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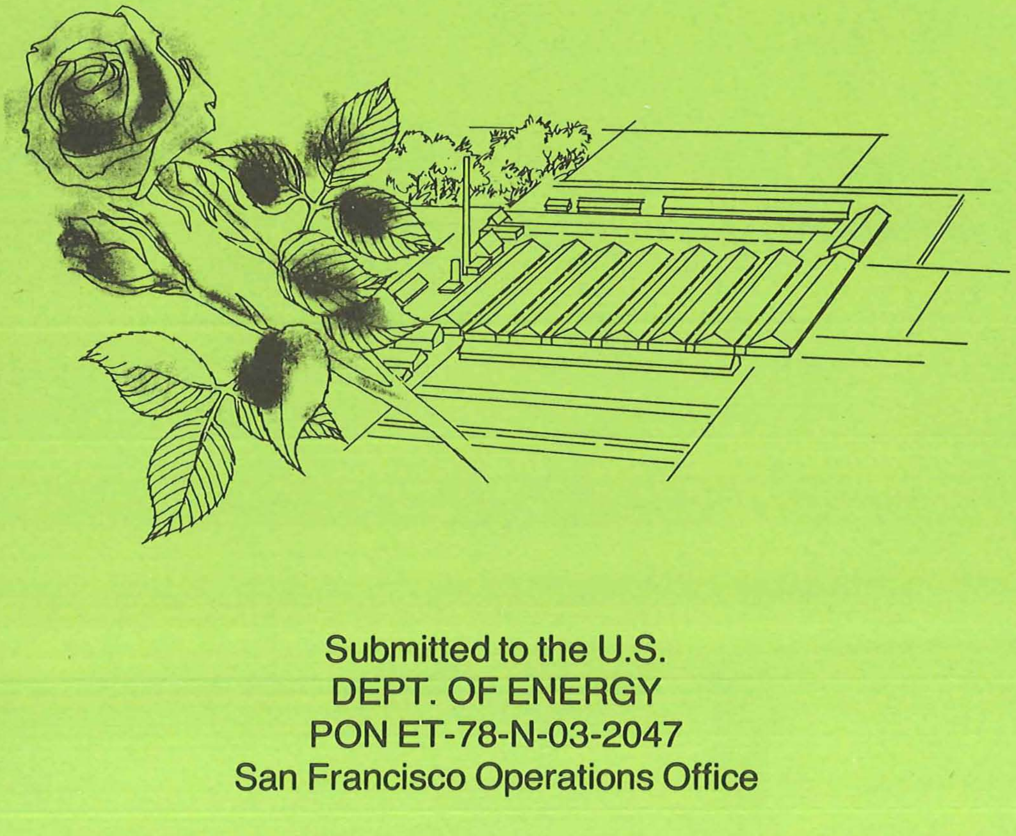
FLORAL GREENHOUSE INDUSTRY GEOTHERMAL ENERGY DEMONSTRATION PROJECT

Utah Roses, Inc.
Salt Lake County
Sandy, Utah 84070



Submitted to the U.S.
DEPT. OF ENERGY
PON ET-78-N-03-2047
San Francisco Operations Office

VOLUME I

TECHNICAL PROPOSAL
UR-G-78

JULY 1978

NAME: Utah Roses, Inc.

CLASSIFICATION: Small Business

ADI 567 W. 90th South, (Sandy)
Salt Lake City, Utah 84070

PROJECT TITLE

FLORAL GREENHOUSE INDUSTRY
GEOTHERMAL DEMONSTRATION PROJECT

Funds Requested: $459,500*

Duration of Project: 130 weeks

Starting Date Proposed: January 15, 1979

Principle Investigator: Mr. Ralph M. Wright
Chairman of the Board
Utah Roses, Inc.
567 W. 90th South, (Sandy)
Salt Lake City, Utah 84070
Telephone: Bus. 801-255-1132
Home 801-295-2023

Authorized Officials

Ralph M. Wright, Chairman of the Board Ralph M Wright

C. Richard Wright, President C. Richard Wright

Ralph M. Wright will conduct negotiations with DOE. He may be assisted in these negotiations by C. Richard Wright and:

Jay F. Kunze
Dr. Jay F. Kunze, P.E., Mgr. Energy Services,
Forsgren, Perkins & Associates

Type of award sought: Cost-Sharing Reimbursement Contract
Date Proposal Submitted: July 18, 1978
Proposal Valid Until: February 1, 1979

Consent is hereby given for review outside the U.S. Government. We make no exceptions to the conditions specified in RFP PON ET-78-N-03-2047.

Ralph M Wright
Ralph M. Wright, Chm. of the
Board, Utah Roses

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* Includes a $100,000 contingency if deep well reinjection is found to be necessary.

ABSTRACT

Utah Roses, Inc., of Sandy, Utah proposes to conduct a commercial geothermal development program for heating floral greenhouses on its property at Sandy, Utah. The program site is located near the Wasatch Faultline which runs along the eastern fringe of Salt Lake City, Utah. This fault zone has the promise of being the major geothermal source for the metropolitan Salt Lake City area and its population of 3/4 million.

The purpose of this program would be to:

1. Extend the commercial applicability of the Wasatch Range geothermal resource by tapping and proving a geothermal resource of considerable potential lying within a huge metropolitan market area where space heating represents 25% of the energy requirements.
2. Use moderate temperature geothermal energy for process heating in commercial floral nurseries, which seem to be well suited for use of geothermal energy at temperatures as low as 100°F.
3. Supplement usage of scarce fossil fuels with a renewable resource of energy.
4. Provide exhibition and demonstration of the system through affiliated floral businesses across the nation and customers in the Salt Lake City area.

The annual fuel consumption (natural gas) for process space heat will be cut from 70,000 million Btu to about 5,000 million Btu, plus electrical power usage additions equivalent to $24,000 (800,000 kwh) annually. An adjacent machine factory will save 10,000 million Btu.

The program will be directed by Utah Roses, Inc. which will also own the resource. Technical development and direction will be supplied by Forsgren, Perkins & Associates, Energy Services Division.

The schedules given for this program could realize a portion of the total system as operational for demonstration by February 1980 (54 weeks from the start of contract); the full system by October 1980.

The project has three major milestone decision points:

1. Decision on type of well and drilling contractor after additional geology, geochemistry, and geophysics is completed in Phase I.
2. Decision on adequacy of the production well after initial testing, following Phase II.
3. Decision on disposal method to be used and the design of heat transfer system. Occurs after additional design following well testing and water quality analysis, at the conclusion of Phase III.

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UTAH ROSES, INC.

SUMMARY DATA (VOLUME I A)

C.1 PROPOSER'S NAME AND ADDRESS:

Utah Roses, Inc.
567 West 90th South, Sandy
Salt Lake City, Utah 84070 Utah Congressional District # 2

C.2 TOTAL CAPABILITY TEAM:

The principal team to complete this project consists of Utah Roses, Inc., Sandy, Utah; and Energy Services Division of Forsgren, Perkins & Associates, Salt Lake City, Utah.* Utah Roses will provide the commercial and financial management of the project and assume complete ownership of the facilities when the project is ended. Utah Roses thus would be solely responsible for the completion of the project and utilization of the geothermal energy. The other principal team member will be Forsgren, Perkins, & Associates who would provide all the engineering services and supervision of the contractors performing the well drilling, installation of pumps, distribution lines, heat exchangers and any components that are a part of the geothermal system, as well as the environmental assessment. With its Energy Services Div., Forsgren, Perkins & Associates is able to offer total capability in both resource development and conventional engineering design and construction management (the latter is often refered to as A&E services). Other team members include consultants from the Univ. of Utah Research Institute and a private consultant in geothermal resources.

C.3A PROPOSED DIRECT UTILIZATION APPLICATION: Floral Process Heat

The geothermal energy from the well to be drilled on Utah Roses property would be used for floral industry process heat. The geothermal water would be of moderate temperature (120° to 190°F) - adequate for this industry. A reinjection well might be used if the chemical content of the geothermal water required such a well. Continual pressurization of the geothermal loop would prevent scaling in the heat exchangers. If the quality of water is adequate for direct use in water-to-air heat exchangers, the secondary circuit could be eliminated. The discharge water could also then be discharged directly into an adjacent irrigation canal, cancelling the need for a reinjection well and reducing the project cost.

There is substantial evidence of a reservoir of the desired temperature throughout a 1000 sq. mile belt in and south of Salt Lake City. Three warm wells exist within three miles of the proposed drilling location. Further confirmation of the nature of this reservoir would stimulate future uses of geothermal energy in this very heavily populated, highly industrialized area. The general geothermal potential extends 50 miles along the Wasatch Mtn. Front, including a population of 3/4 million in the Salt Lake Valley and an additionaal 1/4 million in the adjoing areas of Brigham City and Provo.

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* This project will be operated through the Salt Lake City office, Forsgren, Perkins & Associates headquarters is in Rexburg, Idaho.

C.3B. STATUS:

Utah Roses began a study of floral greenhouse heat with with geothermal energy in 1976, with the intent of seeing such utilization spread nationally among the floral industry. This culminated in a cost sharing proposal submitted to ERDA just prior to the DOE/PON announcement. Realizing that the DOE had created a demonstration program with which Utah Roses was already definitely in step, Utah Roses is again requesting a cost sharing program which would be of national benefit to the floral industry, and is the substance of this PON. Current status is as stated herein. Preliminary conceptual design is complete and the facilities to use the energy exist and can readily be retrofitted. The proposed work begins with Phase I.

C.3C. MAJOR PHASES:

<u>Phase I</u>: (Initial Phase): Preliminary Investigations and Well Drilling. Environmental assessment report prepared and submitted to DOE. Review geological data for this area, and develop qualitative models for the subsurface geology. Preliminary reports of geothermal potential are good and the more detailed study before drilling would allow more accurate well design and specification preparation and the type of drilling equipment both technically and economically suitable to the task. The actual drilling of the exploratory production well, if conditions are favorable, would be scheduled for late summer or fall of 1979. The well site is on the property of the Proposer. Phase I would establish the precise drilling technique and the type of rig to be contracted to probe for the anticipated geothermal target.

1) MILESTONE DECISION POINT - Design of well, depth target, and type of rig to be used-critical to cost.

Phase II: Well Drilling and Development. Obtain usage permits and any other necessary clearances. Prepare specification for test production well. Contract for driller. Prepare site and complete drilling of the exploratory production well as a geothermal source well. Test its productivity and evaluate reservoir parameters. Phase II would be completed by Fall 1979.

2) MILESTONE DECISION POINT - Is well useful? or, should well be used for reinjection and second well of different design drilled? Should stimulation be attempted? Or should project be terminated?

Phase III: Design and procure permanent well head and pump installation. Continue testing well as needed for system design data. Design disposal facilities that will meet applicable state and federal regulations. Design heat extraction system.

3) MILESTONE DECISION POINT -
   a) Method of disposing of used geothermal fluid
   b) Decision on need for and type of primary heat exchanger.
   c) Overall design review and approval, including economics with the contirmed resource.

Phase IV : Fabrication, Construction, & System Engineering. Completion and installation of pipe lines, heat exchangers, pumps, controls, and monitors. Start up and check out of system and monitors. Phase IV would be completed by Sept. 1980. Note: If the well is artesian, some heat exchangers would be installed in one greenhouse for performance testing during the 1979-80 winter, before finalization of specifications for all the heat exchangers.

Phase V: Utilization & Performance. Starting in Oct. 1980, efficiency, economics, service needs, and consumer acceptance will be recorded and evaluated over a period of one year. Reports and documentation pursuant to the program as outlined in the PON will be submitted. Any deficiencies in the system that degrade its performance, so as to be uneconomic compared to conventional systems, will be corrected by modification. The owner will receive a final system review and operating manual. Phase IV would end August 1981.

C.4 PROPOSED SITE OF PROJECT:

The proposed site would be on the property of Utah Roses, Inc. at 90th South, just west of I-15 in Sandy, Utah. Sandy (population 25,000) is in metropolitan Salt Lake City, 10 miles South of the Main City, but part of an extensive urban growth that merges with the city. The property is one mile east of the Jordan River and ten miles west of the Wasatch Range. Additional application of the energy is proposed for Beehive Machinery Inc., on the adjacent property, where geothermal space heating could displace much of the present 15,000 MCF of gas used per year for space heating. Many other commercial potential customers are within ½ mile.

C.5 EVIDENCE OF GEOTHERMAL RESOURCE:

a little exagerated

Utah Roses is located within 6 miles of a major system of faults that extend from St. George northward through Salt Lake City, Ogden, and on into Yellowstone, Montana. Thermal springs are common all along this fault system. A less well-defined east-west cross fault cuts through Sandy near Utah Roses property. Within a radius of 2 miles of the proposed site there are 3 thermal wells. Many thermal wells and springs exist in the metropolotin Salt Lake area. Geothermometric calculations, based on geochemical properties of spring and well water, indicate likely source temperatures at about 170°F to 350°F. Because of the large cool aquifer that exists at shallow depths, few wells deeper than 800 ft. have been drilled in this area.

not necessarily a fault

Major thermal anomalies within the immediate area are as follows:

a) A 1150 ft. deep city well (Sandy) 2 miles south with 90°F water delivered at the surface. Since being plugged at 315 ft., the temperature was reduced to 72°F. (Inactive presently)

b) A county well, 800 ft. deep, within 150 yards of the Utah Roses property. Well delivers 76°F water at the surface. (Inactive presently)

c) A 74°F city-owned (Midvale) well 2 miles north. The thermal water is so heavily diluted with cold water that the geochemical themometry has given erroneous results.

d) Crystal Hot Springs, 6 miles south, 137°F at surface with geochemical indicators of 347°F for the reservoir.

e) A recently (April 1978) drilled well 6 miles south delivering 176°F water from 260 ft. depth. Geochemistry indicates 315 to 350°F reservoir temperatures.

Thermal anamolies d) and e) are within 3/4 miles of a known fault, one that intersects the Wasatch Fault. A similar fault (USGS circular 75 - 616 passes east-west through the Utah Roses property and intersects the Wasatch fault. THis latter fault is encouraging, not merely as a conduit for hot water from depth, but as an indication that fracturing and good permeability should exist at depth.

don't know this — may be right

In summary, the latest geological surveys and interpretations indicated that this region has an extensive groundwater reservoir penetrated by fault systems which allow vertical flow of heated water from depth and provide good permeability in the regions of these faults. The major fault runs past several large population centers. The chemical content of the known sources indicates reservoir temperatures in the 300° to 350°F range, much higher than the minimum required 120°F. The total dissolved solids in the indicated reservoir are moderate (4000 ppm). If such proves to be the case, using a pressurized primary fluid system, heat exchanger, and possibly a reinjection well will be required, as budgeted. A mining canal carrying water with high dissolved solids adjoins the property and could possibly be used for disposal of the used fluids. Since part of this proposal is the proving of a well, if the initial well does not meet the expected potential, then the second well drilling could be altered to improve its potential as a geothermal source. A successful second well could then be used as the source and the first as the injection well. The overall probability of success of the project is thus increased without significantly increasing cost.

170°F

C.6 STATUS OF GEOTHERMAL RIGHTS AND REINJECTION

Utah Roses, Inc. has clear title to the 8-acre site. No mineral or water rights have been reserved by any other party. Utah has no existing or pending legislation concerning the legal status of geothermal water, rather it is treated as a water resource by the State Engineer's Office. As the geothermal resource for this proposal lies below a large, dynamic, open, groundwater system, pumping and consumptive use of geothermal water is permissible. However, if reinjection is required, it appears that communication with groundwaters shallower than 1000 ft. depth is largely prevented by confining beds that minimize cross flow between the geothermal and domestic aquifers. Permission for disposal into the Galena Canal will depend on the condition of the water.

