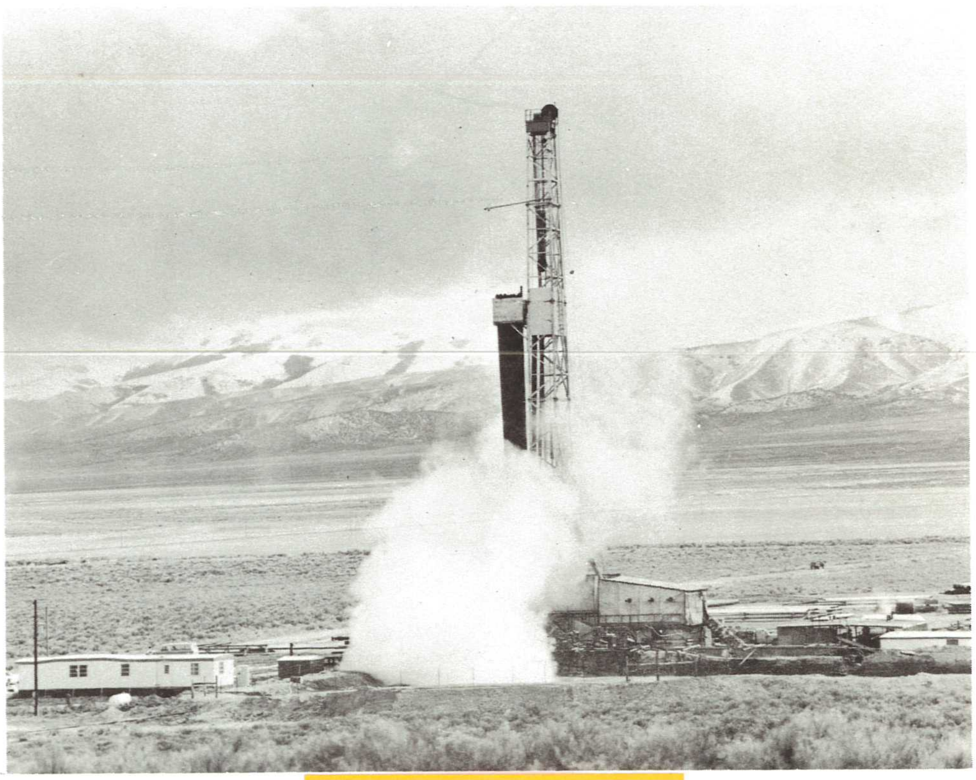
IDAHO GEOTHERMAL DEVELOPMENT PROJECTS

REPORT FOR THE YEAR ENDING FEBRUARY, 1976



IDAHO NATIONAL ENGINEERING LABORATORY

OF THE

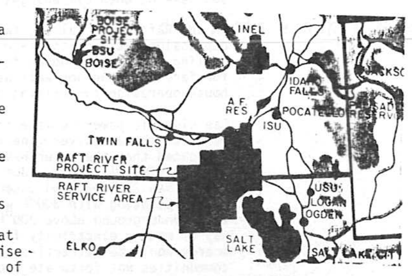
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Geothermal Projects at the Idaho National Engineering Laboratory were initiated formally in 1973. These are research, development, and demonstration efforts to determine if the moderate temperature resources of geothermal energy can be harnessed economically to produce electricity and supply heat.

The Raft River site was initially chosen over many other candidate sites because it appeared to represent an average valley geothermal setting for the Intermountain area. Early geological and geophysical exploration work, principally by the U.S. Geological Survey, confirmed the early assessment. Temperatures were likely to be in the 300°F range, at least 70°F below that temperatures of currently operating geothermal power plants around the world. The preliminary exploration neither confirmed nor denied the presence of a large reservoir. The few hot wells that were accidently tapped were probably finding seeps up fault zones.

