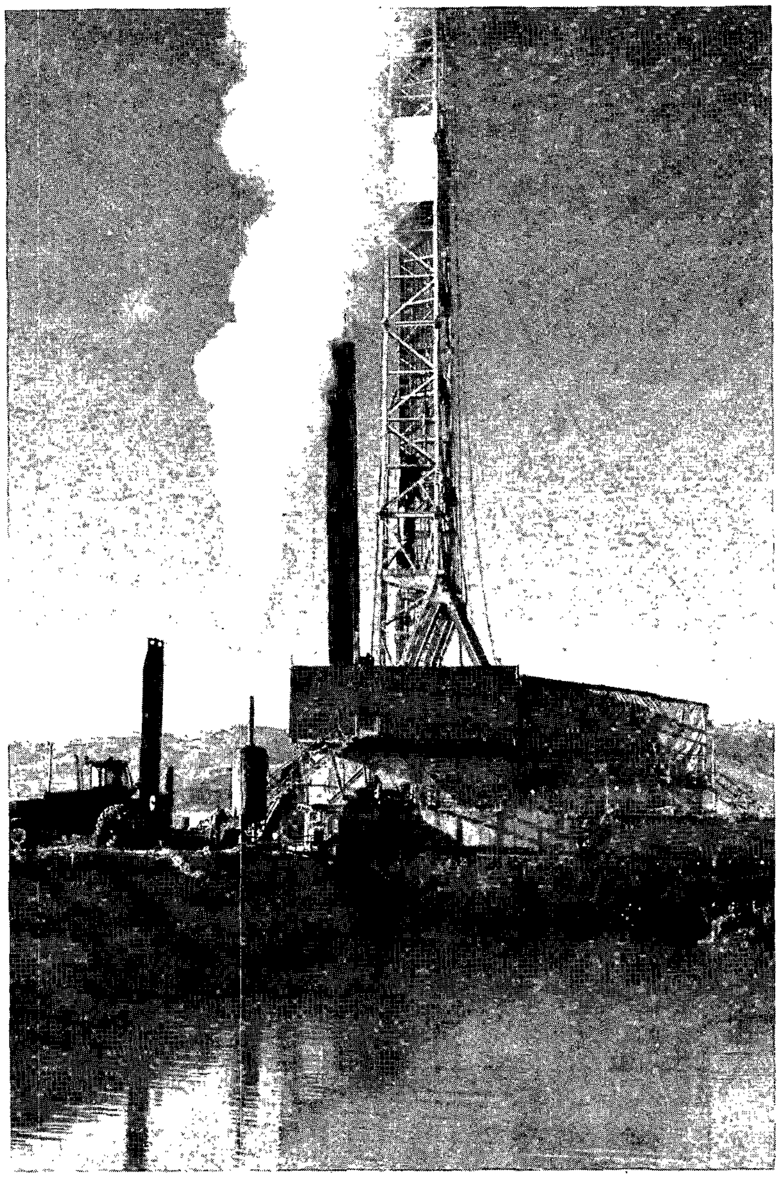
IDAHO GEOTHERMAL PROJECT



January 1978

Sponsored by
THE U.S. DEPARTMENT OF ENERGY
Conducted by
EG&G Idaho, Inc.
IDAHO NATIONAL ENGINEERING LABORATORY
Idaho Falls, Idaho 83401

SITE VISIT BY INDUSTRY REPRESENTATIVES

FOR 9-20-78

AGENDA

12:00 - Meet at Site 1 Conference Room for box lunch.

12:00 - Discussions

Mike Wright - UURI, Regional Geothermal Reservoirs and characteristics

Site Representative - Overview of Raft River Site activities

Direct Applications Representative - Overview of geothermal direct applications potential and site experiments.

a. Geothermal Drying - Lance Cole
b. Aquaculture - J. F. Sullivan
c. Heat Dissipation - Soil Warming - N. E. Stanley
d. Other activity projections - R. C. Schmitt

1:30 - Tour Site Area

Raft River Geothermal Project - Gary

7 wells
- 4 supply
- 3 injection

} Power plant to use 3 supply, 2 inject.

2-2½ mi area between wells

Aquiculture & Environmental Program - Jackie Sullivan

- monitoring existing irrigation wells in area
- geologic aspects monitored
- affect on aquatic & terrestrial animal & plant life
  - esp. ferruginous hawks
- monitor climate

Malta, Idaho, has one cafe. If you wanted a cup of coffee while driving from southern Idaho (Twin Falls, let's say) to Salt Lake City (to go skiing, perhaps?), the Valley Cafe would be one of your few choices between Burley and Tremonton.

As you kick the snow off your shoes and enter the little cafe, you notice the flowers. Every window frames at least one dahlia, and every table holds a vase of two or three. The nearest retail florist is 50 miles away, you realize, and flowers don't grow in snow. You can't imagine how much it would cost to heat a greenhouse in this Rocky Mountain winter. Does the cook double as an indoor gardner, growing flowers under artificial light in a room behind the kitchen?

That's not the case, you soon discover. But there is a greenhouse. The heat is almost free--Crook's greenhouse in the Raft River Valley is heated by geothermal energy.

Crook's greenhouse at Malta, Idaho

The valley is a center of geothermal research, in fact. Nearly a mile beneath the valley floor lies a reservoir of 300°F water, and the Department of Energy and EG&G-Idaho, Inc. are conducting research for their Moderate Temperature Geothermal Electric Program 15 miles south of Malta. The hot water should one day give the town all the energy it needs.

The valley's geothermal resources are anything but unique, however. Waters of this kind—of moderate temperature—are abundant throughout the West. If techniques now being tested at Raft River prove effective, the energy problems of the Rocky Mountain West may be greatly alleviated.

Pilot generating plants will use a dual-cycle system; geothermal water will heat a fluid known as isobutane, which in turn will drive a turbine generator. In this way, the somewhat corrosive waters will not be able to foul expensive equipment, and the brines can be easily injected back into the ground. If the system works, and if the power can compete economically with electricity produced in nuclear and coal-fired power plants, the nation will be a great deal more energy-independent.

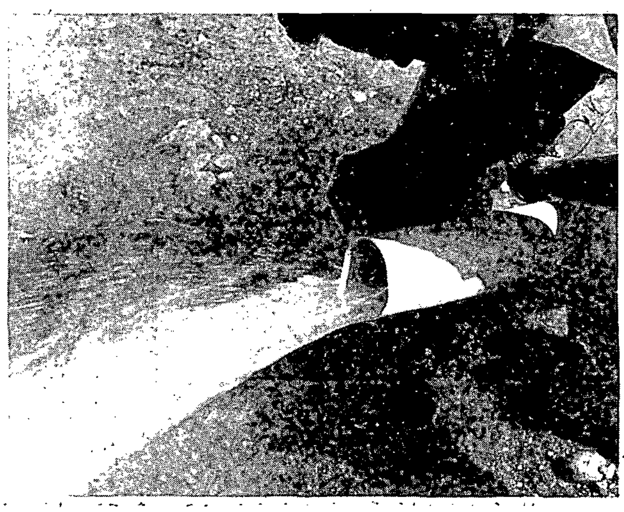
THE RESERVOIRS AND WELLS

If an engineer from the test site has stopped at the cafe on his way back to Idaho Falls, perhaps he'll tell you about the tests that have been run on the four existing wells. Reservoir engineers are compiling a more complete picture of Raft River's geothermal topography as they examine data from last year's tests.