C.7 STATUS OF OWNERSHIP

The proposal site is on 8 acres of property owned by Utah Roses, Inc., and this property is completely sufficient for the implementation of this proposed program. Utah Roses owns subsurface rights. No rights of way will be required for delivery of the geothermal fluid or disposal into the Galena Canal. The greenhouses are owned by Utah Roses, Inc., with a mortgage lien of $315,000 (7/78) from the Federal Land Bank.

C.8 FINANCIAL ARRANGEMENT:

User/Developer financing would be provided by Utah Roses, Inc., using working capital and an existing line of credit for capital improvements with the Federal Land Bank. Ownership of the system will be by Utah Roses, Inc., and would be a part of their commercial enterprise - the loan would be repaid on the fuel cost savings over present cost.

C.9 FUNDING SUMMARY:

The total estimated project costs using geothermal energy and proposed funding by each partcipant is:

DOE Share	459,500*
Utah Roses, Inc. Share	416,700
Total Cost	876,200*

* Includes an extra-ordinary contingency of $100,000 as a differential for a deep disposal well if disposal into the adjacent mining canal or into a 1500 ft. well is not permitted.

Estimated total cost using conventional energy.

Gas and oil-fired boilers are presently being used, consuming annually 70,000 MCF(MBtu) per year at Utah Roses. (Obviously additional conventional energy systems are not needed.) Beehive Machinery Inc., a neighboring industry consumes about 10,000 MCF/year for space heating. Net savings per year would be approximately 75,000 MCF, allowing the present conventional systems to be used for peaking on the coldest days.

Current gas price = $1.22/MCF

Gas-company projected price in 1982 = $1.84/MCF

Average annual savings, first three years = $124,000 less $30,000 electricity = $94,000/year

Enhanced production output: About 10% on sales of $1,000,000 annually, as a result of more benificial and effective climatic control for the plants.

*MCF = thousand cubic feet MBtu = Million Btu - both terms by convention

D. TECHNICAL PROPOSAL (VOLUME I B)

D.1 SUMMARY

The direct use of geothermal energy would be achieved by modifying the present steam supplied space heating system in a six acre greenhouse to accept the use of geothermal water of moderate temperature. Approximately 70 billion Btu of energy (20 million Kwh) will be displaced annually from gas and oil to geothermal energy. (See Table II)

Using 500 gpm source water at a probable temperature of 170°F and reinjecting it at a temperature of 120°F would provide heat equivalent to 12 million Btu/hr. The total use would amount to approximately 60 billion Btu annually for the greenhouse and another 10 billion Btu for the adjacent machine factory.

Drilling would occur on the 8 acre property of Utah Roses, in the heart of the industrial belt known as the Wasatch Front, with nearly one million population. The property is ideally situated in what appears to be an ideal geothermal drilling target area. Water of less than 200°F temperature is sought, and it is hoped to find this at a depth of less than 3000 ft. Temperatures as low as 120°F can be used, but the ecomomics will be less favorable. See Fig. 1 for location.

Using current fuel prices with utility company projections through 1982, payback, without considering tax benefits, will occur in 8 years, if 180°F water can be obtained. The utility projection is likely optimistically low.

D.2 DETAILED NARRATIVE

D.2.a. PROGRAM OBJECTIVES:

The overall objective is to demonstrate an economically successful system for extraction of process heat* from a moderate (120° to 200°F) temperature, geothermal resource. The outcome will be competitive over similar, but conventionally powered facilities. The application is to an existing operation that is a small business. Implicit in this success would be a reliable physical system: reliable operation, needing minimal repairs. A supplemental benefit is to increase the reliability of tapping potential geothermal sources such as these that lay under large population centers. This would come from the demonstration that a resource of satisfactory temperature and productivity exists in a region where there was positive but not conclusive evidence that a useable resource for space heating exists at economical depths

*The production of roses requires the maintaining of the appropriate environment for the process. This is a much more energy intensive process than merely maintaining temperature. For instance, fresh air for CO_2 & humidity control is a demanding requirment.

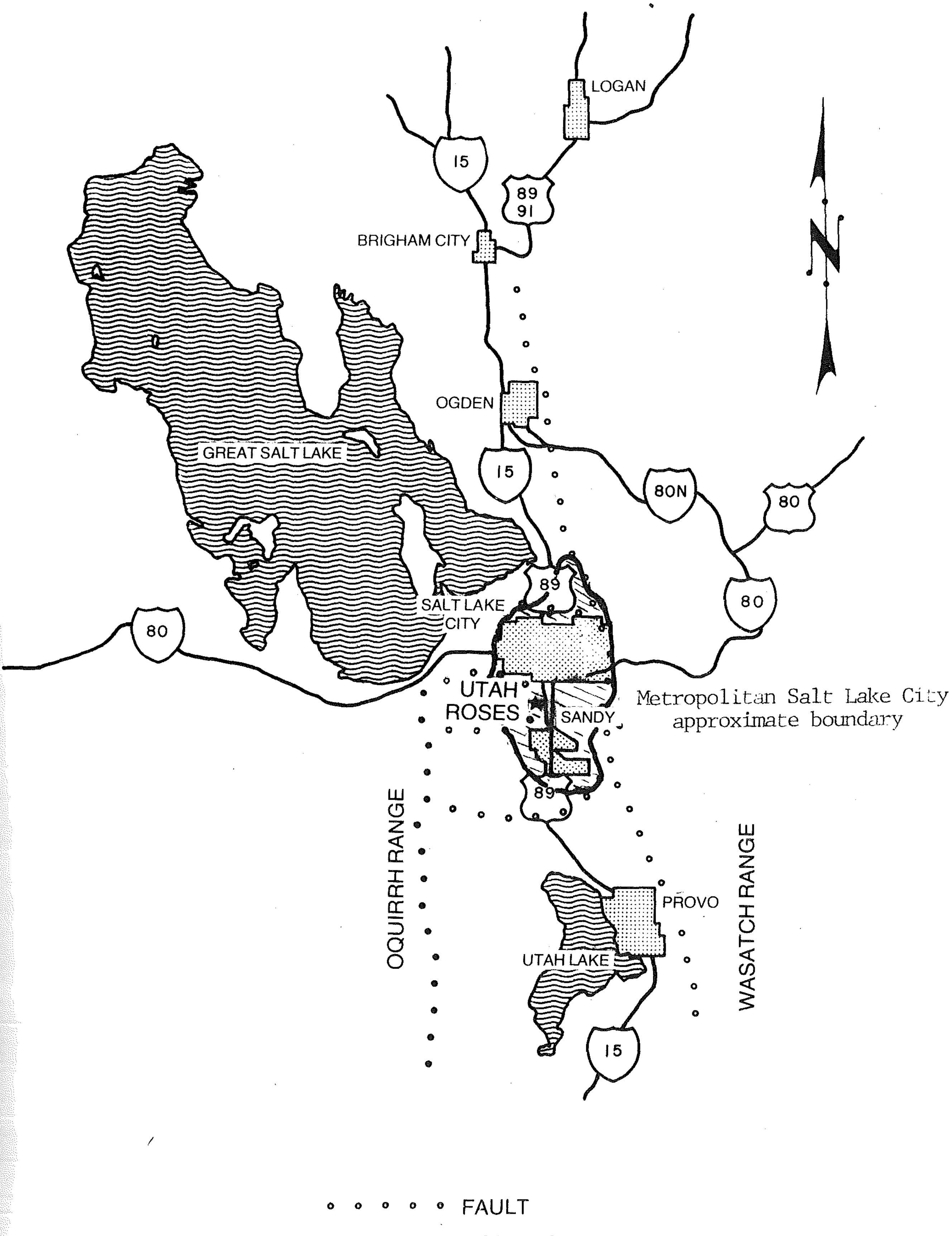

FIG.NO. 1 METROPOLITAN AREA MAP

D.2.b. TECHNICAL BACKGROUND

Utah Roses in common with florist and nursury operators across the nation, has been concerned about the rise in energy cost and their access to it. An endowment fund has been established among the Society of American Florist to promote R&D efforts beneficial to their industry. Solar energy has been proposed, but without extensive storage facilities must be considered Unreliable (except for sunny day heating capability). Adequate and cost effective system do not exist for storage of solar energy to provide for extended, cloudy periods. It was this unreliability that lead the floral industry to fossil fuels for space heating. A current estimate of their total national gas consumption is 40,000,000 MCF* (4x10^{13} Btu = 0.04 Quad) annually. The setting of Utah Roses, near a moderate temperature geothermal source, is shared by a number of other commercial nurseries with greenhouses in the Rocky Mountain West. Thus the concept was developed that if geothermal could be shown to be practical for Utah Roses, it would also be applicable for other floral businesses. Taking the incentive, Utah Roses conducted a study of the technical and economical merits of a geothermal system in 1976-77. Concluding that such a project had substantial merit, but unable to bear the risk of drilling dry wells, Utah Roses submitted an unsolicited proposal for cost sharing of the project, paricularly that of drilling the wells, to ERDA in May 1977. Since this type of project would fall under the soon-to-be-issued, original DOE/PON, no action was taken. This second proposal by Utah Roses is a strengthening and refining of their original concept, designed to meet the encouragement and quidelines of the current PON. Fig. 2 shows the Utah Roses facility.

D.2.c. PRESENT AND PERSPECTIVE USER GROUPS:

Utah Roses would be the sole immediate user. An adjacent machinery factory, Beehive Machinery, Inc., with 50,000 sq. ft. and an annnal space heating energy consumption of 15,000 million BTU is a second near-term potential user. This demonstration project in a metropolitan area, would be readily accessible for exhibit to other florists, HVAC engineers, drillers, equipment manufacturers, architects, and civil engineers, schools and universities, and civic leaders. In addition to personal visits, the national organization among florists, Society of American Florists (SAF), has a monthly newsletter for posting the results of this program as well as yearly conventions where details can be reviewed. A proven, working geothermal well, allowing a small business a competitive edge over the market because of the lower energy costs, would provide considerable incentive

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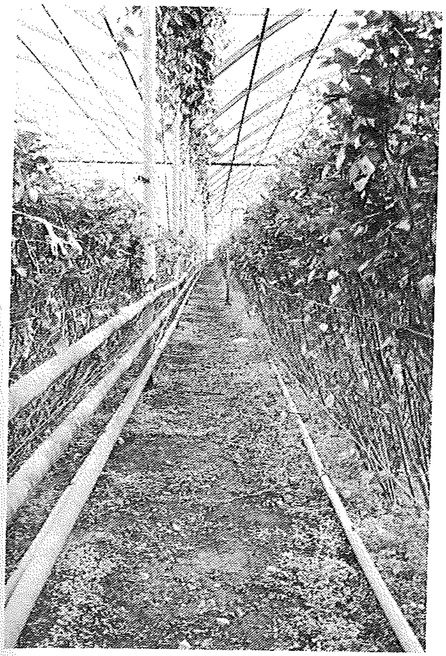
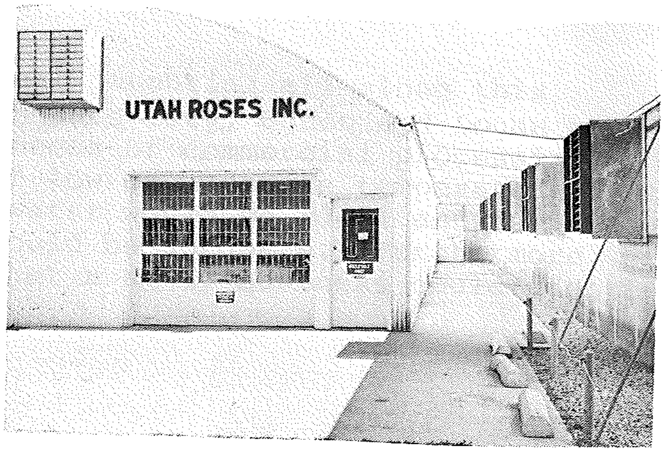
* MCF = 1000 cubic feet

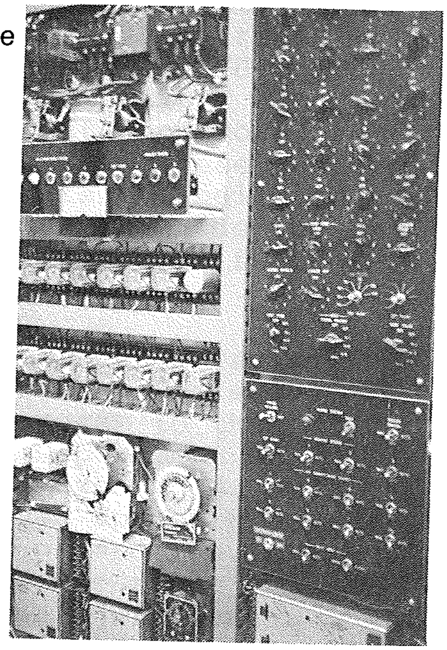


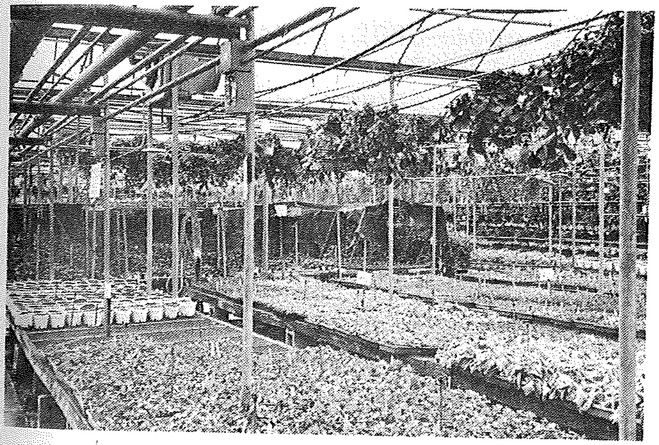
Steam Pipelines used for Radiant Heating



Facility offices. Ventilation Louvers on West Greenhouse are at right.

Heating/Climate Control Panel

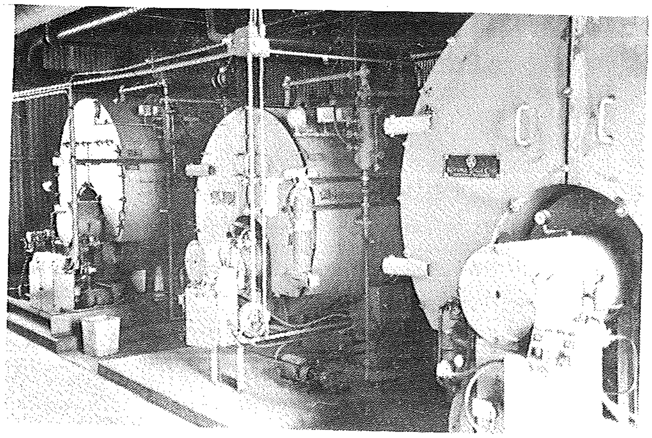




Horizontal-Flow Heater and Steam piping.

Down-Flow Heater (above plants) and Sprinkler pipes (on ground).

Steam Boilers (gas & oil fired) 23 million BTU/HR Total rating.



Utah Roses

Fig. No. 2

to develop the geothermal potential all along this fault zone - Provo, Salt Lake City, Ogden and Logan as a start. Much of the needs of commercial processing and space heating are of low or moderate temperatures where 170°F geothermal water would be ideal and temperatures as low as 120°F could be adequate. Furthermore, it would be a project that a small business could identify with and duplicate.

D.2.d. ENERGY DEMAND

Approximately 40 major floral greenhouses are located in the Idaho, Utah and Colorado region. Moderate temperature geothermal sources have either been found or are quite probable throughout these states, even near the centers of population. (Not to mention California, Oregon, and the southwestern states.) The total annual gas consumption in the Intermountain West by these major greenhouses is about 5 x 10^6 MCF (5 x 10^{12} BTU). These needs could be almost entirely met with 170°F water with wells no deeper than 5000-6000 ft. and more probably 2000-3000 ft. deep in most cases in these western areas. Similar temperature reservoirs are believed to be common in many parts of the east, but at depths exceeding 5000 ft. These may eventually prove feasible for economic development.