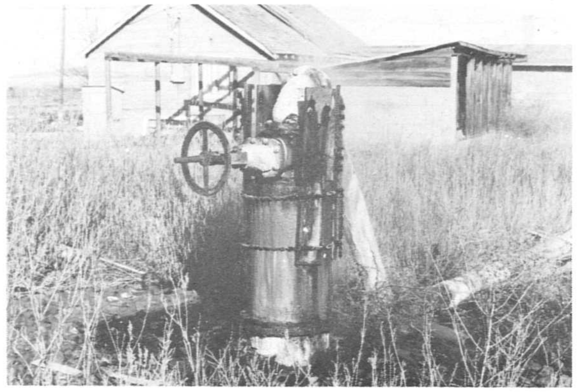
The Energy Research and Development Administration, with its Idaho National Engineering Laboratory is the principal sponsor of the work. The Raft River work is dedicated principally to finding new techniques for making geothermal energy, in the temperature range of 300°F, economical for generating electricity. Other participating and cooperating organizations are: The Raft River Rural Electric Cooperative, the utility serving the 10,000 square mile area; the Northwest Public Power Association; the U.S. Bureau of Land Management; the State of Idaho; Reynolds Electric and Engineering Company, as well as a number of universities and the U.S. Geological Survey.

Concurrently, a small project was undertaken in Boise, Idaho where a geothermal resource of even lower temperatures appears to be plentiful enough to heat not just 200 homes (as has been done for 84 years), but perhaps as much as the entire city. The study of the feasibility of expanding the use of this 170°F water to heating the State Capital and office building complex is nearly complete, showing a $300,000 annual fuel savings is possible by using geothermal waters from several more wells that would need to be drilled. The Boise State University and Idaho Bureau of Mines and Geology are principal participants, along with INEL, in this work.



For further information, contact:

Dr. Jay F. Kunze, Advanced Programs and Geothermal Projects Manager, Idaho National Engineering Laboratory
Mr. John L. Griffith, Advanced Technology Officer, ERDA, Idaho Falls, Idaho
Mr. Lowell G. Miller, Geothermal Field Operations Manager, INEL
Mr. Robert J. Schultz, Non-Electric Geothermal Manager, INEL
Mr. Roger C. Stoker, Project Geological Engineer, INEL
Mr. Jud F. Whitbeck, Power Plant Design Manager, INEL
Ms. Susan G. Spencer, Environmental Project Engineer, INEL



One of the 40 year old wells, now heating a greenhouse near Bridge, Idaho

THE RAFT RIVER GEOTHERMAL PROJECT - THE KEY TO:

A local source of power in a state having no coal, oil, or gas

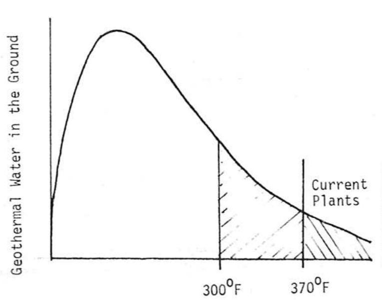
A demonstration of improved techniques and economics

The harnessing of the bulk of the hot water underground throughout the Western United States

The story of Raft River is typical of virtually every valley in the Rocky Mountain West. An occasional warm spring, a well that produces annoyingly warm water. Some places swimming pools were built, or an occasional greenhouse. But seldom did anyone seriously consider the water as a major energy source--not when oil and gas were available so cheaply and conveniently.

In the Raft River Valley, two of the many irrigation wells drilled during the depression years of the 1930's eventually became naturally flowing wells of boiling water. Abandoned for nearly 30 years--"Who can use boiling water for farming," the one well was converted in the 1960's to heat a small greenhouse operation for raising tomatoes and flowers.

Can electric power be made from the Raft River Geothermal Waters? Measurements of the dissolved minerals in the water coming from the old wells indicated that the water had originated from a reservoir at a temperature of approximately 300°F. But geothermal power plants in California, Mexico, Italy, New Zealand, and Japan use steam at 370°F or higher. A similar power plant operating with 300°F water would be expensive. But, there is much more water underground above 300°F than above 370°F. If a different and cheaper way of making electricity from the more abundant waters can be found, geothermal energy would be attractive not only to Raft River but to those many, many other communities not fortunate enough to be near the very few high temperature resources.



There is much more water and energy in water between 300°F and 370°F than above 370°F

GROWTH OF THE RAFT RIVER PROJECT

In 1970, the management of the 1800 consumer-owner member electric cooperative serving the area took a closer look at the geothermal resource. The Raft River Rural Electric Cooperative hired a geologist to gather all available data and analyze it.

Where was the heat coming from? Is there just a "trickle" of hot water, or is it a huge reservoir?