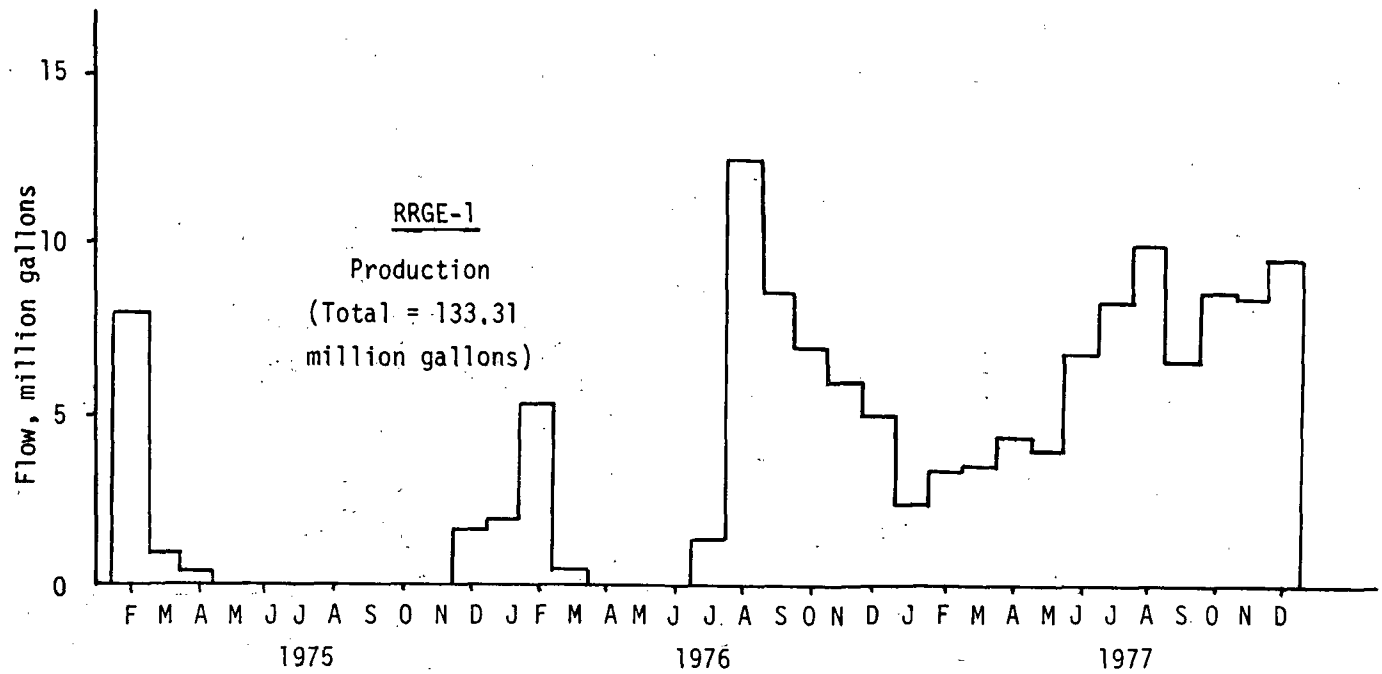
The geothermal water produced by the Raft River wells is drawn from a fractured zone 3,750 to 6,000 feet deep. Faulting has produced numerous fractures that hold the hot water, creating reservoirs which wells can penetrate and use. It now appears that water from the zone below RRGE-3 is welling up through the fractures, then spreading sideways through porous rock formations close to the surface. As researchers picture the resource, this water does not mix with that from below RRGE-1 and RRGE-2, which seems to be naturally confined below a relatively impermeable layer of rock. The wells have thus tapped two separate resources.

Considered as a whole, though, the known geothermal reservoir is about five square miles in extent. Engineers predict the actual reservoir may cover more than ten times that area. A conservative estimate predicts a volume of 300,000 acre-feet; more realistic estimates run as high as four million acre-feet.

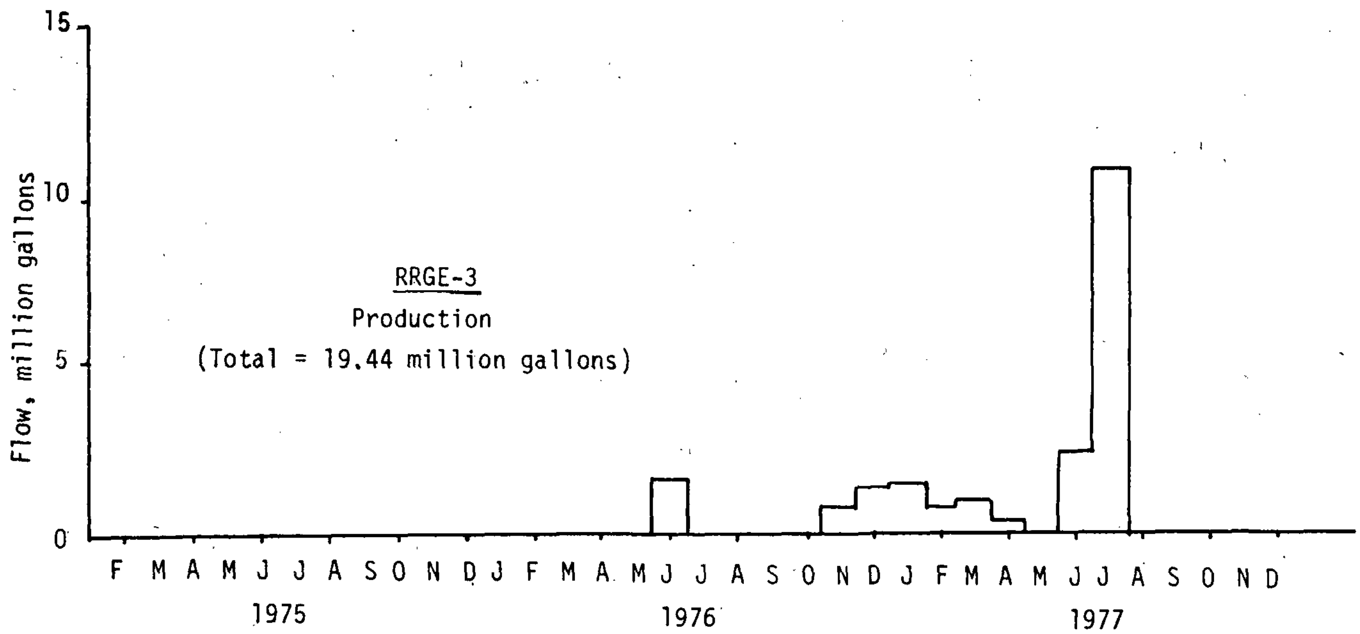
The wells have been tested to determine their ability to produce this water. Flow tests have been run on the existing production wells, RRGE-1, RRGE-2, and RRGE-3, as shown in the following bar charts. Researchers conclude that 1,000 gallons of fluid could be pumped from RRGE-1 every minute for ten years. RRGE-2 and RRGE-3 could produce at least 800 and 450 gpm for the same period—all without noticeably affecting the pressure of the resource. Thus, these three existing wells could produce at least 2,250 gpm for ten years.