Nationwide the prospects are much more encouraging, particularly now that DOE has launched a "normal gradient" geothermal direct heat program in the eastern states. According to U.S. Department of Agriculture statistics, there is in excess of 137,000,000 square feet of greenhouse space in use at the present time for flower production. (See Table I.) Estimated fuel use is in the range of 40,000,000 MCF of natural gas or the equivalent in other fuels, primarily fuel oil.

Leaders in the flower-growing industry are seriously concerned about the future source of heat for greenhouses. The Society of American Florists* Endowment, a research fund for the industry, has and is funding research programs on heat conservation in greenhouses and on solar heating. Energy costs for most greenhouses have more than doubled in the last four years, and they are expected to double again.

Solar heating for greenhouses is far from feasible now, because of the large amount of heat needed to be stored. Cost effective storage methods have yet to be devised.

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* The principal investigator, Mr. Ralph Wright, is the immediate past-president of the 6500 member Society of American Florists.

· Yet, the industry is ready to change. The heating methods outlined in this project could be adopted immediately, and cost effectively, by the industry. Also, it is possible that the greenhouses that might be able to utilize geothermal heat resources could serve as the nucleus for a heat-supplying company to supply heat to businesses and homes in the vicinity of the greenhouses. The funds now paying for the greenhouse heat load could serve as the source of funds that would be used to discover and develop the reservoir, and, once available, the reservoir could be used to serve other customers.

TABLE I

Total Heat Load in Greenhouse Industry*

Twenty-three states:

Production Area: 1976	Sq. Ft.
Standard Conditions	28,768,000
Miniature Carnations	2,706,000
Standard Chrysanthemums	22,441,000
Pom Pom Chrysanthemums	37,412,000
Potted Chrysanthemums	17,689,000
Hybrid Tea Roses	23,420,000
Sweetheart Roses	5,240,000
Total square feet	137,676,000

*Source: USDA: Flowers & Foliage Plants, Production & Sales, 1975 & 1976

Sp.Cr. 6-1(77)

Using a variety floral greenhouse in Farmington, Utah (between Salt Lake City and Ogden) as a typical case:

1976, natural gas used: 93,355 MCF for 250,000 sq. ft. = .373 MCF/sq. ft.

Project usage for seven major crops in twenty-three major producing states:

137,676,000 x .373 = 51,333,000 MCF of natural gas, or the equivalent in other fuels. (9.2 million BBI of oil.)

Table II shows that Utah Roses' 1978-79 season gas and oil bills will be approximately 13% of gross expenses. Utah Roses is supplied natural gas by Mt. Fuel Supply (of Salt Lake City) that has one of the lowest rates in the nation ($1.22/MCF presently with a boost to $1.35/MCF scheduled later this year for interruptible industrial customers). In neighboring states served be Intermountain Gas, the rates are $2.25/MCF for industrial customers, closer to the national average.

In examining the range of heating costs in Table III, category I, the coldest areas of the country, represent the greatest incentive for fuel cost reduction. Category 3, the warm regions present the least incentive. Indeed many floral items (roses in particular) grow poorly in very warm conditions, and forced ventilation and evaporative cooling becomes the major cost consideration in this area. Salt Lake City (location of Utah Roses) lies midway between category 1 and 2 with about 6000 degree F - days of heating requirements, and about average sunlight (annual integrated total). Thus, the Utah Roses situation does not represent the most desperate type of situation, either in climate or in fuel costs. Yet Utah Roses feels very high incentive to find an alternative fuel supply, in part because the gas supply is demand interruptible. (Fuel oil heating costs are 220% those of present gas costs.)

A real but still intangible and hence difficult to estimate benefit of a geothermal heating system to the floral industry is the flexible options offered to increase productivity and quality by better control of environment. Fresher air and better humidity control will be practiced if the incremental cost of the additional heat energy is virtually zero. It is not unreal to anticipate 10% higher yields, perhaps by increasing energy usage 30%. If this increase added 30% (instead of just a few percent) to the energy bill, such practices would not be cost effective. An even more intangible benefit is the option of enhancing quality with better climate control. The returns of such an effort can be tremendous in terms of a more stable and higher priced market. Experimenting with quality enhancement of the product by more energy consuming climate control would not be attempted with expensive fossil fuels. (62° to 64° with low humidity is considered ideal climate for roses. Maintaining CO_2 enrichment consumes about 600 MBtu annually, less than 1% of fuel usage.

Should the above arguments be construed as a push toward profligate use of geothermal energy, we hasten to stress that these are merely some of the advantages that Utah Roses lists in arriving at its decision to develop its own geothermal resource. The net result, in DOE's eyes, is a reduction in scarce fossil fuel consumption and a demonstration to prompt similar geothermal attempts elsewhere.

TABLE II
UTAH ROSES FUEL CONSUMPTION REPORTED IN MCF OR MBTU*

	1975	1976	1977
JAN	8431	9025	11145
FEB	10230	9477	10050
MAR	8882	7743	8983
APR	6513	5607	5284
MAY	4025	3346	5045
JUN	2020	1980	197
JUL	244	675	85
AUG	1141	1167	143
SEP	3111	2938	2028
OCT	2425	5918	5141
NOV	9174	7870	7681
DEC	8610	9400	9957
FUEL OIL**	5500	3000	0
TOTAL	73310	68146	65739

*MCF = THOUSAND CUBIC FEET; MBTU = MILLION BTU
?
**AT 150,000 BTU/GAL

TABLE III
VARIATIONS IN FLORAL GREENHOUSE HEATING COSTS NATIONWIDE

LOCATION	TYPICAL HEATING SEASON DEG.F.-DAYS	APPROXIMATE MBTU ANNUALLY FOR ACRE OF GREENHOUSE*	TYPCIAL NATURAL GAS COST $/MBTU	FRACTION OF GROSS EXPENSES FOR HTG**
1-N.INTERMTN WEST, NEW ENGLAND,N. PLAINS STS.	6000 TO 9000	12,000 TO 18,000	1.20 TO 3.00	9 % TO 34 %
2-S.INTERMTN WEST,MIDDLE PLAINS STS., MID-ATLANTIC STATES	3000 TO 6000	5,000 TO 13,000	1.50 TO 3.00	5 % TO 24 %
3-CALIFORNIA COAST,DESERT SW & SE STS.	1000 TO 3000	2,000 TO 7,000	1.20 TO 2.50	2 % TO 11 %

*ASSUMING THE GREENHOUSES ARE IN AN ARRAY OF ATLEAST ONE ACRE OF TOTAL AREA. SMALLER UNITS WILL HAVE LARGER HEAT LOSS.

**ASSUMES THAT ONE ACRE OF GREEHOUSE GROSSES $160,000 ANNUALLY. IN FIGURING THE RANGES OF COSTS, ACCOUNT WAS MADE FOR VARYING CLOUD COVER EVEN WITHIN THE GOOD GREENHOUSE AREAS.

D.2.e. ESTIMATE OF OVERALL LIFE-CYCLE ENERGY COST/INITIAL & LONG TERM SAVINGS

Table IV summarizes the savings compared to natural gas, the investment costs in the new system, and the projected cost savings over 15 years by using a goethermal system instead of a conventional system. For purposes of comparing with a brand new facility, a conventional vs a hybrid geothermal-fossil system are compared. Both systems are assumed to have a 15 year lifetime. The additional electrical expense comes from the power demand of the pumps particular to the geothermal system. The Salt Lake City area uses coal predominately in its electrical power production network. Thus a much less amount of a plentiful fuel (coal) is used to power a system which uses a renewable resource (geothermal) as a replacement of a scarce fuel (gas). The energy used to develop and install the geothermal system will be minimal (a few percent) compared even to the first years facility operation and has not been computed.*

<u>Designing For Total Cost/Benefit Effectiveness</u> The Utah Roses facility already has an operable gas/oil fired steam heating system. It is prudent to adjust the capital investment in a geothermal system to give optium cost benefit by using the conventional boiler to peak the system on the coldest of days. Figure 3 shows a temperature frequency plot for Salt Lake City. It is apparent that to add geothermal heating capacity to supply needs below an outside temperature of 25° F would not be cost effective in general. The exact design point could only be determined once the production well water temperature, water quality, and productivity are known. But for an example, designing the geothermal system to "hold its own" at 25° F, will require the conventional system to burn 5% of its present normal annual fuel use in order to supply the difference. (The conventional system is only capable of maintaining 60° F inside with outside temperature as low as 18° F. Lower temperatures than this are not uncommon in Salt Lake City, though less than 10° F is rare.)

D.2.f and g. SYSTEM DESCRIPTION & HYDROTHERMAL POINT OF APPLICATION

The complete facility is comprised of the well system, the pumps and motors, the heat exchangers, the distribution system, the control system and the disposal system. The well system would consist of two wells, a source well (nominally supplying 170°F water) and a reinjection well. Based on experience with the first well, if it is not highly successful, it is expected that the second well to be drilled could be designed to produce more energy (fluids and temperature) than the first. In such a case, the best producing well will be selected as the source and the other

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* (We cite, as an example in a related, highly capital intensive industry, nuclear power. There a study by DOE showed that total energy consumed in building the plant was only 8% of the first years' energy production.)

TABLE IV

LIFE CYCLE ENERGY COST AND SAVINGS
1980 TO 1995

ENERGY SAVINGS ANNUALLY(1) - 75,000 MILLION BTU, GAS & OIL

TOTAL OVER 15 YEARS LIFE CYCLE - 1.13 X BILLION BTU, GAS & OIL

LESS ADDITIONAL ELECTRICY CONSUMED
ANNUALLY - 800,000 KWH EQUIVALENT TO 7600 MBTU (2)
OVER 15 YEARS - 12,000,000 KWH EQUIVALENT TO 114,000 MBTU

← $6.74(10^9)$ btu/yr

NET SAVINGS OF FOSSIL FUEL - 67,400 MBTU ANNUALLY
- 1.02 BILLION BTU OVER 15 YEARS ?

← $70(10^9)$ btu

COST OF ENERGY SAVED - ASSUMING $1.84/MCF GAS PRICE PROJECTED BY MT. FUEL SUPPLY FOR 1982 WILL ESCALATE AT 8% ANNUALLY UNTIL 1990, THEN 12% ANNUALLY TO 1995 (ASSUME NET ENERGY COST OF ELECTRICITY AT BUSBAR IS DETERMINED BY THE EQUIVALENT COST OF GAS FIXING THE GENERATING PLANT.)

	TOTAL NET FUEL SAVINGS	TOTAL DEBT COST IF AMORTIZED OVER 15 YRS AT 16% COST OF CAPITAL	TOTAL DEBT COST IF 5 YR AMORT. AT 16%
THRU 1985	$ 749,000	$ 668,000	$1,139,000
THRU 1990	1,759,000	1,334,000	1,139,000
THRU 1995	3,467,000 ($2,020,000 IF NOT ESCALATED AFTER 1982)	2,003,000	1,139,000

(1) INCLUDES 10,000 MBTU FOR BEEHIVE MACHINERY, INC.
(2) BASED ON ELECTRIC POWER PLANT HEAT RATE OF 9500 BTU/KWHR

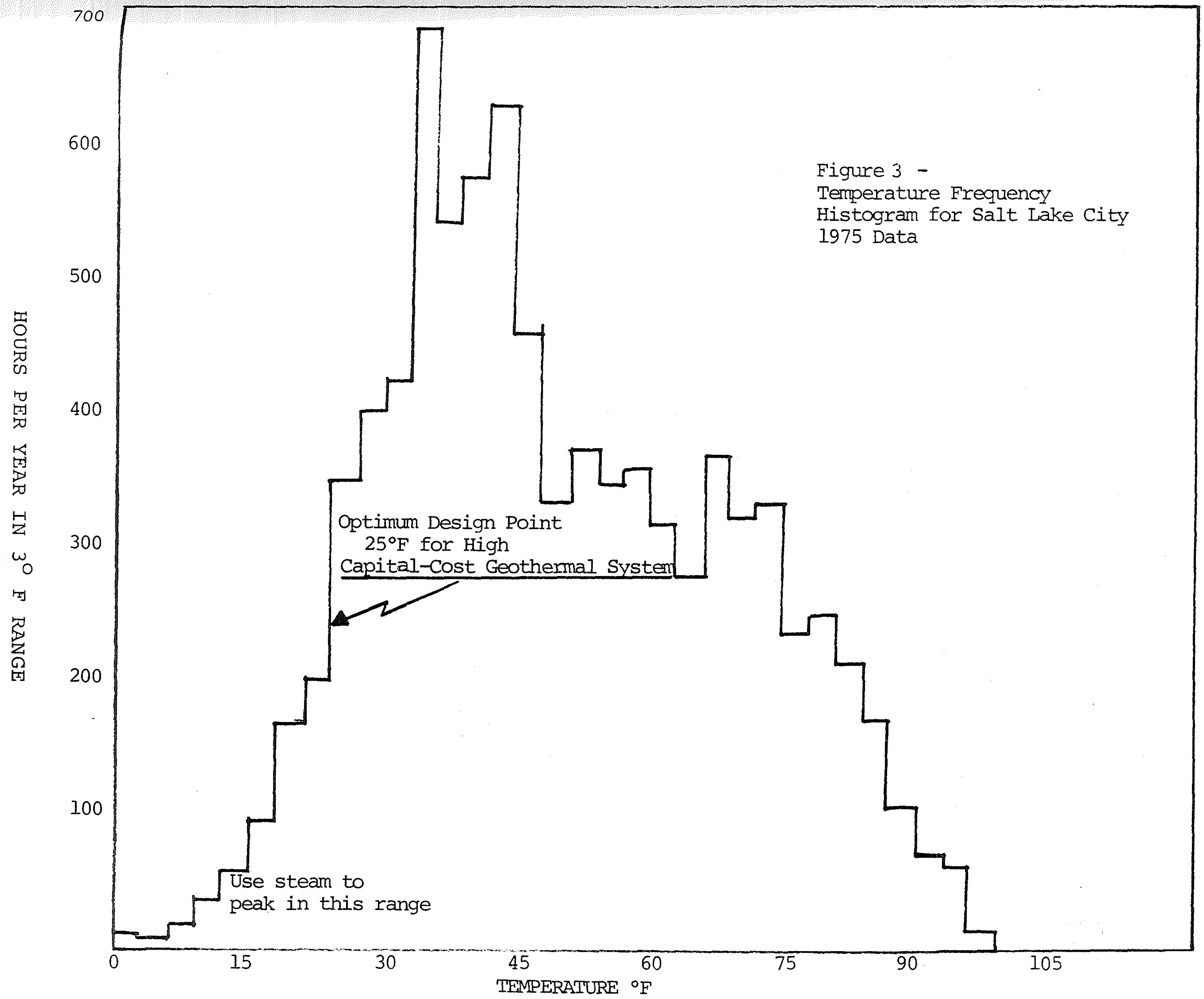
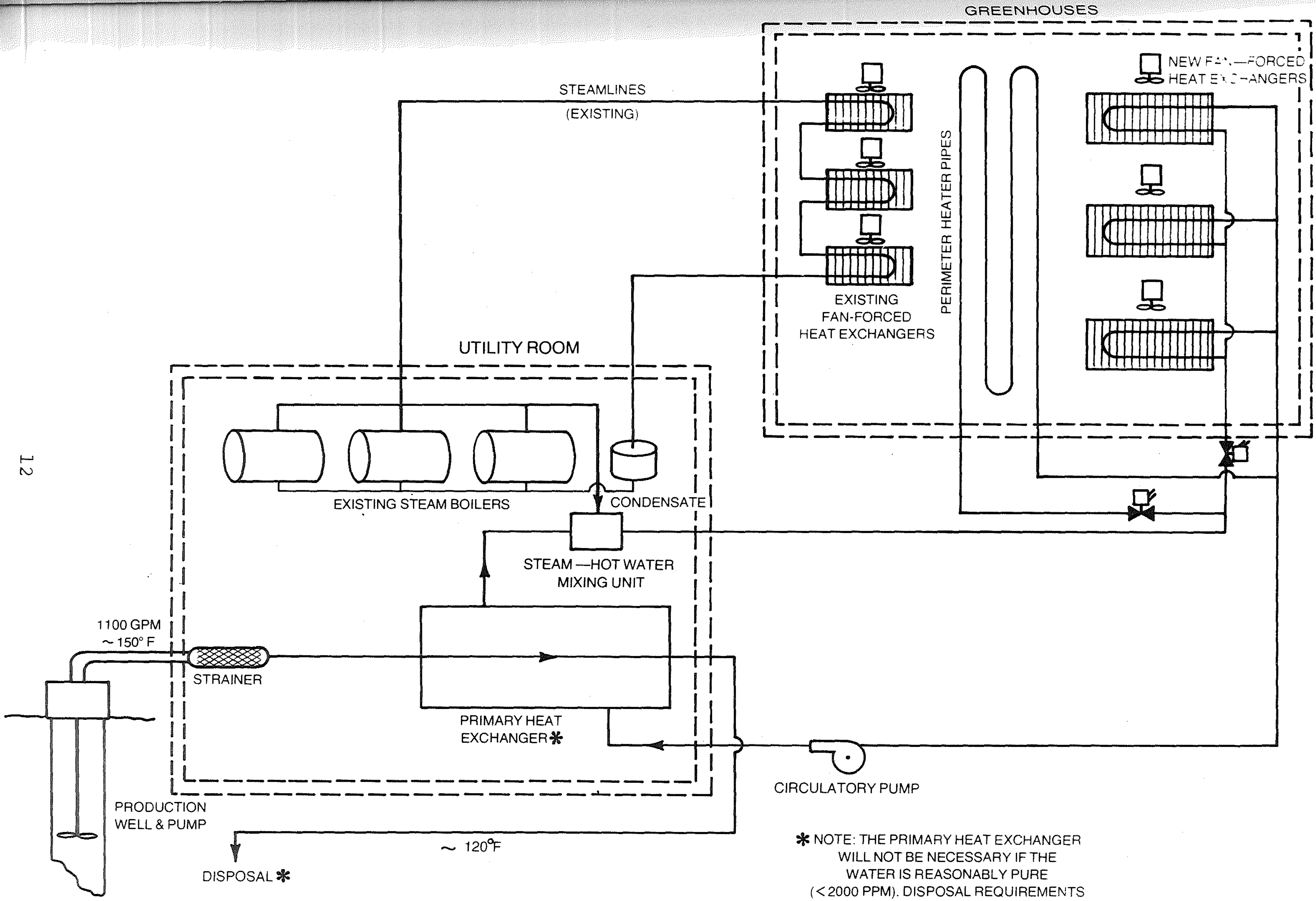