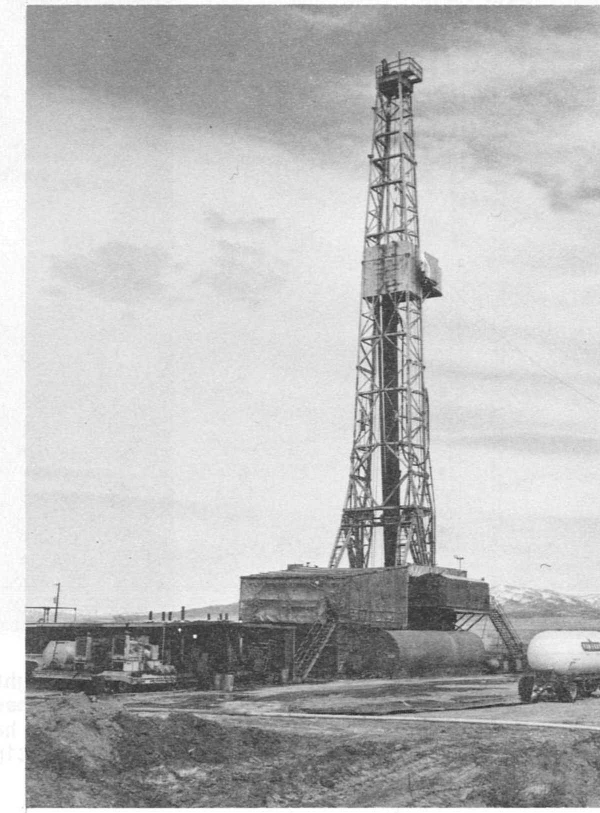
It is difficult to answer these questions from on top of the earth's surface. But a start was made.

Then the Idaho National Engineering Laboratory, where 51 experimental nuclear reactors had been built since 1949, turned its attention to a local source of untapped energy--geothermal. In early 1973, INEL and the Raft River Rural Coop. were working together to further probe the area's geothermal potential with shallow exploratory drilling.

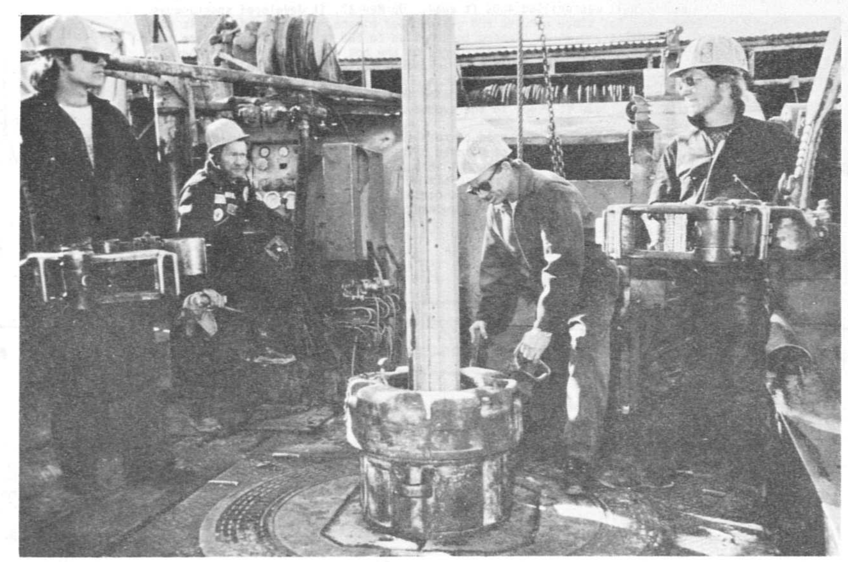
In late 1973, the U.S. Geological Survey crews moved in with the latest sophisticated electronic techniques to probe the underground. The results were in by October 1974; encouraging, but not unusually promising.

In the fall of 1974, the three Northwest governors, convinced by Governor Andrus that the River River area potential was typical of that throughout much of the Northwest, contributed $200,000 of Pacific Northwest Regional Commission money to get the first drill hole started. Most of the Northwest's 104 publicly owned utilities also backed the project with contributions to assist the Raft River Rural Electric Coop. All were convinced they wanted to know as soon as possible whether they could count on geothermal power from such moderate temperature waters.