Flow testing at Raft River



RRGE-1
Production
(Total = 133.31 million gallons)
Flow, million gallons
15
10
5
0
F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1975
1976
1977



RRGE-3
Production
(Total = 19.44 million gallons)
Flow, million gallons
15
10
5
0
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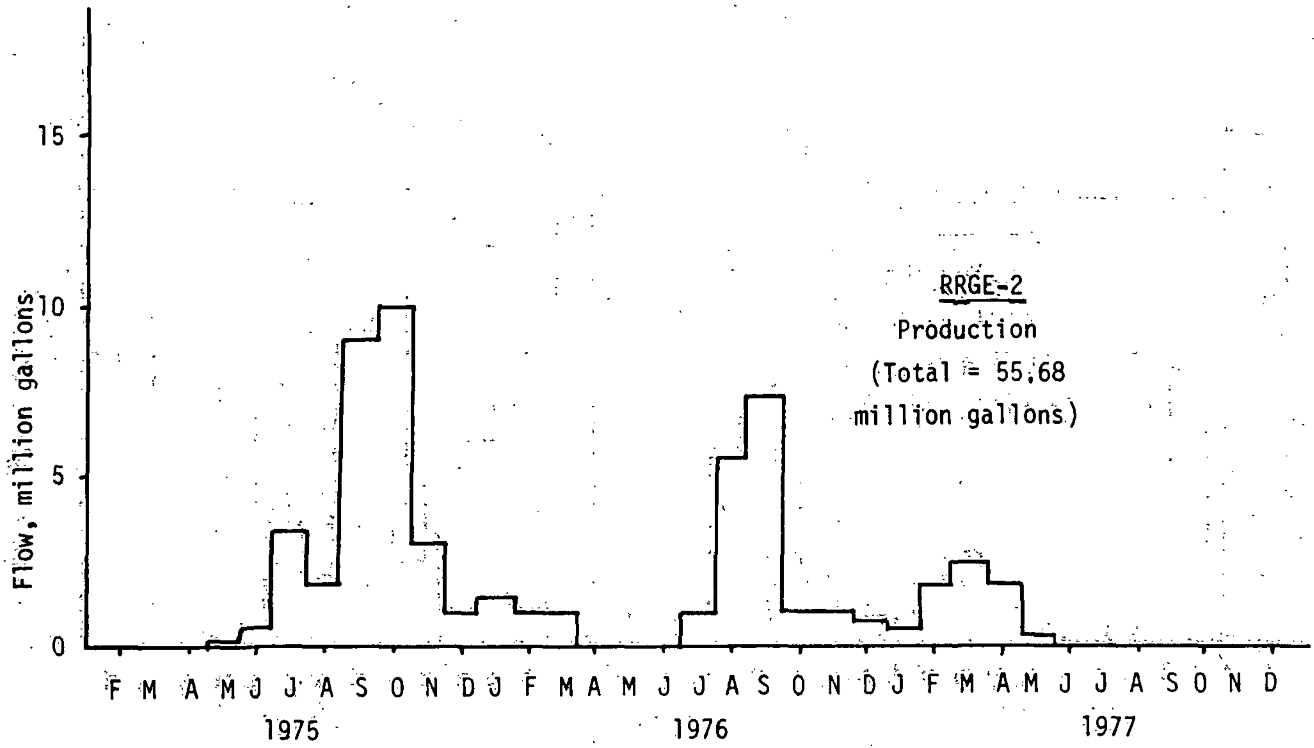
1975
1976
1977