Figure 3 -
Temperature Frequency
Histogram for Salt Lake City
1975 Data

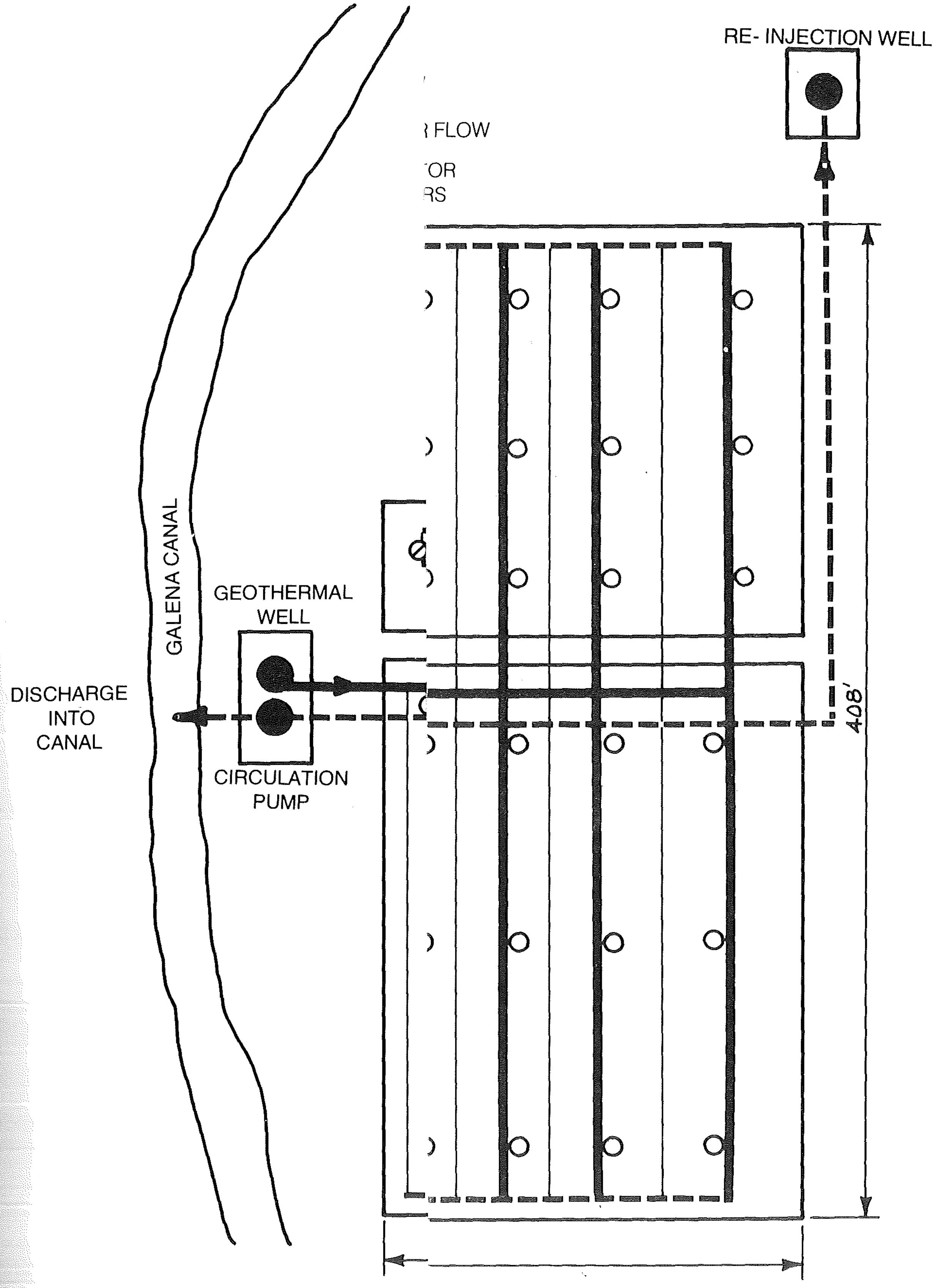


✱ NOTE: THE PRIMARY HEAT EXCHANGER WILL NOT BE NECESSARY IF THE WATER IS REASONABLY PURE (< 2000 PPM). DISPOSAL REQUIREMENTS WILL DEPEND ON THE NATURE OF THE WATER.

FIG. 4 PROPOSED HYBRID GEOTHERMAL/STEAM SYSTEM FOR GREENHOUSES as the reinjection well. The source well should be able to supply at least 500 gpm of 170°F water when pumped. Standard geothermal well drilling techniques will be followed in terms of casing, well head finishing and discharge/supply lines. Very careful monitoring of the drilling will be enacted to provide accurate data and avoid drilling inadvertantly past a moderate or low temperature geothermal strata. The discharge line will feed into a water-to-water heat exchanger at nominally 170°F and into the reinjection line from the heat exchanger at 40°F less with a line pressure of 60 psi to prevent losing dissolved CO_2 (as biocarbonate ion). Experience has shown that scaling problems are minimized or almost non-existent if low-to-moderate temperature geothermal water is kept pressurized and the salts in solution. This prevents the formation of $CaCO_3$ scale. Silica scaling will not occur with 300°F geothermal water unless it is cooled below 100°F. At that temperature, the amorphous phase solubility becomes less than the 300°F crystalline phase solubility. There are few other deposition/scaling problems of significants. The drilling plan is preliminary, presented in Figure 15 . This plan would not be finalized until all nearby well drilling logs had been examined and conclusions drawn on the best approach to adopt in the near surface (first 1000 ft.) where loose unconsolidable formation might be encountered. Well head equipment would be procured conventionally using off-the-shelf equipment. A complete geothermal unit (such as WKM) would be purchased if steam pressures were to develop at the surface.

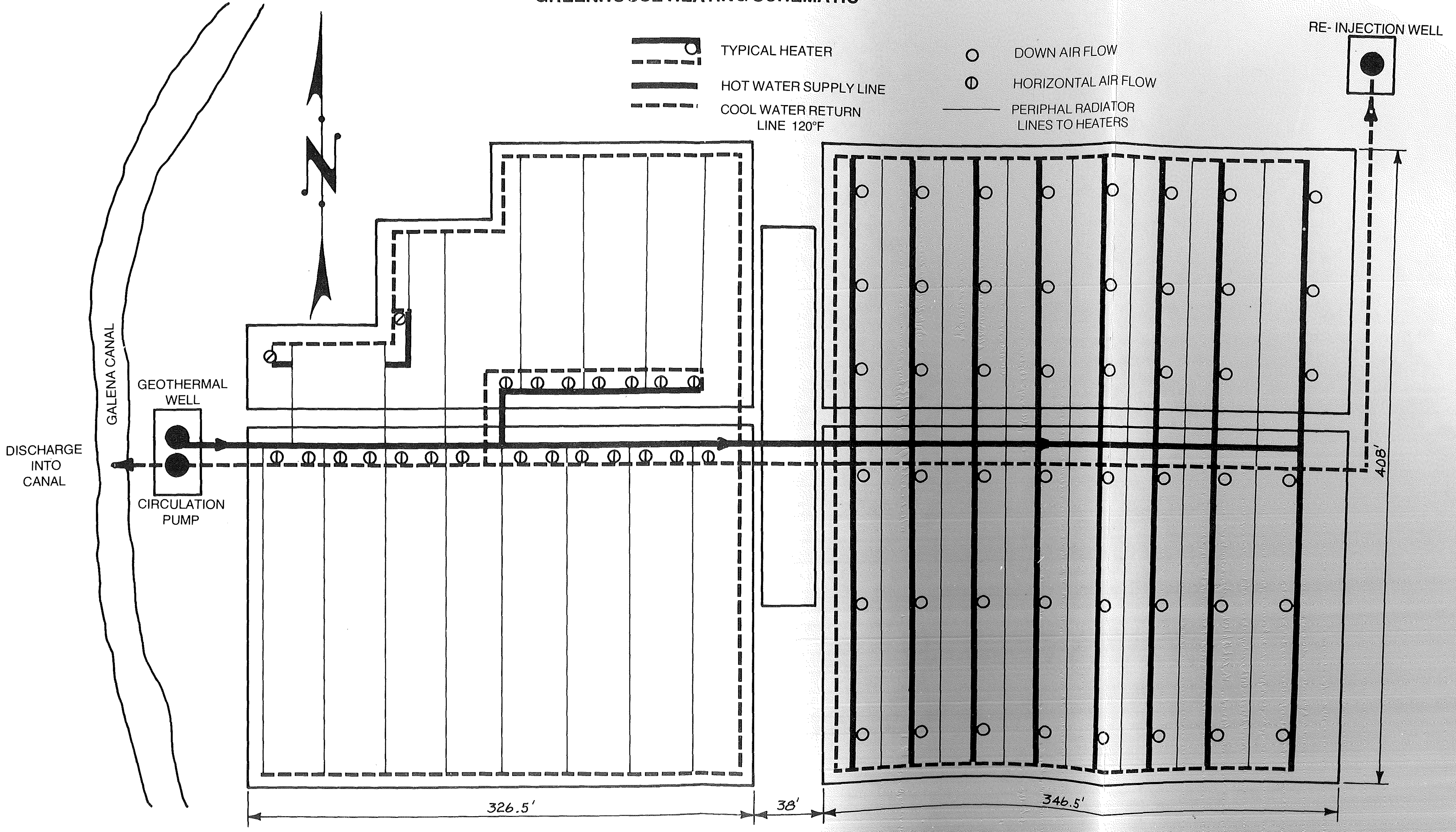
The pump system would consist of one large pump and motor of nominally 200 HP and one or more smaller circulation pumps. (The large pump would supply 500 gpm of geothermal water into a head of 1500 ft., or 1000 gpm into a 750 ft. head. The selection would not be made until well drawdown charecteristics were determined). The smaller pump(s) would handle the secondary ion-free hot water system for the water-air heat exchangers used to heat the greenhouses. (Figure 4)

The heat exchanger system would consist of one large counter flow unit to transfer energy from the geothermal, primary system (pressurized) with ions in solution, to the hydrothermal, secondary system with a minimum of ionic content. About 1800 sq. ft. would be needed in this unit. The smaller, water-air units would heat the air inside the individual greenhouses. The secondary lines would be ordinary galvanized steel pipe with 3 inch diameter trunk lines and 3/4 inch diameter branch lines. The primary lines would be of steel and nominally 6 inches diameter. Fig. 5 shows the present layout of the greenhouse facility showing where the well and main trunk lines would be placed.



DESIGNED	SCALE		PROJECT NO.
DRAWN	DATE		
CHECKED	REVISION		SHEET NO.
ENG. DIV. APPROVAL			

Fig. 5 **UTAH ROSES GEOTHERMAL PROJECT GREENHOUSE HEATING SCHEMATIC**



DESIGNED
SCALE
DRAWN
DATE
CHECKED
REVISION
ENG. DIV. APPROVAL

FORSGREN / PERKINS & ASSOCIATES, P.A.
CONSULTING ENGINEERS
Rexburg • Pocatello • Preston • Logan • Salt Lake City

PROJECT NO.
SHEET NO.

Presently, the installed heater complex is as follows:

a) Perimeter pipe heating, 1¼" pipe, 16,000 ft. This provides about 1.5 x 10^6 Btu/hr. (up to 4 lines on outside walls, 2 to 3 lines between bays).

b) 12 Units, Modine Model V1020 (357,000 Btu/hr. on 50 psig steam) downward discharging on periphory of east greenhouse.

c) 36 Units, Modine Model V675 (236,000 Btu/hr. on 50 psig steam) downward discharging on interior of east greenhouse.

d) 21 Units, Modine GHS 296 (444,000 Btu/hr. on 50 psig steam) horizontal discharging with plastic tube distributors to end of greenhouse and motor-controlled louver.

Boiler capacity is 23.5 million Btu/hr. and can maintain 62°F inside with 18°F outside (5 mph wind or less).

Figure 6 shows the performance characteristics of the V-1020 heater units. Use on hot water at 180°F reduces the energy output to 1/3 compared to 50 psig steam. This hot water rating is taking a 40°F T water temperature reduction through the unit. Under these conditions, the V-1020 units each would required 5.8 gpm, and would use 295 gpm.

There are several options that are being considered for retrofit. In each case all of the peripheral pipe would carry geothermal water, and might be added to with additonal finned tubing. (The present pipe is badly corroded externally and would be cleaned, but would not be finned.) The heater options are:

1. Convert part of the present steam system to geothermal water plus the additional units. Retain part of the old on pure steam. Use steam bleed into a mixing bank to boost the geothermal water.