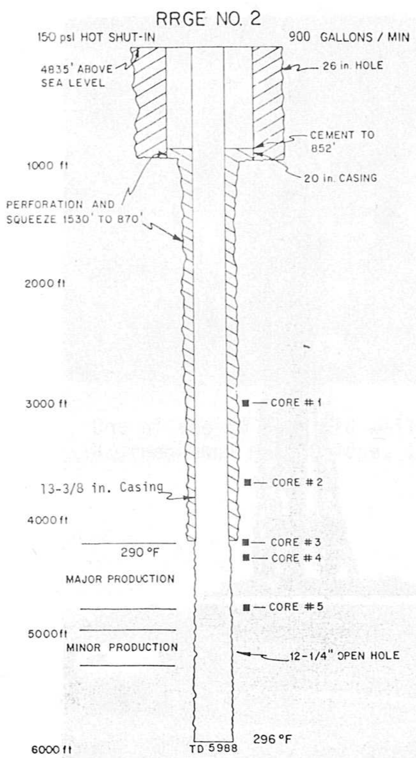
In the cold of December 1974, a large drill rig was set up near Bridge, Idaho, to be manned by drilling crews of the Reynolds Electric and Engineering Company from Las Vegas. The engineers from INEL made plans for the rig to drill to 8000 ft, hoping somehwere along the way a large flow of the predicted 300°F water would be encountered. Plans were made to stimulate the well with high pressure water or chemical explosives if it wouldn't yield the desired hot water.



The drill rig against snow-capped Jim Sage Mountains



Drilling crew on the platform, near rotating table and drill rig controls



Cross section of the second well

The nights of February 2, and 3, 1975, when the first well developed such a large flow of boiling water that the valves had to be closed and a plan developed for safely completing the well.

WHAT IS HAPPENING NOW?

A 12-inch diameter pipeline has been buried underground between the two wells and is being used to transfer the water pumped from the first well to the second, where it is reinjected into the geothermal aquifer. Flows of up to 1900 gallons per minute of 280°F water have been delivered through the concrete asbestos pipeline.

Reservoir Engineering

How long will the reservoir last? How big is it? During last fall, data was gathered using sensitive pressure and logging instruments. The No. 2 well was flowed for six weeks while the No. 1 well was monitored. At this time, we can only say that the permeability of the reservoir is much better than expected and the six week test only indicated that the reservoir is at least several square miles in area, and probably at least 500 ft thick.

Environmental Controls

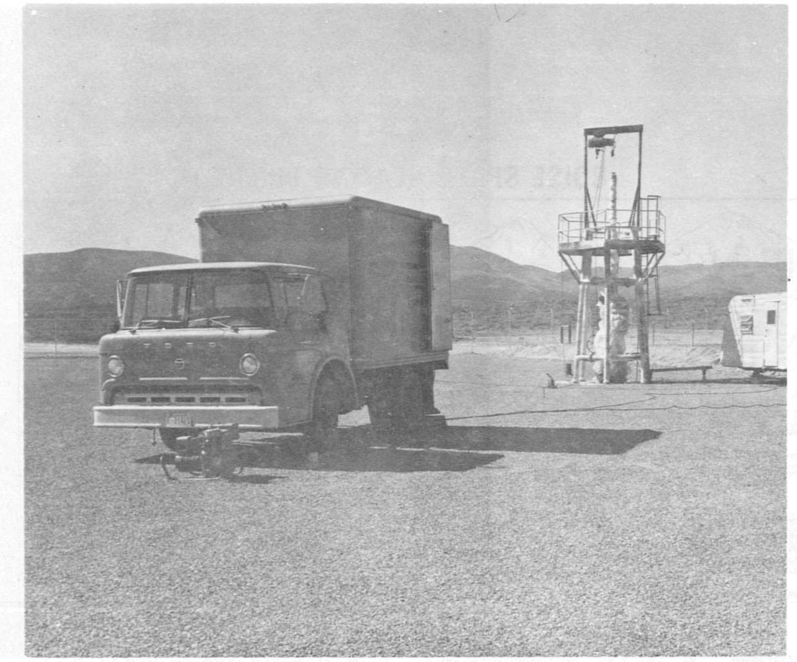
The key is putting the water back into the ground. Though clean by geothermal standards, it is believed that the sodium salts in the water would eventually accumulate to harmful levels if the water was used to irrigate for many years. Reinjection also maintains the fluid quantity in the ground, preventing settling (subsidence). Reinjection is being carefully monitored by sensitive seismometers, and all natural water sources are routinely being examined for flow and chemical content to be sure that the geothermal activity has no affect on these. The air quality is being examined, and the surrounding vegetation and animal life carefully monitored. All the care is to be convincing in the contention that geothermal energy can be one of the most environmentally acceptable forms of energy.

