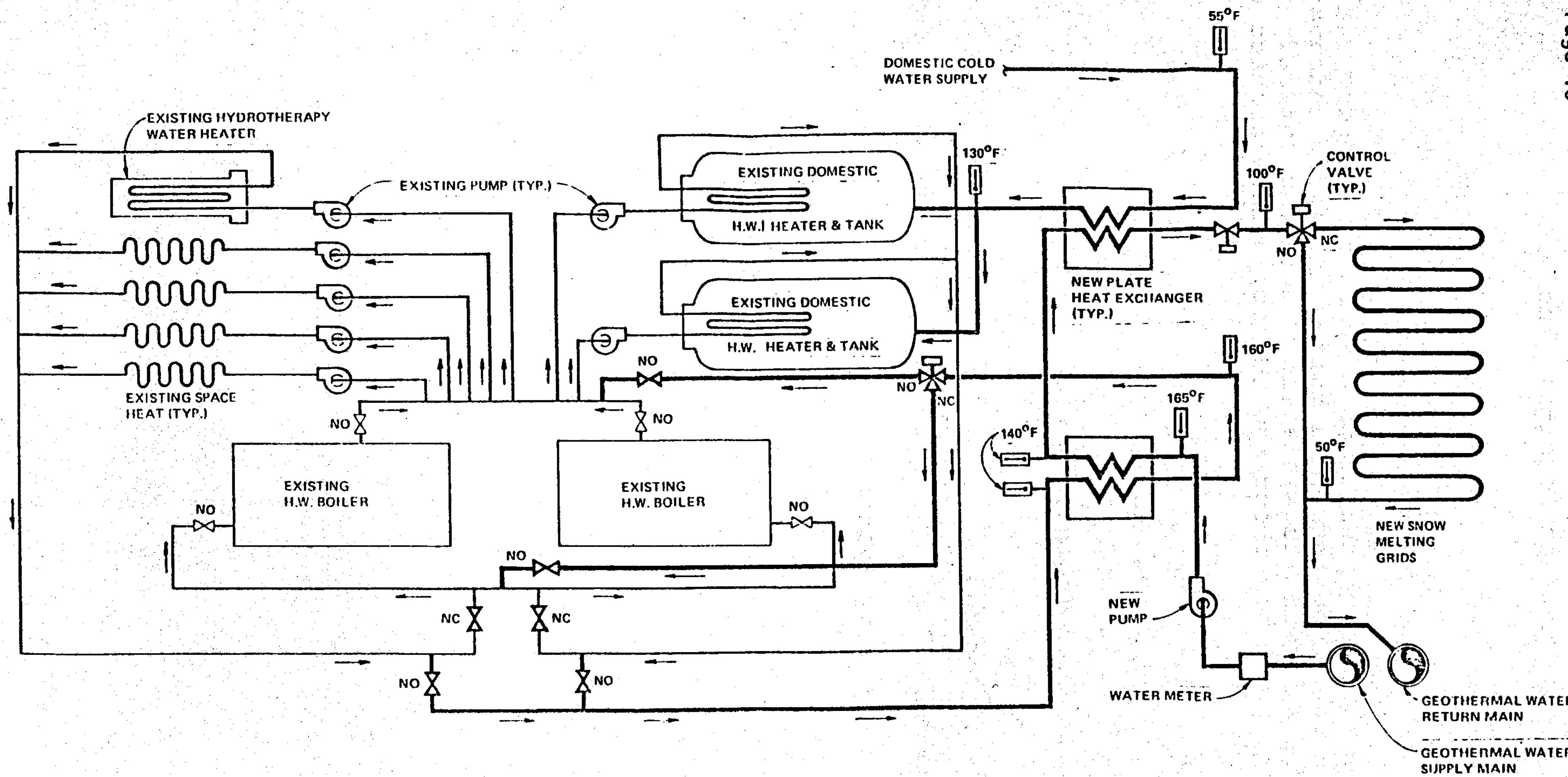

FIGURE 1

GEOTHERMAL WATER RETROFIT

ELK'S HOSPITAL

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