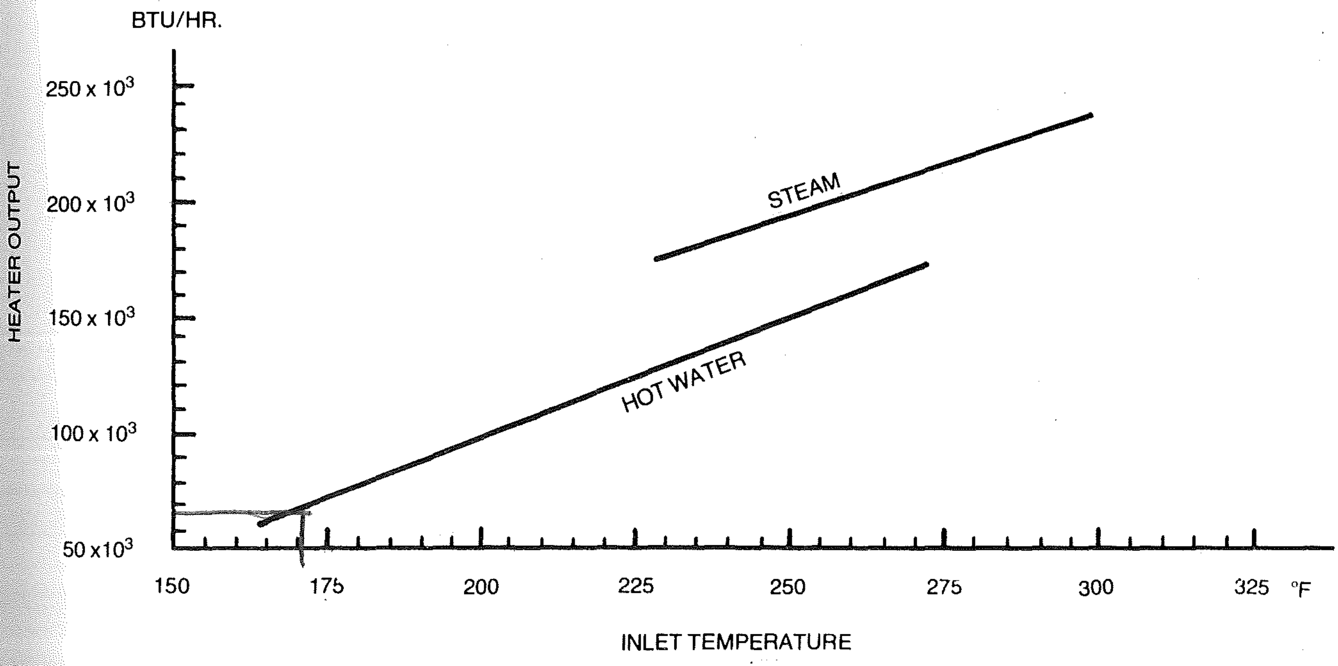
2. Convert everything to hot water, using steam bleed in a mixing tank.

3. Retain the present system and install a completely independent geothermal system.

The option to be chosen will depend on the geothermal source, temperature, flow rate, and water quality. Concerning the latter, we nominally prefer the use of a primary heat exchanger and a secondary circuit with corrosion inhibitors added. Since some metallurgical effects can be anticipated from the geothermal water, it is best to concentrate this in one unit. This approach also avoids requiring steel (instead of the customary copper tubing in all the heaters.

Fig. 6

UTAH ROSES GEOTHERMAL PROJECT
HEATER PERFORMANCE ON WATER



The cost of doubling (exact duplication) of the present heaters is approximately $31,000 plus installation. Converting portions of the present piping to carry hot water will require some additional mechanical support, but these modifications will be minor.

Figure 5 shows the present Utah Roses complex of heaters, as they would be connected into the geothermal system as in option #2. Placement of additional heaters will be determined during the final design, based on the characteristics of the well.

The control system would consist of all those components to control the pumping rate, motor operation, valve action, heat output, etc. Final design and specification of these will depend on the temperature and capacity of the source well. In general, the finished system will be on an operating convenience par with conventional systems it replaces, which are all automatic. A variable speed pump motor would probably be employed to minimize stops and starts.

The performance monitoring system would consist of temperature and pressure probes and flow meters coupled with data storage units to adequately monitor the physical state of the operating system. Retrofitting recorders to control points on the present unit would be considered. This data will be reduced to provide the performance figures for the required reports and the systems efficiency.

The deepwell pumps and motor and large primary heat exchanger are the long lead-time items for this program. The lead times on these would be 6 months.

D.2.h. FINAL SPECIFICATIONS

Preliminary design specifications have been the basis of this PON. Final design specifications are dependent on the wells first proving themselves and then on the capacity and temperature of the source well. When that data is available (completion of Phase II) preliminary design specifications (in report form) will be prepared. Using these, final designs will procede, resulting in specifications for the heating equipment.

D.2.i. DESIGN/CONSTRUCTION/INSTALLATION SCHEDULE

The graphic presentation of the schedule is shown in Section 0-3-c of this volume. The schedule is based on a start of the contract by mid-January 1979*, after completion of negotiations following award on December 15, 1978. The principal constraint on schedule, imposed by nature (weather) and floral business conditions, will be the necessity of making major retrofit installations in the greenhouse between mid-June and early November.

Phase I - Preparing for Drilling

Environmental report preparation will commence during negotiations and be completed and the reports delivered about one month after contract signing.
Acceptance of Environmental Assessment position is projected for one month later, as word from DOE.

Decision Point - Drilling conceptual design and approval to drill should be available by early May (two months after environmental acceptance.)

Note: The above part of the schedule is the most easily shortened portion, if approvals of documentation are received in a timely manner. As much as two months could be shortened at this point, providing some slack time on the long-lead time component procurement and installation schedule.

Phase 2 - Drilling, Testing, Evaluation and Remedial Action If Necessary

Completed by mid-December 1979.

Note - The drilling contracting schedule is realistic based on present heavy drill-rig demand. However, we suspect that oil and gas drilling demand may slacken by next year and that several months might be trimmed from the schedule. We have also chosen a drilling schedule which does not cross fiscal years. The latter may not be a necessary constraint.

Decision Point - Decision as to whether the resource is adequate and how useful, would be made by mid-January.

Phase 3 - Design for Using the Heat

The necessary lead time for procuring pumps and especially heat exchangers is critical in order to meet the mid-June to early November installation "window" for accomplishing the construction.

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*We have chosen a month later start date than estimated by DOE in its May 22 Questions and Answers because of floral industry rush season through Christmas.

Install small test geothermal heat exchanger (if well is artesian). Obtain metallurgical data from this unit for 3 months.

Six months lead time for ordering and delivery is scheduled for the primary heat exchanger, the down-hole pump and the reinjection pump. Other items have shorter lead times. To gain useful design data, a small heat exchange system would be placed on test for 3 months, begining in February 1980, if the well is artesian.

Decision Point - Design approval on heat exchanger and method and design for disposal of used fluid.

Phase 4 - Construction

Ordering equipment and installing it. Scheduled for completion in early October 1980.

Phase 5 - Start-up, Operation, and Evaluation

Beginning in October 1980. Evaluate through one heating system.

Phase 6 - Reporting and Information Dissemination

The final report would be completed by September 30, 1981.

Note - The above schedule gets a small geothermal unit (~300,000 Btu/hr) on the lines by late winter 1979-80. The complete system will only be ready for service at the start of the 1980-81 winter.

D.2.j. DRAWINGS OF PROPOSED SITE AND FACILITIES

Figures 7 and 5 show, respectively, the plot plan of the Utah Roses property and the arrangement of the present heating system if it were entirely converted to geothermal. As discussed in D.2.f, additional heaters will be needed, depending on the resource conditions. All activity will occur on Utah Roses property.

D.2.k. PLAN FOR DEVELOPMENT OF AN OPERATION AND MAINTENANCE MANUAL

A manual describing the new system, recommended operating procedures and equipment specifications will be prepared by Forsgren, Perkins and Associates. Copies of this manual will be distributed to appropriate personnel in the organization of Utah Roses for operating use and reference prior to start-up. After several months of operation, revisions as required will be made to the manual by Forsgren, Perkins and Associates. Operation and design references will key to applicable ASHRAE, state and local codes.

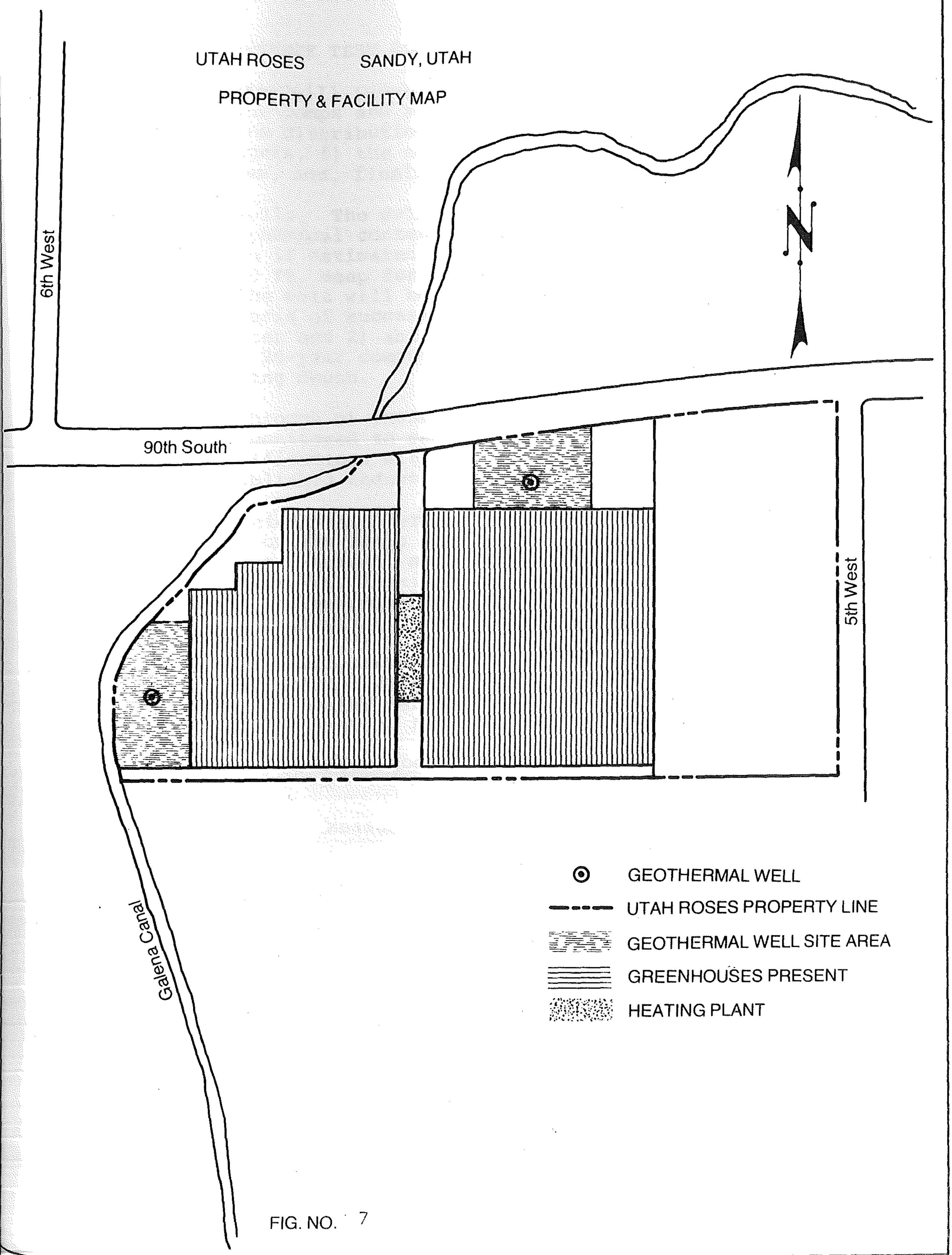

UTAH ROSES
SANDY, UTAH
PROPERTY & FACILITY MAP
6th West
90th South
5th West
Galena Canal
N
◉ GEOTHERMAL WELL
— - - — UTAH ROSES PROPERTY LINE
GEOTHERMAL WELL SITE AREA
GREENHOUSES PRESENT
HEATING PLANT

FIG. NO. 7

D.2.1. ACCEPTANCE TEST PLAN

Testing will involve distinct components: a) the wells, b) the pumps and motors, c) the primary heat exchanger, d) the distribution system, e) the secondary heat exchangers, f) the control system, g) the monitoring system, and, finally, the overall efficiency and performance.

a) Wells. The wells will be monitored for temperature and chemical content as they are drilled. Drilling depth is estimated to be in the range of 1,500 - 3,000 ft. deep for 170°F water. Performance testing of the well will be done at time of drilling. The criteria of success are 1) 150°F temperature or greater and 2) ability to pump to get 500 gpm capacity with 20-year computed drawdown not to exceed the pump setting depth.

b) through g) These components will be brought on line and monitored to see if they meet design operating specifications with no operating failures following established industrial practice.

Efficiency and Performance. An assesment of this will be made on the basis of the operating data over a heating season (Phase 5) and a statement prepared for Utah Roses by Forsgren, Perkins and Associates showing the performance parameters and efficiency of the system. The same analysis will be included in report.

Specifically, the heating system acceptance test plan will include balancing of the heating system, measurement of heater performance, and monitoring of disposal system operation for the initial one month period.

<u>Heater Performance</u> - To establish initial performance

Measure: Water ΔT vs inlet T for variety of conditions. Report air temperature outlet and inlet. Pipe-strap thermocouples for water and probe thermometers for air. One unit will be equipped with a flow meter - orifice Δp unit.

<u>Primary Heat Exchanger</u> - To establish initial performance (parameter range) for later comparison to determine if fouling is ocurring on heat exchange surfaces. Inlet and outlet primary and secondary temperatures and flow rates. Flow rate will be with orifice - Δp unit. Variation in conditions will give a short curve range on the variables.

Disposal System Performance and/or Monitoring

a) If reinjection well: measure pressure draw-up and calculate transmissivity for later comparison, to see if formation is suffering with time.

b) If surface discharge ditch: monitor conditioning facilities (spray pond), H_2S levels, radioactivity (initially)

System Balancing - Adjust heater orificing (valves) to provide the appropriate uniformity (or non-uniformity as required by horticulture conditions for various flowers grown). Do same for several different outside climate situations. Include changes in settings vs. outside weather in operating manual.

D.2.m. RELEVANT ENVIRONMENTAL AND INSTITUTIONAL STUDIES

The environmental impact of the operating system is expected to be very minimal. The primary and secondary systems are closed loops - avoiding any question of unacceptable discharge, if reinjection is employed.

An environmental assesment will be filed within 60 days (our schedule sets a 30 day goal) from time of contract signing, according to the guidelines and procedures for DOE-DGE Guideline ERHQ 0001.

We do anticipate that unusual thoroughness will need to be applied to the analysis for the environmental report. Geothermal energy is a new concept to be applied to the Salt Lake Valley, and many citizens will probably express concern. Exaggerated reports of adverse environmental effects from southern Utah geothermal developments may be incorrectly extrapolated to the Utah Roses situation.

D.2.n. THE PLAN TO ATTRACT OTHER USERS OF GEOTHERMAL ENERGY

Sandy is readily accessible to a high percentage of industrial Utah and within 30 mile of its two major universities. When the well is proven, then a series of press releases will be initiated with the major papers, covering the project an its progress. When the system comes on line and its advantages are verified, then appropriate detailed reports will be made to the Utah Academy of Science, engineering departments of the colleges and universities, the State Legislature (when in session). Reports will also be submitted to the Society of American Florists Roses, Inc., and other floral trade association monthly newsletters. In addition, Forsgren, Perkins and Associates will have representitives make reports, give technical and/or business analysis talks at suitable levels to local business organizations, technical organizations, and technical societies.