Corrosion and Deposition Testing

Geothermal fluids are generally thought of as being highly corrosive and difficult to handle. This is generally true, particularly of the high temperature fluids which have or may have as much as 30% dissolved solids content. The more moderate temperature fluids have low salinity; in the case of Raft River, less than 2000 parts per million. Also, the absence of oxygen in the water makes the fluid non-corrosive until exposed to the air. Even though these moderate temperature fluids are relatively easy to handle, a thorough testing program is being conducted in the field, on samples of materials that will be used to build the power plant.

Heat Exchanger Testing

Several new heat exchanger concepts are being tested. One, instead of using tubes to separate the geothermal water from the isobutane, mixes them directly for good heat transfer. They do not dissolve each other, and theoretically can be easily separated to go their separate paths.



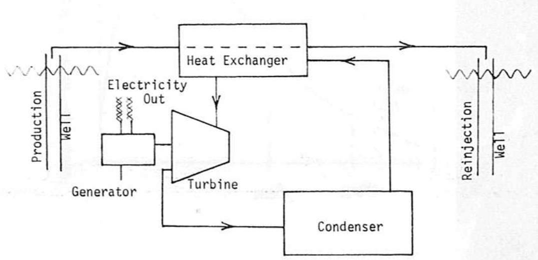
INEL well logging truck lowering temperature probe into well

WHAT HAS HAPPENED?

The first deep well began to flow on February 2, after being drilled to 4500 ft. Upon being cased and cemented, the flow became a steady 600 gallons per minute naturally. A pump was set at the 650 ft depth a few months ago, and is able to deliver a steady 900 gallons per minute without drawing down to more than 450 ft in the well.

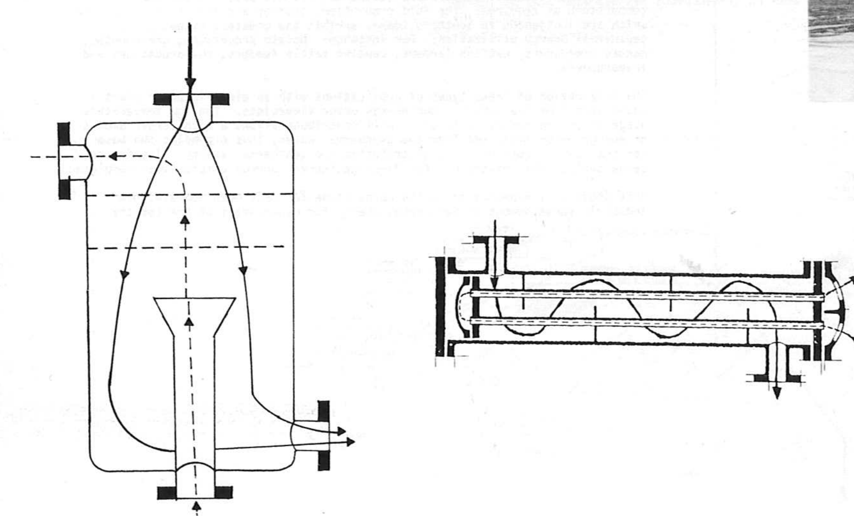
A second well was drilled 4000 ft away. On May 27, it developed spontaneous flow, that has since reached 900 gallons per minute. The second well is now 6000 ft deep, and it is planned to drill up to 500 ft deep because there is reason to believe that the main source of the hot water may still not have been penetrated. The temperatures in the second well are a few degrees hotter (296°F) than the first, which has been drilled to 5000 ft. The main flows from the first well appear to be coming from the 4000 to 4500 ft level, and from 4200 to 4800 ft level in the second well.

Since 296°F water will not produce much steam, it is planned to use isobutane to operate the turbine of the planned pilot power plant. The geothermal water will heat the isobutane, turning it into a vapor. The experimental pilot plant and test facility should be an exciting effort since none has ever been built or operated. But, if it operates successfully, it will produce twice as much power as could be produced by a standard steam power cycle.