RRGE-2
Production
(Total = 55.68
million gallons)
Flow, million gallons
0
5
10
15
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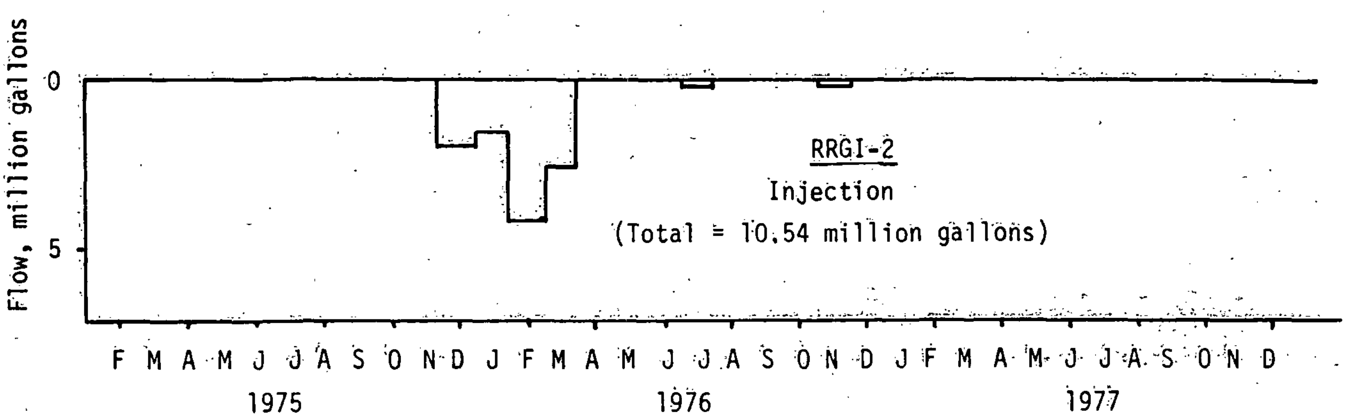
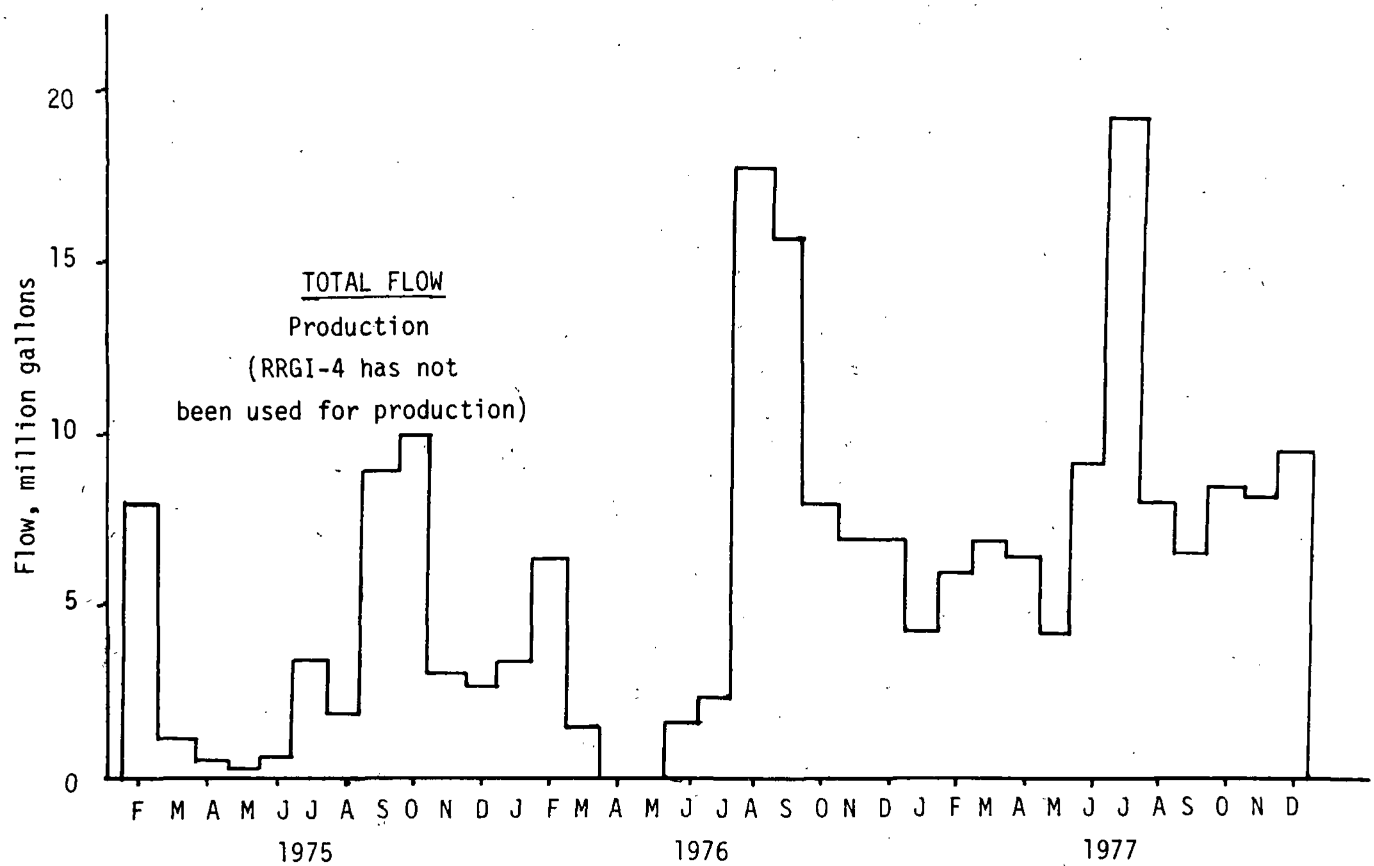
1975
1976
1977

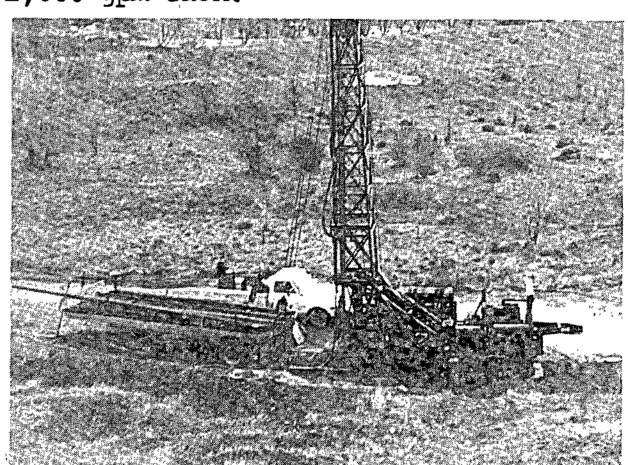

RRGI-2
Injection
(Total = 10.54 million gallons)
Flow, million gallons
0
5
F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1975
1976
1977



The fourth well , RRGI-4, may be used for injection or deepened for production. The well was intended for experimental injection, and tests have proven that it can easily accept a flow of at least 600 gpm. If it is to be used as an economical geothermal injection well, it must accept 1,200 gpm flows for many years. Tests to determine its long-term capability will start before spring.

In Boise, Idaho, where research into geothermal space-heating now centers, engineers are also beginning to understand more about the underlying reservoir. The Boise resource is cooler (about 170°F), but it can be found nearer the surface (around 900 feet). Future production wells should be able to pump from 600 to 1,000 gpm each.

The Boise reservoir may be part of the extensive Snake River Plain aquifer system. Producing geothermal wells extend 1-1/2 miles along the Boise Front Fault. Engineers suspect, however, that good production could stretch as far as three or four miles.