A key element to be stressed is that most cost analyses predict more substantial savings when business or private groups drill their own well - compared to buying geothermal energy from a resource developer. The risk they are reluctant to accept and usually unable to afford is that of a dry well. The more successful wells that are brought into existence, the more probable the success of a new one. And that is a major part of the justification of a program like this that has its setting in a large industrial and urban area - where the potential for economical geothermal applications and the associated savings in cost and scarce fuels are great.

Reviewers are referred to Section 7 of Vol. II A where the Public Awareness approach is discussed in more detail, stressing the national reputations that the principals have in the floral industry and the goethermal and energy community.

As to expanding the use of geothermal energy from the Utah Roses project, much depends on the productivity and temperature of the discovered resource. Beehive Machinery, Inc., the adjacent factory, is interested in making the conversion of an economical'price. They will add 15% to 20% to the Utah Roses load. A major new shopping center is being developed within two blocks, and a large pharmaceutical laboratory is less than a mile away. If Utah Roses has excess geothermal energy available, they would definitely plan on making a business proposition to those other organizations. A second production well at the opposite end of the property is a distinct possibility. The 800 ft. spacing should reduce interference between wells to a negligible level.

All other adjacent land is currently unoccupied, but "ripe" for industrial development. Utah Roses would sell geothermal fluids to any new industries to the extent its well can supply these additional needs.

D.3. MANAGEMENT PLAN

Utah Roses and Forsgren, Perkins and Associates both have a proven record of expertise, versatality and successful growth in their respective fields.

Utah Roses is one of the larger floral companies and markets its products across the western states and at several locations on the Atlantic seaboard. Their management ability has provided their growth and the foresight to aniticipate the need for a program such as this PON. They have the depth of leadership to see this project through to a successfully managed acquisition of new technology. (Their growth rate has averaged 20% each of the last 3 years).

Forsgren, Perkins and Assoicates, P.A. This company is a multidiciplinary consulting engineering organization, operating under its present charter in the state of Idaho for the last 15 years. It provides engineering services to a variety of industries, to towns, county, city, and the state government. Since its beginning in 1963, Forsgren, Perkins and Associates has been rewarded with the opportunity to meet the many engineering challenges attendant to new developments in the intermountain area, using their personnel, experience, and facilities accordingly. Presently, Forsgren, Perkins and Associates handles the fesibility studies, design, funding arrangements and implementation management for projects and studies amounting to an equivalent of $10 million for construction project yearly.

D.3.a. TECHNICAL APPROACH

The engineering skills and experience to design and implement a project of this nature are available and proven. Supervision of geothermal well drilling, geothermal well preparation, installation and choice of heat exchangers, distribution lines, reinjection, control and performance monitor installations are all within the range of the team's successful engineering experience. It is reasonably certain that drilling will produce an adequate amount of hot water. Heat conversion system fabrication is expected to be completely successful. One scheduling limitation exists because of the heavy business from November to June. Retrofit inside the greenhouse must therefore take place between June and October. This is an appropriate time anyway, as the heating load is least.

Well Drilling Success (Phase 2)

We are reluctant to place a probability figure for the expected degree of success on the primary uncertainty (problem), the success of striking the desired resource. There are so very few case histories for low-to-moderate temperature geothermal energy that statistically assigning a probability to success is without foundation. What is certain is that there is hot water directly under the location but its temperatue and depth are unknown. If similar to that water at the surface 6 miles to the south, the source temperature is well above the minimum needed, by some 50 to 150°F. Finally, an inferred fault runs directly through the location, further enhancing the chances of getting a productive hot water well.

There is little question adequate temperature will be found. The prime concern is well productivity. The project manager directed the first production enhancement program on a geothermal well, using sidetracking techniques with a Dynadrill (or Turbo drill). In that successful first-of-a-kind technique application, the RRGE-3 well's productivity was enhanced 500% with only a 20% increase in cost. (Such a remarkable improvement would not occur in a homogeously fractured formation, only in a heterogeneous formation.) Therefore, we are confident that expected success on this well has better than 50% possibility.

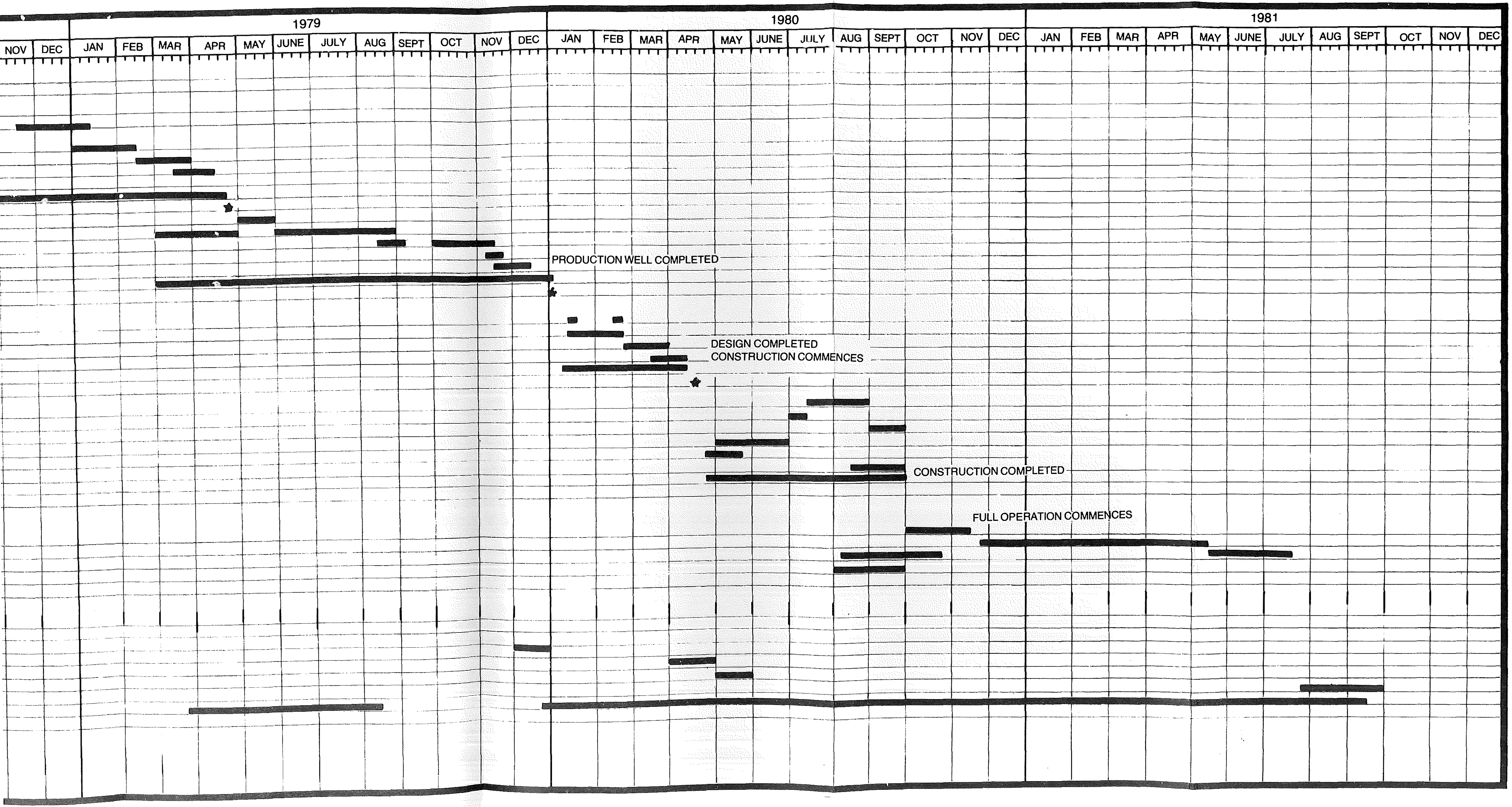
Disposal Problem (portions of Phase 3 and 4)

The other principal concern is disposing of the water in a satisfactory way - environmentally, economically, and with negligible effect on the geothermal resource.

Because of the small quantity of geothermal water involved with this project, production and ultimate surface disposal would not noticeable deplete the fluid content of the reservoir. Disposal into the old Galena Mining Canal and ultimatley into Salt Lake would be permitted for high solids content. However, unusually high solids content, significant presence of poisonous elements, or H_2S, would require either treatment or reinjection. We anticipate no serious problems with reinjection which has been practiced for many years on several space heating geotheraml projects in France (having 10% dissolved solids in the water). Forsgren, Perkins and Associates personnel have had first hand experience with the reinjection experiments at Raft River, which worked successfully except for motor control problems. Therefore we do not foresee any natural situation that would prevent successful reinjection.

Fig. 8

UTAH ROSES GEOTHERMAL PROJECT WORK SCHEDULE



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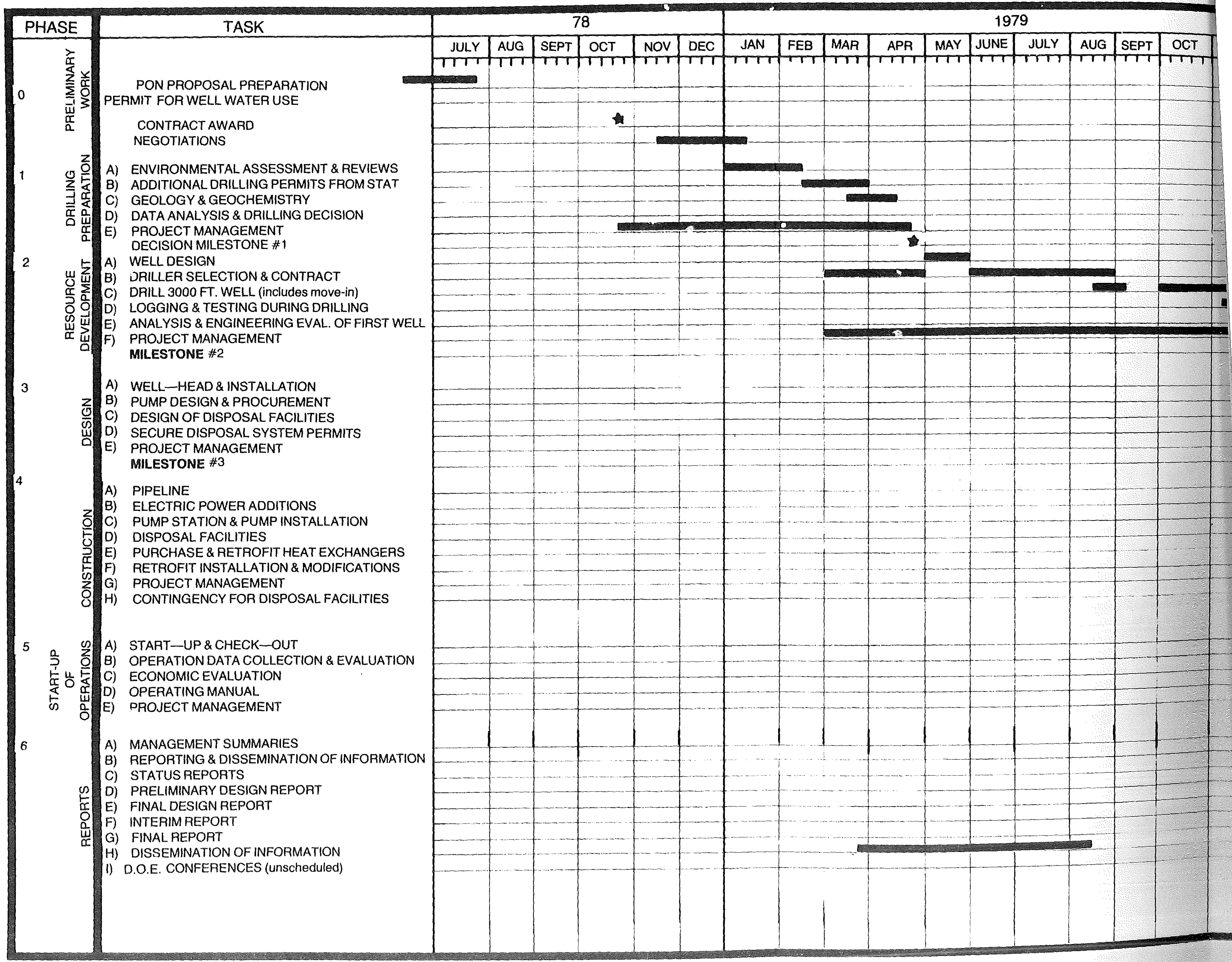


PHASE		TASK
0	PRELIMINARY WORK	PON PROPOSAL PREPARATION
		PERMIT FOR WELL WATER USE
		CONTRACT AWARD
		NEGOTIATIONS
1	DRILLING PREPARATION	A) ENVIRONMENTAL ASSESSMENT & REVIEWS
		B) ADDITIONAL DRILLING PERMITS FROM STAT
		C) GEOLOGY & GEOCHEMISTRY
		D) DATA ANALYSIS & DRILLING DECISION
		E) PROJECT MANAGEMENT
		DECISION MILESTONE #1
2	RESOURCE DEVELOPMENT	A) WELL DESIGN
		B) DRILLER SELECTION & CONTRACT
		C) DRILL 3000 FT. WELL (includes move-in)
		D) LOGGING & TESTING DURING DRILLING
		E) ANALYSIS & ENGINEERING EVAL. OF FIRST WELL
		F) PROJECT MANAGEMENT
		MILESTONE #2
3	DESIGN	A) WELL—HEAD & INSTALLATION
		B) PUMP DESIGN & PROCUREMENT
		C) DESIGN OF DISPOSAL FACILITIES
		D) SECURE DISPOSAL SYSTEM PERMITS
		E) PROJECT MANAGEMENT
		MILESTONE #3
4	CONSTRUCTION	A) PIPELINE
		B) ELECTRIC POWER ADDITIONS
		C) PUMP STATION & PUMP INSTALLATION
		D) DISPOSAL FACILITIES
		E) PURCHASE & RETROFIT HEAT EXCHANGERS
		F) RETROFIT INSTALLATION & MODIFICATIONS
		G) PROJECT MANAGEMENT
		H) CONTINGENCY FOR DISPOSAL FACILITIES
5	START-UP OF OPERATIONS	A) START—UP & CHECK—OUT
		B) OPERATION DATA COLLECTION & EVALUATION
		C) ECONOMIC EVALUATION
		D) OPERATING MANUAL
		E) PROJECT MANAGEMENT
6	REPORTS	A) MANAGEMENT SUMMARIES
		B) REPORTING & DISSEMINATION OF INFORMATION
		C) STATUS REPORTS
		D) PRELIMINARY DESIGN REPORT
		E) FINAL DESIGN REPORT
		F) INTERIM REPORT
		G) FINAL REPORT
		H) DISSEMINATION OF INFORMATION
		I) D.O.E. CONFERENCES (unscheduled)

D.3.b. ORGANIZATIONAL ELEMENTS AND KEY PROJECT PERSONNEL

Utah Roses will be responsible for the financing of the project and will be the contractor to DOE. Utah Roses is responsible for the interfacing of the modifications of their physical plant with their commercial product preparation activities.

The key personnel associated with this project, and their principal duties, are shown on the Project Organization Chart. (Fig. 9)

As projects have become more complex it has become essential to secure modern computer equimpment for technical analysis design and management control and accounting functions. These capabilities are regularly updated to better serve and satisfy a growing clientele'. Forsgren, Perkins and Associates is one of the three major computer software vendors for Wang Computer Equipment throughout the United States, Canada, and Mexico. Their professional staff has increased to 29 graduate engineers and 60 support personnel. As a general consulting office, Forsgren, Perkins and Associates provides extensive experience in all areas of municipal and county facilities, feasibility studies, envioronmental engineering and many other areas unrelated to this project. The Company currently has operating offices in four Idaho, two Utah, and one Washington cities.