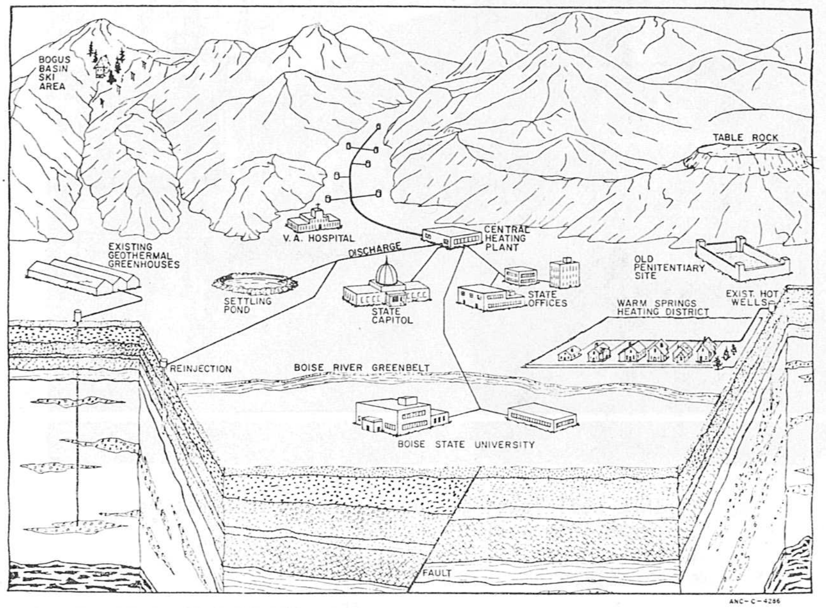
Binary-Isobutane cycle generating 15 MW gross (10 MW net) from 5000 gallons/minute of 300°F water

Corrosion Test Trailer



Heat Exchanger (fluidized bed and/or direct contact)

BOISE SPACE HEATING PROJECT

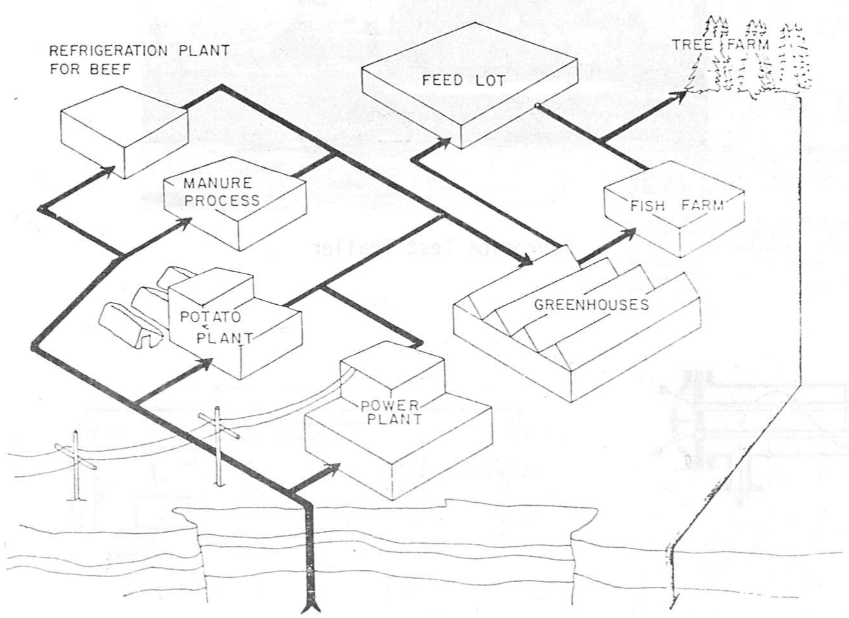


DIRECT USE OF THE HEAT

Hot water has been and still does create the heat distributing system in many homes and buildings today. Geothermal hot water at 170°F has been used along Warm Springs Ave. in Boise, Idaho since 1892. Produced from wells along an earthmovement fault at the northeastern foothills, the water is piped up to two miles in uninsulated pipes.

Today, improvements on such a system would be few. Boise would not appear to be in an unusual geological setting. Many cities and small towns in the West probably could have available lukewarm geothermal water within several miles of its homes and buildings.

The Boise plan of INEL is to examine the costs of using geothermal water from new wells to be piped to the state capitol, office buildings, and university buildings, supplying all or most of their winter heat. Three exploratory wells were drilled this winter, and the pipeline and building heating conversion systems designed. It appears that the fuel savings at present prices should pay for the system in less than 10 years, including provisions to dispose of the fluid.