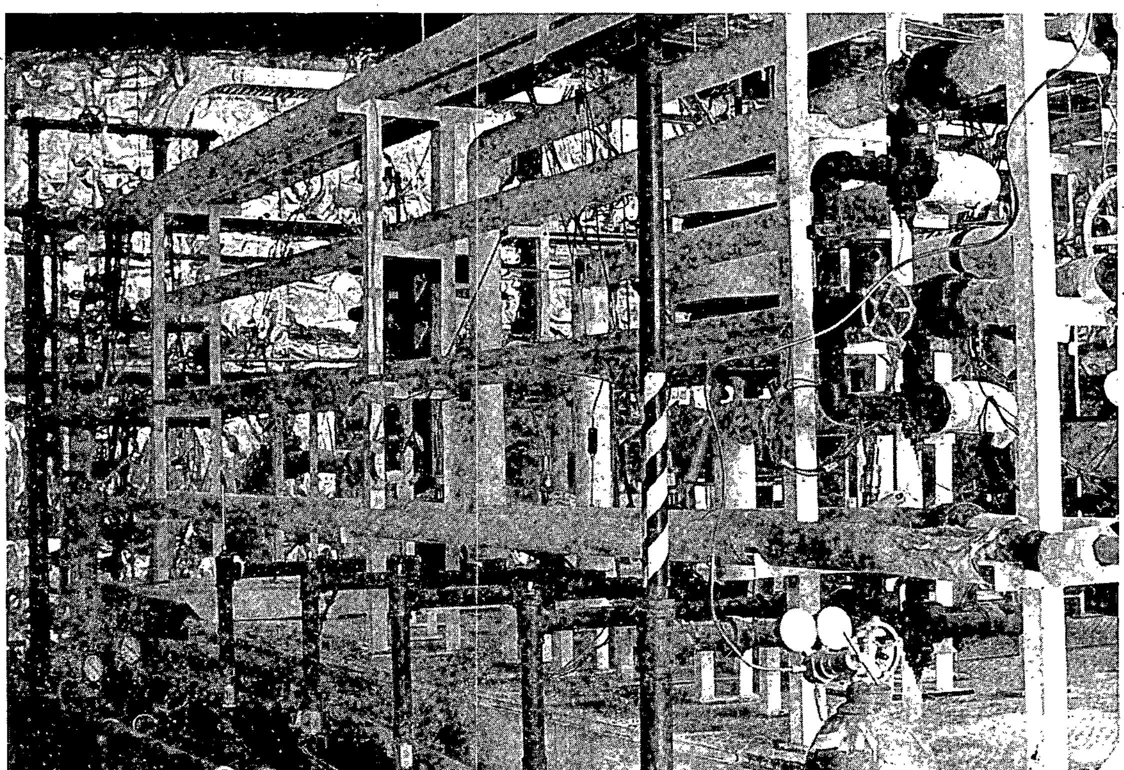
Boise test well

1977 TESTS

During the last year, a number of Raft River experiments examined the effectiveness of hardware that will be used in geothermal plants. Engineers evaluated conventional equipment that will be applied to geothermal uses (like pumps and pipelines), and they tested advanced components that have been designed specifically for geothermal applications (like special heat exchangers).

Two kinds of pumps have been analyzed during production tests: lineshaft and submersible. A number of factors tend to favor long-term use of the submersible type. The pumps will force the fluid out of the wells and through cement-asbestos pipelines. These pipes have given satisfactory service, and their cost is less than half that of conventional steel pipeline.

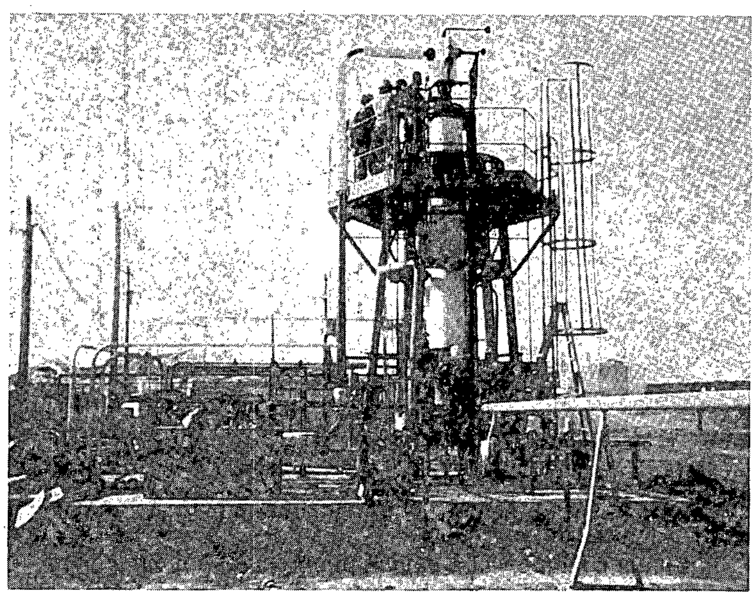
Different metals were analyzed in corrosion and deposition tests on the test loop at RRGE-1. Brasses and bronzes (except nickel-bearing alloys), cast iron and steel in thick sections, titanium, some stainless steel alloys), and various exotic alloys are all usable with proper precautions. Copper-zinc admiralty brass will be used in the heat exchangers constructed for Raft River uses, because it is the least expensive of the acceptable materials.



Corrosion test trailer

Attempts to find less expensive devices to transfer heat are continuing. Both fluidized-bed and direct-contact heat exchangers have been developed. Models of the fluidized-bed exchangers, which will use a bed of floating sand to scrub the scale from heat-exchanger tubing, were tested to analyze their flow distribution characteristics. It now appears, however, that component development will center on the direct-contact exchangers. Mock-ups of direct-contact boilers and preheaters were tested at the Raft River site, and the models performed well.

Perhaps the most exciting project at Raft River, though, was the construction of the first power generator. A 60 kW(e) generator will begin producing power in early 1978. For the first time, a system using moderate-temperature geothermal fluid in a binary system will provide electricity to a commercial power grid.

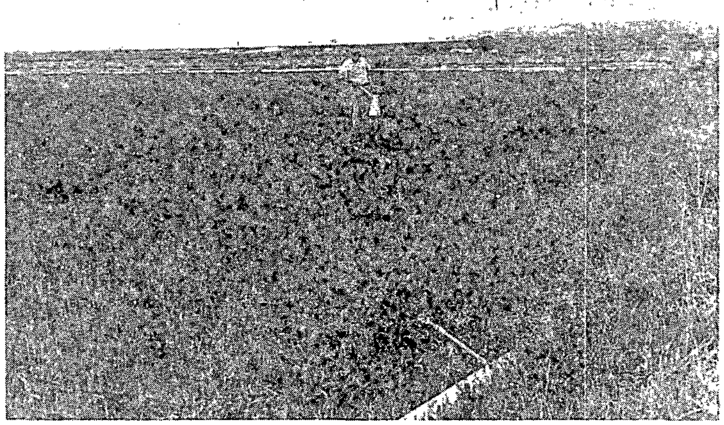


60 kW(e) generator

As engineers successfully tested fluid-supply equipment and power-plant components, they continued to be concerned about the consumptive use of water. Biologists joined the team in efforts to find effective agricultural uses for waste heat from power plants. In one experiment, a grid of small pipes was buried under a 2.6-acre plot of land. Researchers will pump power-plant condenser water through the grid and test the reactions of crops and trees to the added warmth. If things work out as planned, such plots could take the place of open cooling towers in power cycles. The dissipated heat would lengthen the growing season and increase the productivity of the land. The loop would cool the power plant without consuming the water that could be used in agriculture.

Soil-warming experiment

Geothermal water could also be used to irrigate the crops, thus doubling the benefit of a soil heat-dissipation cycle—especially in the arid West.



Alfalfa field at Raft River

A crop of winter barley was planted in the fall of 1977, and sugar beets, alfalfa, mixed grasses, and various vegetables are being planted this spring. The trees, including species of poplar, elm, willow, ash, spruce, fir, pine, juniper, and Russian olive, have been growing since October.