Program Manger - Ralph M. Wright, Chm. of the Board and founder of Utah Roses. MBA from Harvard. Fourteen years experience as an owner/manager of floral business. Recent past-president of Society of American Florists.

Project Manager - Dr. Jay F. Kunze, P.E., Mgr. of Energy Services Div. of Forsgren, Perkins & Assoc. Six years in developing and managing geothermal energy program at Raft River and Boise as Mgr. Geothermal and Advanced Programs at the Idaho National Engineering Laboratory, EG&G - Idaho, Inc.

Deputy Project Manager - Dr. Klane F. Forsgren, P.E., Mgr. of the Salt Lake Office of Forsgren, Perkins & Assoc. A chemical engineer with 12 years commercial industrial research on new product development, and 3 years in consulting engineering.

Geologist and Reservoir Engineer - Roger C. Stoker, Mgr. of Geological Engineering for Energy Services Div. of Forsgren, Perkins & Assoc. Four years experience as chief geologist on the Raft River & Boise geothermal programs.

Operations Mgr. for Geothermal System - C. Richard Wright, President and General Mgr. of Utah Roses. Bachelor of Business Administration.

D.3.c. WORK SCHEDULE

The task listing for this project has been organized into 6 main phases (plus the "zero" phase that includes preparation of this proposal) Each phase has a number of tasks. Key decision points (three)occur after phases 1,2, and 3. There are other minor milestone and/or decision points, which are obvious from the completion of a task in the graphical presentation that follows.(see fold-out schedule)

This same listing of tasks is also repeated in the Statement of Work, Section D.3.4., with some elaboration.

The fold-out schedule (following) is not arranged in PERT diagram fashion, primarily because the phases are sequential, by nature of the program, requiring very definitive decisions to be made before proceding with the next phase. (The interties of a PERT network would unduly complicate the schedule chart without adding any useful information at this stage.)

D.3.d. PROJECT MILESTONES

Milestone	Phase
	1) Prepare for Drilling
2/15/79	Environmental report completed
4/15/79	Additional required geology and geochemistry completed
5/15/79	Decision on type of drill rig, well specification
	2) Drilling for Resource
6/ 6/79	Drilling specs complete; bid package ready
9/ 1/79	Driller under contract
12/ 1/79	Drilling complete on production hole
12/31/79	Production testing complete
1/15/80	Decision on adequacy and usefulness of well and technical limitations on proceding with system final design and construction. Should project procede to final design? Should this well be stimulated, used for reinjection? Should another well be drilled to supplement the first? Or should project be terminated?
	3) Design for Using Resource
2/15/80	Small scale test unit in operation in greenhouse
2/15/80	Order well pump
3/ 1/80	Permanent well head installed
3/15/80	Preliminary design report delivered
4/ 1/80	Disposal facilities and heat exchanger design complete
4/15/80	Decision - Design approval of disposal facilities and heat exchange system. If deep well is necessary, appropriate plans to drill must be added to Phase 4.

4) Construction

4/15/80	Award purchase orders for large heat exchanger (primary) and heaters for greenhouse
6/ 1/80	Interim report delivered
7/ 1/80	All heat exchangers, small pumps delivered
9/ 1/80	Final design report delivered
9/ 6/80	Downhole pump installed
10/ 6/80	Construction and installation complete, including disposal system.

5) Operation

11/15/80	Start-up test completed; full scale operation commences
6/15/81	One-season data collection completed
9/30/81	Final report delivered

6) Reporting and Dissemination

Major reports shown above. Information dissemination schedule will concide with particular milestones.

D.3.e. DEFINITIVE ASSIGNMENTS AND RESPONSIBILITIES

Ralph M. Wright is Geothermal Program Manager, responsible for all financial management and contracting with DOE. He is Board Chairman of Utah Roses, Inc.

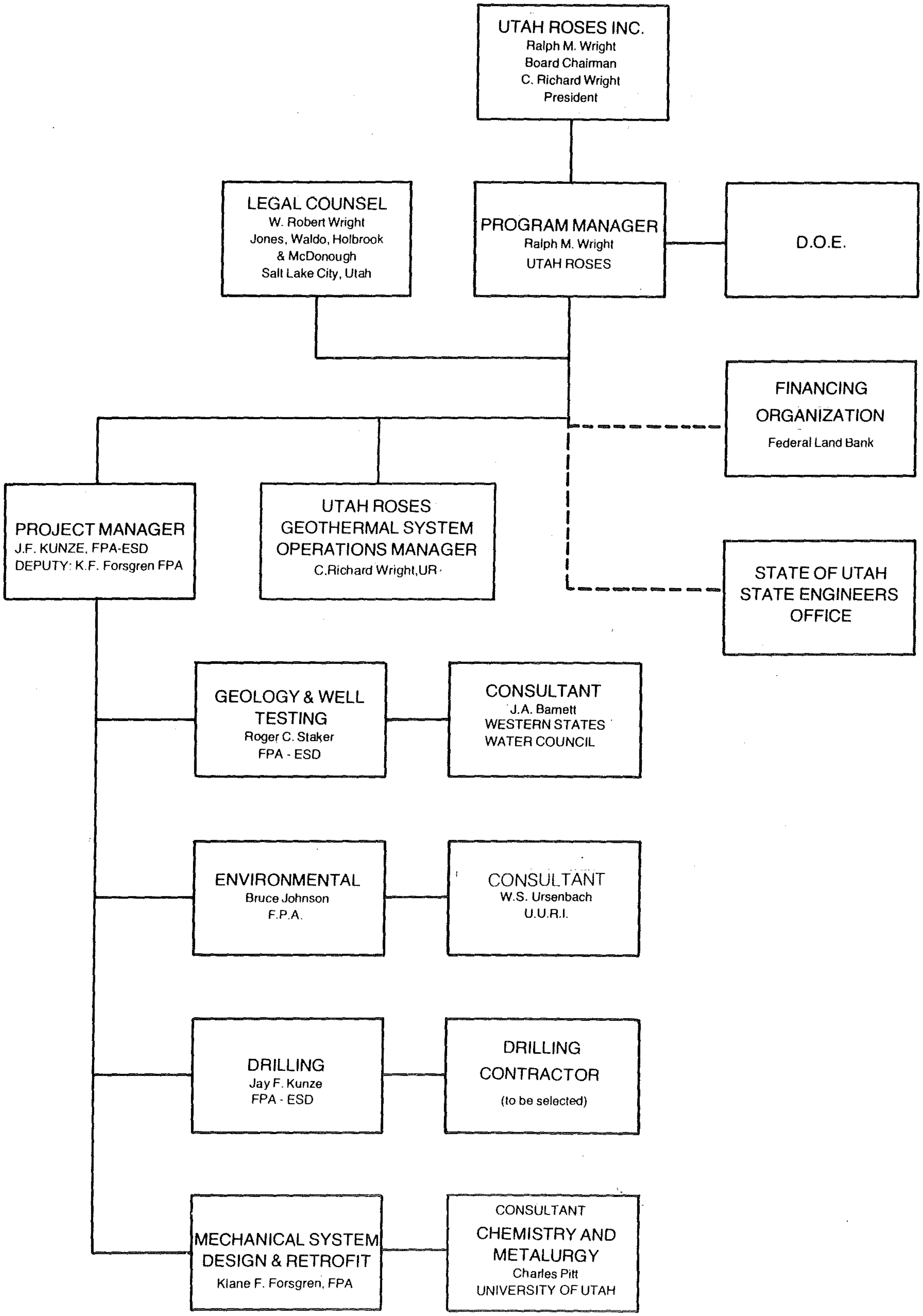
Jay F. Kunze is Project Manager for the Utah Roses Geothermal Project.
Klane F. Forsgren is the Deputy Project Manager. Kunze is Manager of Energy Services Division and Forsgren is Manager of the Salt Lake City Office of Forsgren, Perkins and Associates, P.A. They are responsible for technical project management, and for purposes of this project are responsible to Mr. Wright.

C. Richard Wright will be the Geothermal Operations Manager once the system is acceptance tested. He is the President of Utah Roses and the principal hands-on manager for the floral business.

Figure 9 shows the organizational structure/management plan for the project.

Fig. 9

MANAGEMENT PLAN
UTAH ROSES GEOTHERMAL PROJECT



D.4 STATEMENT OF WORK

The tasks to bring well sites into functioning, construct units completing the geothermal heating system and having the entire system function successfully and economically are, more specifically:

1) Preparation for Drilling

   a) Prepare and deliver to DOE an environmental report in sufficient detail for DOE to write an assessment. The purpose of the report is to provide backup data to support an assessment of insignificant impact on the environment.
   b) Secure additional permits, as required, by State of Utah and City of Sandy, for drilling operation.
   c) Conduct additional geochemical analysis on at least two nearby warm wells. Determine reservoir temperature indicators, using the dilution model(chemical and enthalpy) on both SiO_2 and Na/K/Ca.
   d) Assemble all relevant geological and hydrological data for final review and analysis and formulate drilling plan.

---Decision--- and approval from DOE to procede with drilling.

2) Drill for Resource

   a) Prepare a drilling specification in format for an RFQ, and issue to latter to drilling companies. DOE stipulations will be followed, as directed.
   b) Review bids, inspect drilling equipment of bidders, make selection of driller (with DOE concurrence).
   c) Drill 3000 ft. well by managing drilling contract, ordering bits, casing, cement and casing services, etc.
   d) Conduct logging and testing during drilling to evaluate resource in well.
   e) Once well is apparently complete, conduct full-scale testing to determine reservoir parameters and well production characteristics over long term.

---Decision--- Is well adequate? What are basic system design specs. Should well be stimulated, or project abandoned?

3) Design for Use of Heat

   a) Plan and conduct well stimulation if necessary (Dynadrilling side channels, acidizing, etc.)
   b) Install small scale heater unit if the well is artesian. This would be a single water-to-air heat exchanger with same tubing material as being planned for geothermal water heat exchanger.

c) Procure and install permanent well-head that meets applicable code and goethermal regulations.
d) Specify type(s) of downhole pumps, obtain bids, procure the pump through RFQ.
e) Design disposed facilities that will meet the applicable regulations for the type of geothermal water being disposed. Ditching to the Galena Canal (with proir cooling pond aeration) or reinjection are apparently the only options.
f) Design heat extraction system, considering the need for or desirability of intermediate (primary) heat exchanger. Also design greenhouse heating system, considering several options on the mix between geothermal system and the present steam system. The most cost-effective system, with emphasis on saving scarce fuel is the desired result for the particular geothermal resource conditions and the Salt Lake City climate.

---Decision--- and approval on e) and f) designs

4) Construction

a) Install pipeline from well head to greenhouse utility room.
b) Install needed electric power additions for downhole pump and circulation pumps.
c) Build pump station and install pump into well, with appropriate controls and monitors in the greenhouse utility room.
d) Construct disposal facilities - either cooling and filtering and pumping (if into Galenal Canal) and environmental monitoring equipment, or drill reinjection well and install pump.
e) Specify and purchase retrofit heat exchangers (air heaters) for greenhouse.
f) Specify and purchase intermediate (primary) heat exchanger.
g) Purchase other miscellaneous equipment.
h) Install heat exchange and heating system.

5) Operation

a) Start-up and check out unit ready for operation.
b) Collect operational data during most of one heating season.
c) Perform economic evaluation of long term use of system.
d) Prepare operating manual which will specify the most economical method of operation between geothermal and steam.

6) Reporting and Dissemination of Information

a),b),c),d),e) - Prepare the necessary reports for DOE as specified in the PON.
e) and f) Prepare press releases, business and tech-

nical articles for trade journal, and make the facility available at certain times for inspection by persons interested in a successful geothermal application.

In general, the above tasks are listed sequentially and numbered to correspond to the schedule and budget. Some time overlap naturally occurs between tasks.

TABLE V

WELLS AND AQUIFER PUMPING IN JORDAN VALLEY

TOTAL WELLS - 11823 (1971 DATA)	
LESS THAN 100 FT. DEEP	2321
100 TO 300 FT.	5559
300 TO 500 FT.	1310
500 TO 1000 FT.	284
MORE THAN 1000 FT.	18
DEPTH UNKNOWN	2321
DIAMETER	
2" OR LESS	6298
2 1/4" TO 6"	4132
MORE THAN 6"	730
DIAMETER UNKNOWN	590
DUG	73
ANNUAL PUMPING (1965)	107,000 ACRE-FEET
TOTAL GROUND WATER DISCHARGE	367,000
(INCLUDING EVAPOTRANSPIRATION, SEEPS, FLOW TO GREAT SALT LAKE, ETC.)	
STORAGE INDEX FOR PRINCIPAL UNCONFINED AQUIFER	50,000 ACRE-FEET/FT. (APPROXIMATELY)

D.5 THE GEOTHERMAL RESOURCE

D.5.a. TOPOGRAPHY

The proposed geothermal site is within the Jordan Valley, a structural valley in the Basin and Range physiographic province. The valley occupies about 400 square miles with Salt Lake City located in the north and east portion of the valley. Sandy (Utah Roses) is near the southern end of the valley, and is about 6 miles west of the mouth of Big and Little Cottonwood canyons.

The valley is bounded on the east by the Wasatch Range, with peaks higher than 11,000 feet, above mean sea level and a local relief of about 6,000 ft. On the south the valley is bounded by the Traverse Mountains, whose relief is about 2,000 ft. On the west are the Oquirrh Mountains with a relief of 4,000 ft. The northern boundary of the valley is the Great Salt Lake and a low east-west salient from the Wasatch Range. The valley floor is relatively flat and gently sloping northward.

5.b. HYDROLOGY

i) Surface Water

The principal source of surface water is the north-flowing Jordan River and six major creeks that drains the Wasatch Range. Most of these creeks drain from about ten miles back from the mountain front and flow westward through deep canyons. When the streams exit from the Mountain range they flow westward across deposits of coarse unconsolidated material at the edges of the valley, losing part of their flow by influent seepage. This water recharges the vast ground-water basin that consists of unconsolidated deposits of gravel, sand, silt and clay. No perennial streams enter the valley from the Traverse or Oquirrh Mountains.

ii) Ground Water

The ground water in the Jordan Valley occurs in three general divisions: a shallow unconfined ground-water body, local perched water, and an artesian reservoir. Ground-water is unconfined along the benches and forms a continuous body with the artesian reservoir in the central valley. Most of the recharge to the ground-water system is along the benches. The bulk of the ground-water resource is in the artesian reservoir in the lower portions of the valley. Few wells exist below 1000 ft. depth (Table V) and natural discharge from the valley's unconfined aquifer are given in the same table, totalling 367,000 acre-feet per year.

The sediments that filled the Jordan Valley were deposited by several forces in several environments, and the complex pattern of deposition resulted in ground-water aquifers that range widely from place to place in permeability and storage capacity. The lensey and discontinuous aquifers have been characterized into six districts bases on geology, water-bearing properties of the deposits, and the quality of the ground water.

The Utah Roses site is located above lenses of high quality ground water, with dissolved solids less than 3000 ppm. This is probably the result of the run-off from Big and Little Cottonwood Creeks, whose canyon mouths are 6 miles to the east. The run-off from these canyons is approximately 100,000 acre-feet per year. An influx of poorer quality ground water (1000 ppm) seems to occur, being manifest to the south and west, and may be related to geothermal water influx.

Beneath the Sandy area are large thicknesses of well-sorted gravels interbedded with lake-bottom clays. There are also numerous channel gravels of ancient perennial streams. The ground water moves generally northwest. There exists many large diameter wells. Most wells are less than 150 feet in depth. The deeper wells often are artesian. Specific capacities range from 6-200 gpm/ft of drawdown with an average of 45 gpm/ft of drawdown.