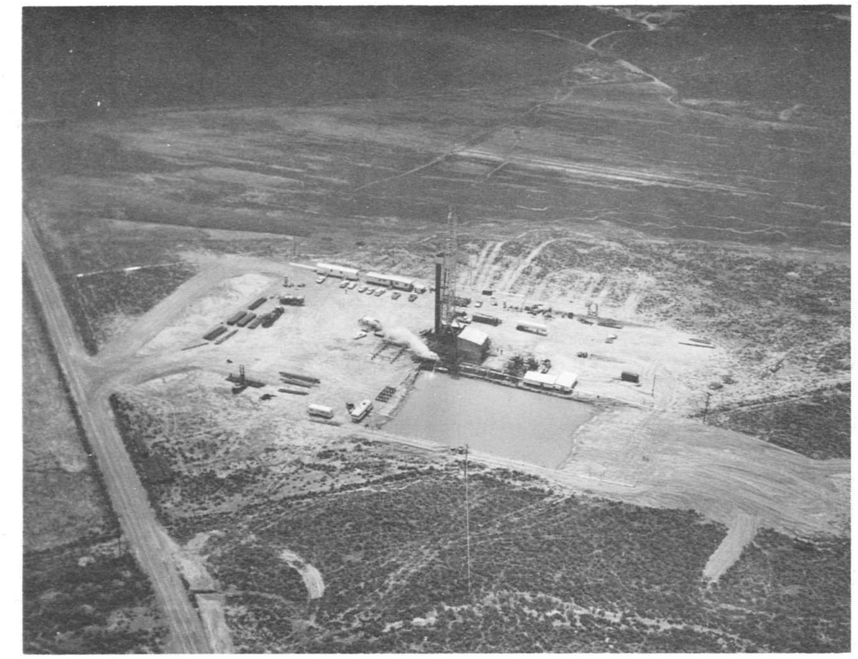


Integrated Raft River Geothermal Energy Complex

The 300°F geothermal energy resource can also be used for industrial process heat. The Raft River Project is being considered as a demonstration site to prove the viability of geothermal energy in industrial processes. INEL has been working with many industrial groups to develop their interest in participating in a demonstration at Raft River. The demonstration units will by necessity use moderate temperature geothermal fluids, possibly boosted in temperature as required. The food production, storage and processing industries, which are indigenous to Southern Idaho, exhibit the greatest potential for geothermal energy utilization. For instance: potato processors, greenhouses, manure processors, catfish farmers, captive cattle feeders, and processors and treebreeders.

The integration of these types of applications with an electric power plant is sound both from the economic and energy usage viewpoints. The low temperature usage which the non-electric units will contribute allows a much larger amount of energy to be extracted from the geothermal water, thus expanding the base for the cost of obtaining and distributing the geothermal energy. The figure below depicts the integrated Raft River geothermal energy complex when completed.

This project is expected to be the cornerstone for continued non-electric industrial development of geothermal energy for other areas of the country.



Air view of one of the well sites. Underground pipelines will connect the various wells

WHAT ARE THE FUTURE PLANS

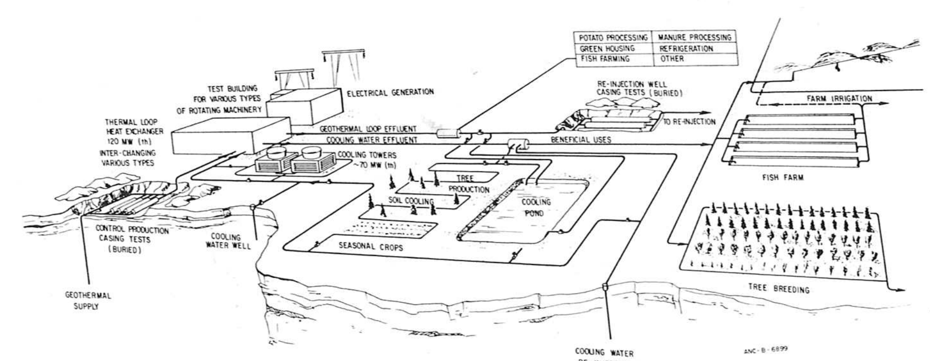
The Raft River resource is now proven to be large enough to conduct the needed experiments involving:

Six or seven wells--some used for reinjection

A surface test facility equivalent to 10 MW of electrical power output

1. To operate the basic isobutane power cycle
2. Conduct the experiments to further improve the economics of that power cycle
3. To use as much of the heat as possible in a beneficial way

The main goal is to show how to economically use geothermal energy in Raft River, so that such use can subsequently be made in many, many other valleys of the West.



Test facility for operating the basic cycle and experimenting with improved concepts