Barley field at Raft River

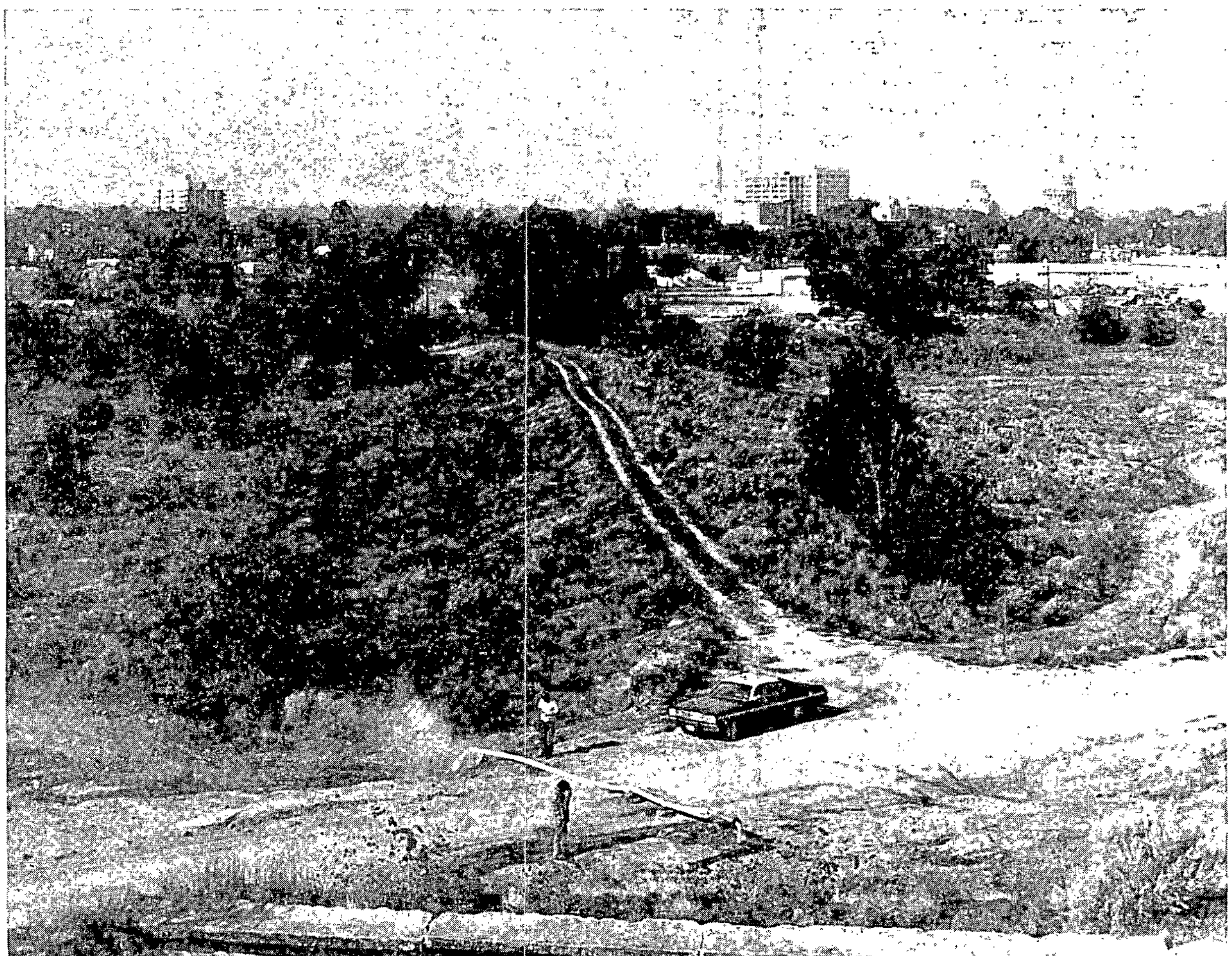
In a separate agricultural experiment, researchers have irrigated an additional plot of barley, alfalfa, oats, grasses, and hardwood trees with geothermal fluid from RRGE-2. Control crops have been sprinkled with water from conventional irrigation wells. The analyses showed some surface contamination of forage crops by fluorides, at a level which would be of concern to the healthiness of teeth in cattle. However, for those crops which receive a rainfall before harvest, fluoride content should be quite acceptable. Preliminary analyses of yield and feed value have indicated that there was essentially no difference between the experimental and control crops.

A similar experiment has tested the effects of heated water on fish and shrimp. Channel catfish, freshwater shrimp, and a warm-water African fish called Tilapia have been grown in an environment simulating power-plant discharge. Though it seems difficult to culture shrimp, the catfish and Tilapia have thrived during the past year.

But the direct use of geothermal energy for space heating as in Boise, may have more potential for contributing to our national energy budget than any other application.

At Raft River, several trailers and buildings have been heated with a geothermal system. Water from RRGE-1 passes through a heat exchanger to heat a solution that is in turn piped through conventional horizontal heaters. The building-heating loop has averaged 171 to 190°F. The system should save an average of 110 barrels of oil per year.

Attention must shift back to Boise, though, for a look at a real space-heating project. For more than 85 years, two wells have pumped up to 1,800 gpm of 170°F water. The system now serves about 200 homes and a large state laboratory and office building. EG&G-Idaho, Inc. and the Boise City Energy Task Force have been conducting a complete study of the Boise resource's potential for powering a much expanded system, and their conclusions should be reported sometime this summer.



Geothermal testing at Boise

The Boise office of the Bureau of Land Management has begun constructing its own heating system. The system will use water from the INEL test wells drilled during 1976. Two BLM office buildings and a shop are being prepared for the project.

Boise city also has another plan for using its geothermal water. The city will clear sewers of tree roots by killing the roots with hot water. If the roots can be subjected to 140°F heat for 30 minutes, the project should succeed. In one test of the plan, 40 blocks of sewer line were filled with 160°F water for an hour; the results were promising.

THE ENVIRONMENT

Clearly, the moderate-temperature geothermal program is maturing. Commercial power plants are only a few years away, and space-heating projects are already underway. In addition to economic feasibility, researchers are now demonstrating the environmental soundness of development plants.

First, the impacts on the surface environment must be considered. An analysis of the native mammal, bird, and insect populations is being completed, and continuing studies will assess the effects of geothermal development. A vegetation study is also being conducted, and the air around the wells is periodically analyzed for pollutants.

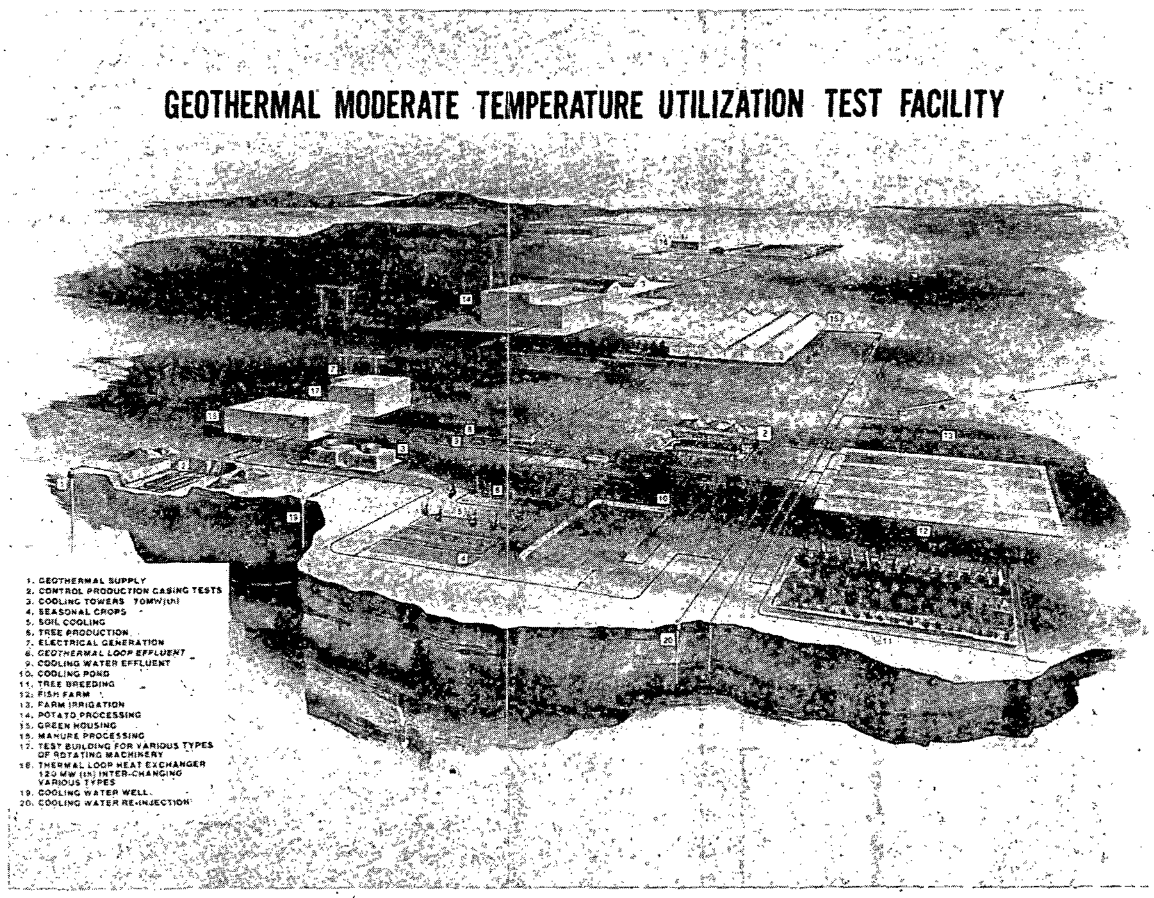
The subsurface effects of fluid production and injection must also be very carefully analyzed. A network of monitoring wells is now being drilled. These wells will be used to monitor the effects of fluid injection, primarily to ensure the safety of aquifers providing water for irrigation and domestic uses. The study will also make certain there is no chance of subsidence, or ground-settling. In addition, instruments will measure the seismic effects of a fluid loop; they would detect tiny tremors if the ground showed any structural weakness.

Finally, power-plant designers are considering the environmental effects of different plant configurations. The low thermal efficiency of geothermal power plants could cause problems. Conventional cooling towers, again, would lose millions of gallons of valuable water to evaporation. The soil heat-dissipation experiment may provide one solution to this problem, and other non-consumptive water-cooling loops are being designed.

Socioeconomic effects are more difficult to estimate, but geothermal plants appear to have built-in advantages. Geothermal energy complexes will be most economical in small units. A study by the Battelle Human Affairs Research Center concluded that the development and operation of a 5 or 10 MW(e) power plant would have little impact on local communities. The study also identified the most likely level of additional development (4.5 acres of greenhousing and one fish farm producing and processing 125 tons of warm-water fish annually) and the maximum possible development (53 acres of greenhousing; one fish farm handling 496 tons of fish annually; one 20,000-head feedlot and an associated manure-processing facility; one 50 MW(e) power plant; and one potato processing plant producing 100 tons of hydrated flakes per day). The maximum possible development, the Battelle researchers decided, could require 300 non-local workers by 1983.

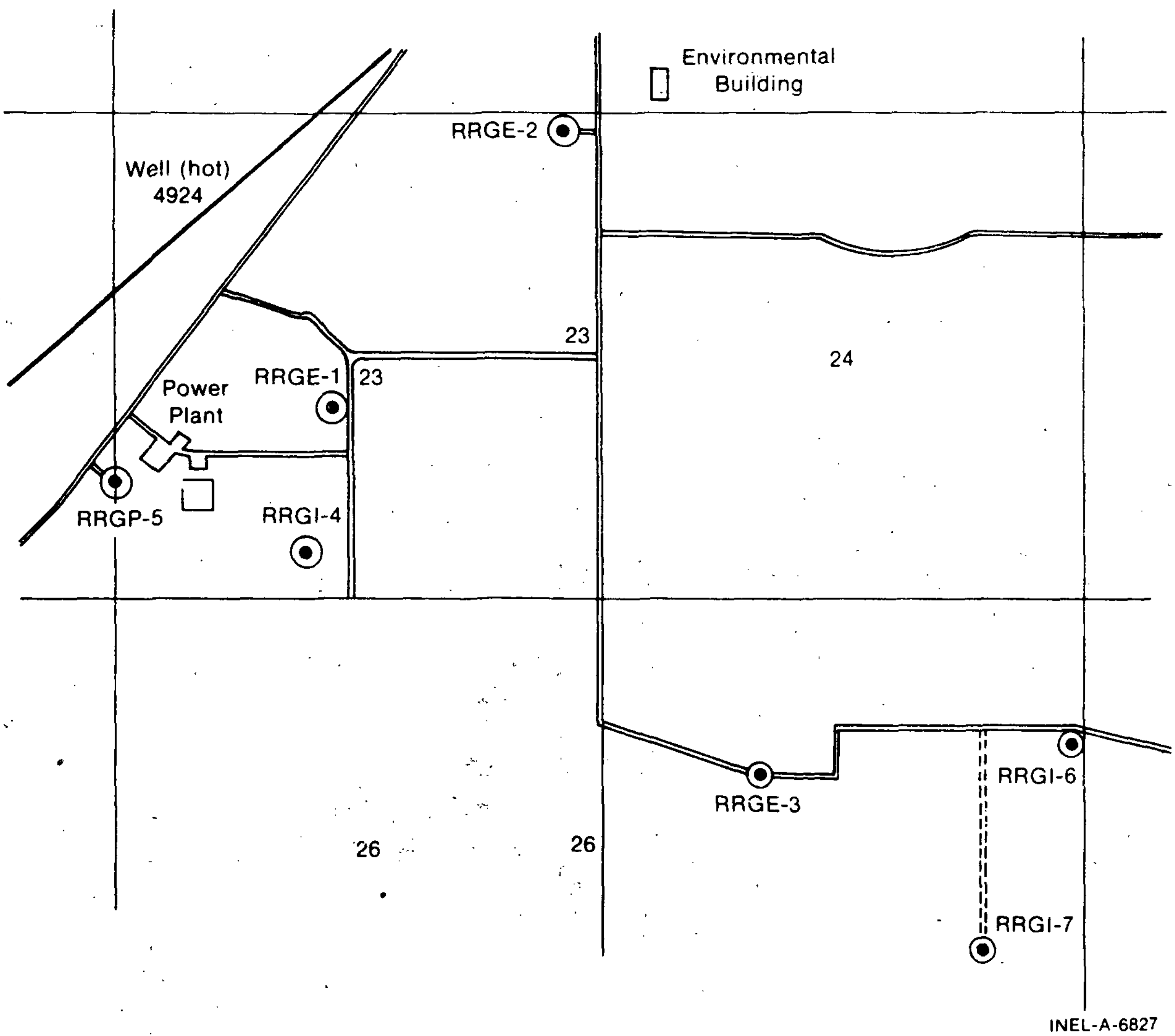
PLANS

There's an exciting plan for 1978. The completed 60 kW generator will be operated and tested. Biologists will grow and analyze crops in the agricultural experiments, and they will culture and test fish in the aquacultural test. Environmental engineers will continue their studies of wildlife populations and begin a special examination of the ferruginous hawk. The Raft River space-heating system will expand as the installation grows. In Boise, the EG&G report of the city's geothermal reservoir potential will be published this summer. The city can then make decisions about expanding the heating network. By all present indications, most of the city of 100,000—certainly all downtown buildings and the residential areas north of the Boise River—could soon be heated with geothermal energy.



Artist's conception of an expanded geothermal facility

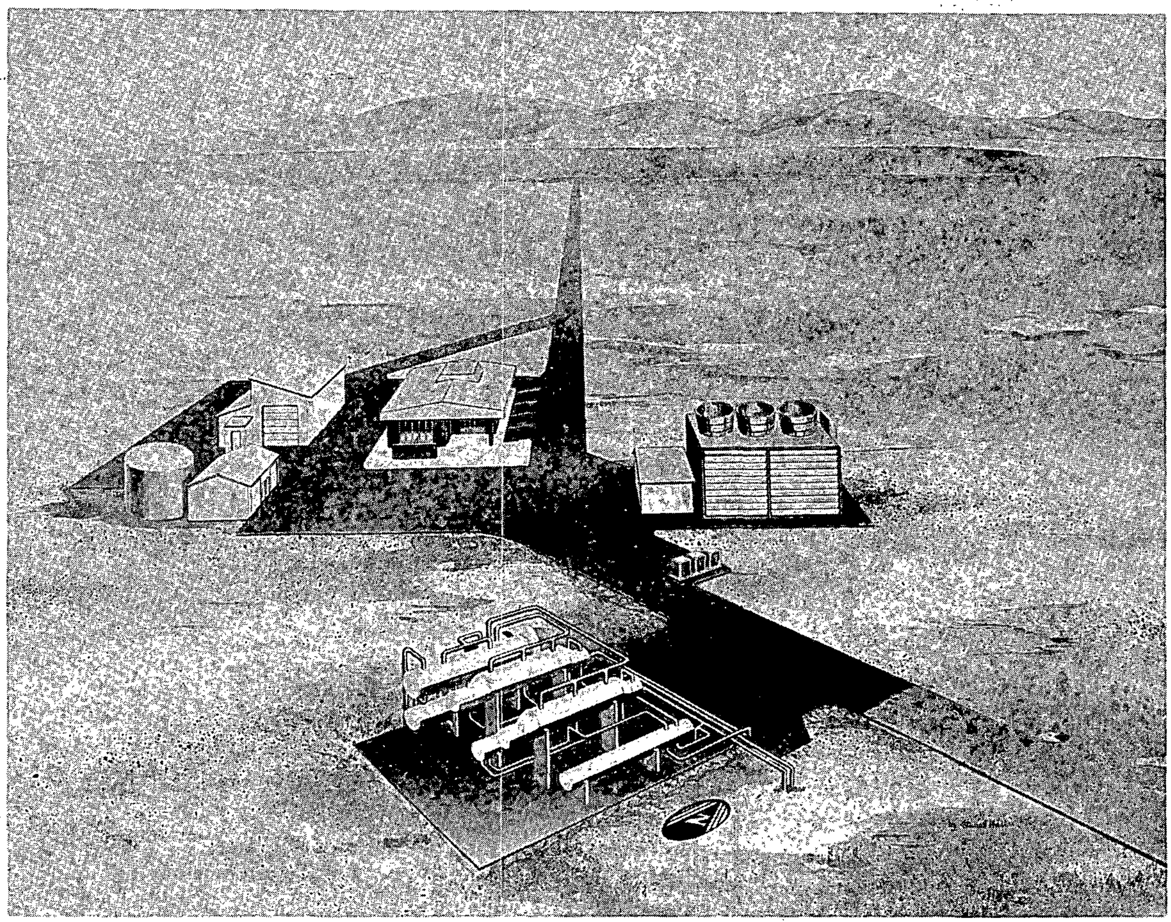
This year, crews will also complete an enlarged fluid supply and injection system. By the end of the year, three new wells will be added to the Raft River system. The completed well field will consist of seven wells: three production wells, two injection wells, and a reserve well of each type. RRGP-5, intended for production, will be drilled west of RRGE-1 and RRGI-4. The two new injection wells, RRGI-6 and RRGI-7, will be located east and southeast of RRGE-3. Three miles of new pipeline will connect the wells.



Raft River geothermal well locations

The completed well and pipeline system will supply more than enough fluid for the biggest experiment yet—a pilot power plant. During the summer, crews will begin constructing a 5 MW(e) plant—a unit which will produce almost a hundred times as much electric power as the 60 kW generator, or enough for a city of 5,000 people.

The pilot plant will be built just west of RRGE-1, and the first full-power operation will take place in March of 1980. During the course of its five-year life, the plant will demonstrate the workability of a geothermal power plant and generate the data from which commercial costs can be estimated. The plant will also provide a realistic setting in which to test the performance of materials and components.



Artist's conception of 5 MW(e) pilot power plant

Design is now proceeding on more advanced conversion systems, which should be even more economical. Assuming that the results of this work show that the moderate-temperature resources are a viable source of electrical power, the construction of a 50 MW(e) demonstration unit would be the next logical step. This unit would probably be built with significant utility participation.

Next year, as travelers pass through Malta, the electricity that lights the Valley Cafe may be generated from geothermal energy. Winter dahlias are just an early flowering of a growing concern, and with the construction of the full-scale plant, probably before 1985, the commercial production of electricity from common, moderate-temperature, geothermal resources will be a reality. Within a decade, today's geothermal research may bring a significant degree of energy independence to the Intermountain West.

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