D.5.c. GENERAL GEOLOGY

The area is characteristic of the Basin and Range physiographic province. The Jordan Valley is a graben and the surrounding mountains have been uplifted relative to the valleys. Faults mark the boundaries between the valleys and mountains. In addition to the boundary faults separating the Jordan Valley from the adjacent mountains, other east west cross faults define inner grabens which contains a considerable thickness of sediment derived from the adjacent mountains.

The Wasatch fault zone separates the Wasatch Range from the valleys and is the predominate structural feature in the area. The fault zone is a typical Basin and Range normal fault zone. It consists of a several individual fault with a braided or branching pattern. Most of the faults along the valley's edge strike N-S. The dip is unknown, but the faults are believed to be high angle normal faults. Some of the major faults included in or associated with the Wasatch Fault zone are the Warm Springs, the Lime Kiln and the East Bench faults, Fig. 7.

The Wasatch Fault zone and associated faults are currently active and movement along them have resulted in 53 strong earthquakes from 1850 to 1970(above Richter magnitude 3). The majority of the disturbances were relatively minor in nature and undetectable to the general populace. It would appear that the movements began in late Tertiary and have continued intermittently to the present time. The latest movement on the Wasatch Fault is that of normal upthrusting and the mountain block has been uplifted, carrying sediments of the Lake Bonneville group and younger alluvial fans upward from 60 to 200 feet.

The total vertical displacement along the Wasatch Fault zone is difficult to estimate because of the amount of sedimentation that has accumulated in the valleys and the covering of many of the fault lines. Several faults have been inferred from gravity surveys, but their displacement can only be estimated. The earth movements that originally formed the valley have continued into comparatively recent times and have formed scarps in the unconsolidated deposits of the valley. The most prominent of the faults showing late movement is the East Bench fault which is marked by a scarp that reaches a height of 80 ft. in the unconsolidated deposits in the northeastern part of the Jordan Valley.

D.5.d. TEMPERATURE OF GROUND WATER

The temperature of ground water as measured and reported in the Jordan Valley ranges from 46° to 139°F. The temperature of the water in most wells and springs, however, range from 52° to 60°F. Table VI lists the wells with recorded temperatures above 60°F.

The temperature of the ground water exceeds 60°F in two principle areas of the valley. One of these areas extends from Point of the Mountain northward to the area around Sandy. Several warm wells in the Sandy/Midvale region are shown on Figure 11 *. The highest temperature recorded in this area is 139°F at Crystal Hot Springs near the state prison, with the ground water temperature apparently decreasing away from this spring. Within a few hundred yards of Crystal Hot Springs, a 290 ft. well was drilled in April 1978, striking 175°F water artesian pressure water at 250 ft.

The other area of high temperature ground water occupies much of the northern part of the Jordan Valley. The eastern margin of this area is marked by several hot springs which rise along the Warm Springs Fault. The warmest temperature measured during this study was 131°F at Beck's Hot Springs. Most of the wells west of Beck's Hot Springs yield water warmer than 60°F. Another nearby spring (Wasatch) discharges 106°F water. Figure 12 shows the distribution of ground water temperatures, generally in the level above 800 ft. depth.

The significance of the geological structure to the presence of geothermal resources is the recent age of the formations. The Wasatch Range has numerous granitic intrustions of late Cretaceous or early Tertiary age. The many recent faults have tended to maintain good permeability in the rocks at depths. This, coupled with the abundant near surface water, leads to the conclusion that the geothermal ingredients of hot rock, water, and permeability are present, plus sedimentary layers of sealed cap-rock forming barriers and insulation to maintain the heat in the geothermal reservoir.

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*Fig. 11 is a Topographical map of southern Salt Lake City metropolitan area.
Warm wells near Utah Roses shown as ◉

TABLE VI

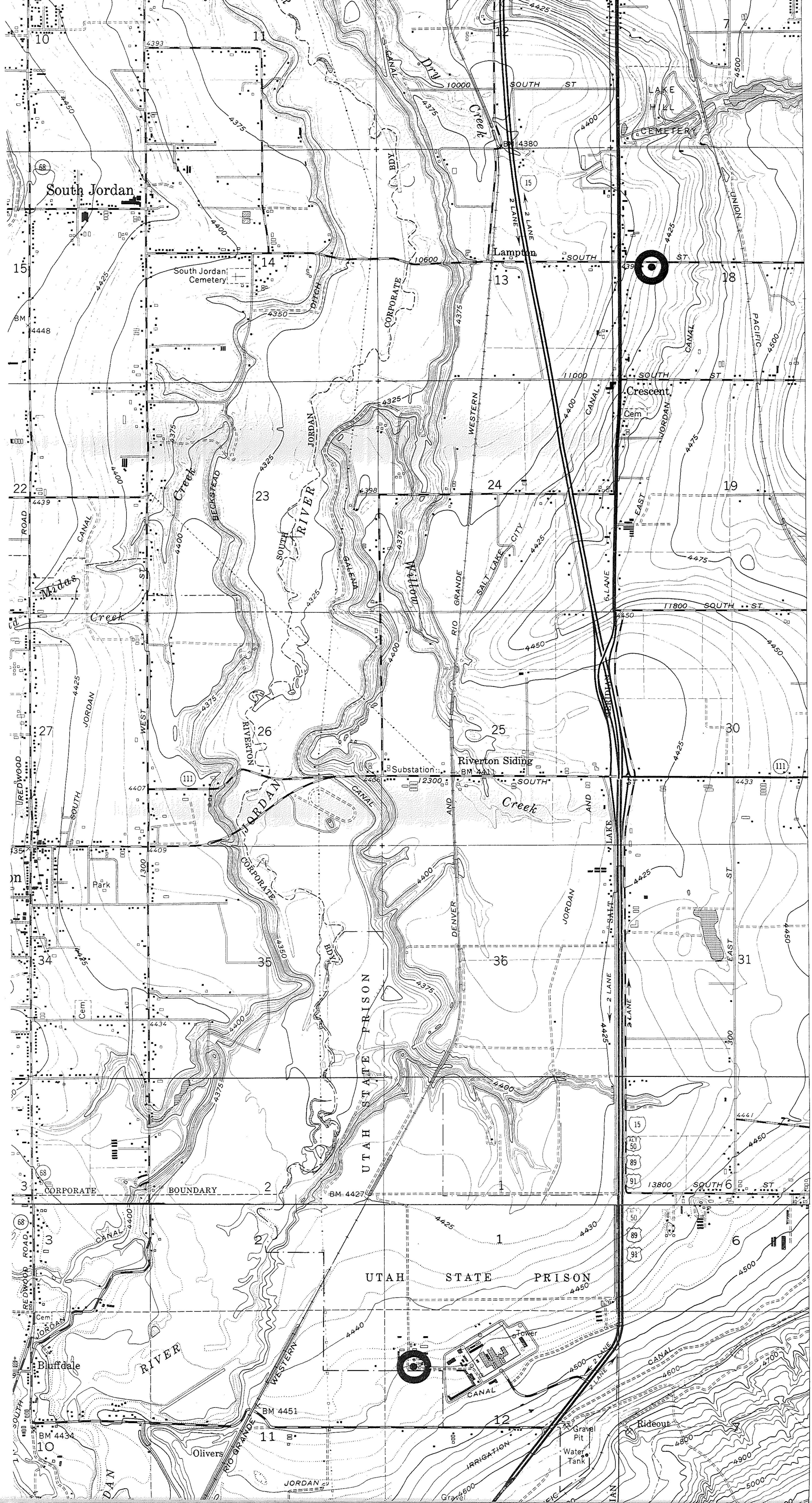
Average change in the water temperature, in degrees Celsius, per 100 feet in selected wells, in Jordan Valley

Aquifer: A, principal aquifer; B, deposits of Tertiary age; C, principal aquifer and deposits of Tertiary age.
Temperature: Determined by thermistor survey in well.

Well number	Aquifer	Temperature (° C)	Depth (feet)	Temperature (° C)	Depth (feet)	Change in temperature per 100 feet (° C)
(A-1-1)31ccc-2	A	13.8	160	14.0	370	0.1
(B-1-3)34bcb-1	A	26.3	672	28.1	744	2.5
(C-1-1)19caa-1	C	25.5	452	32.8	1,038	1.2
20bdd-1	C	24.8	611	26.0	908	.4
24bbd-2	C	17.2	484	19.2	740	.8
25aab-4	C	13.9	100	20.5	930	.8
25bdb-1	C	17.1	550	18.2	986	.3
30dca-1	C	14.7	144	17.0	385	1.0
(C-1-2)24aaa-2	A	23.3	192	24.7	454	.5
24dba-1	C	23.8	307	30.9	840	1.3
25aad-1	C	15.1	300	26.1	778	2.3
(C-1-3)15bca-2	C	15.3	60	27.5	520	2.7
	B	27.5	520	27.7	869	.1
15cbb-2	C	16.3	35	30.5	430	3.6
	B	30.5	430	30.5	570	.0
15dbb-1	C	14.7	20	18.9	435	1.0
(C-2-1)3cdd-4	A	14.3	30	20.2	637	1.0
9ccc-1	B	16.6	187	23.8	781	1.2
12aab-1	C	14.0	150	19.2	608	1.1
(C-2-1)24bcd-1	C	12.7	80	25.3	986	1.4
25ddb-2	C	15.0	90	24.2	785	1.3
(C-2-2)9bdb-1	B	13.5	100	14.2	448	.2
(C-3-1)1cab-2	C	16.2	50	29.3	766	1.8
5dbb-1	C	13.9	185	17.6	440	1.5
(C-3-2)4adb-1	C	14.9	160	18.2	880	.5
(C-4-2)1bbb-1	C	13.0	82	17.0	531	.9
9bad-1	B	14.3	135	22.1	590	1.7
(D-1-1)16caa-1	A	11.2	60	13.3	466	.5
(D-2-1)6dbb-10	C	11.5	20	18.0	650	1.0
8daa-5	C	10.5	18	14.5	434	1.0
(D-3-1)2ccc-1	C	12.9	550	14.8	996	.4
4bbb-1	A	11.7	324	11.7	800	.0
	B	11.7	800	13.0	886	1.5
18cba-1	A	15.5	80	20.5	308	2.2
20baa-1	C	15.7	197	19.9	542	1.2
21ada-1	C	11.1	400	11.5	626	.2
29cbc-1	C	18.0	58	30.6	269	6.0

Average of 24 wells above 140°C 1.85

(Technical Publication No. 31, Utah Dept. of Natural Resources, 1971)


South Jordan
South Jordan Cemetery
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10000 SOUTH ST
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LAKE HILL CEMETERY
BM 4380
Crescent
Cem
Dry Creek
CANAL
DITCH
CORPORATE BDY
SOUTH JORDAN RIVER
GALENA
Willow
BECKSTEAD
Creek
Midas Creek
ROAD
REDWOOD ROAD
SOUTH 1300 WEST ST
JORDAN
RIO GRANDE WESTERN
SALT LAKE CITY
DENVER AND RIO GRANDE WESTERN
SALT LAKE AND JORDAN
EAST JORDAN
UNION PACIFIC
300 EAST ST
2 LANE
6 LANE
Riverton Siding
BM 4411
Substation
RIVERTON
Park
Cem
CORPORATE BOUNDARY
BM 4427
UTAH STATE PRISON
Tower
Bluffdale
BM 4451
BM 4434
Olivers
Gravel Pit
Water Tank
Rideout
IRRIGATION
BM 4448
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4407
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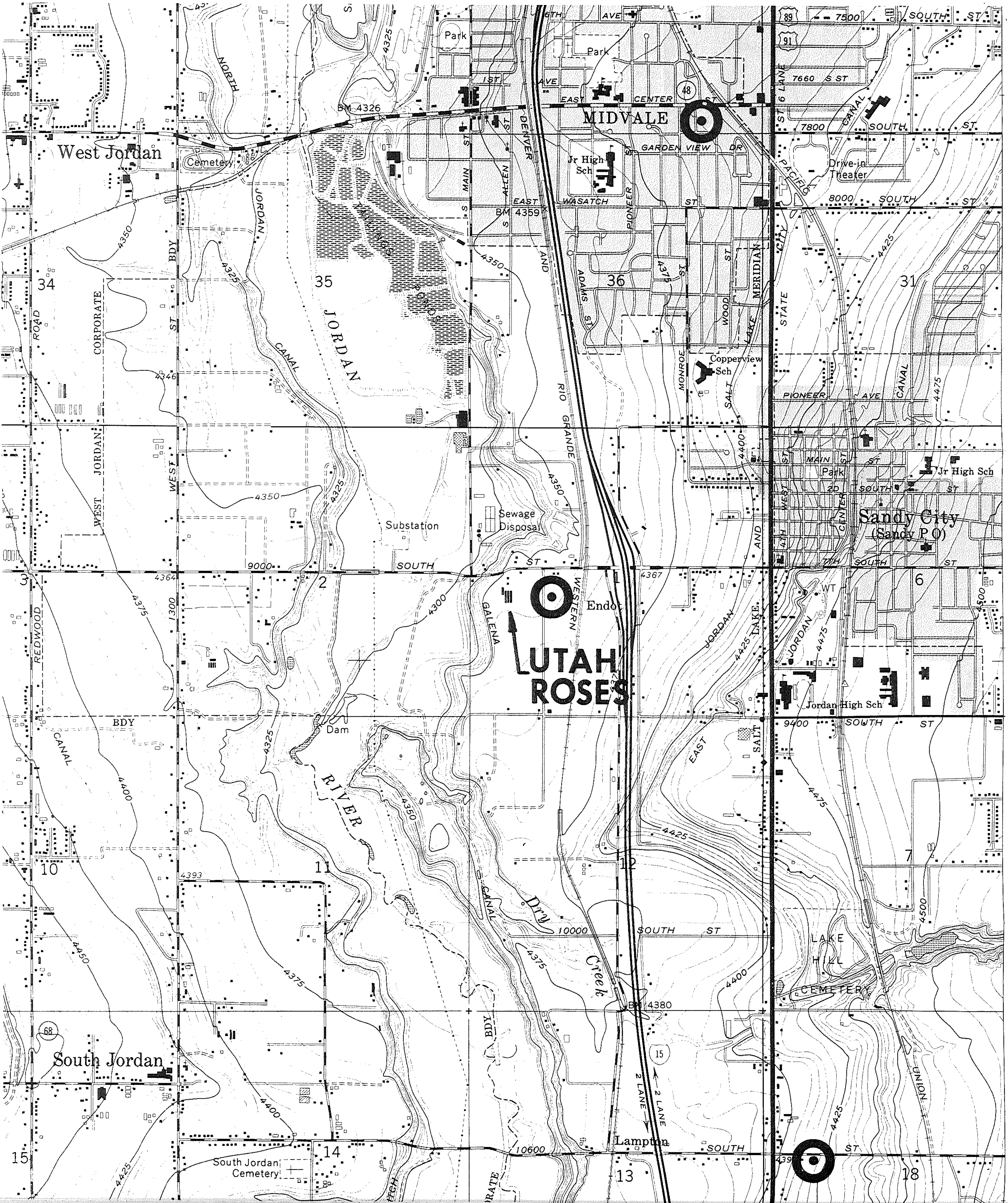
UTAH ROSES
MIDVALE
West Jordan
Sandy City
(Sandy P.O.)
South Jordan
Endot
Lampton
Cemetery
Park
Jr High Sch
Copperview Sch
Drive-in Theater
Jordan High Sch
Sewage Disposal
Substation
Dam
LAKE HILL CEMETERY
South Jordan Cemetery
JORDAN RIVER
JORDAN CANAL
NORTH JORDAN CANAL
EAST JORDAN CANAL
GALENA CANAL
Dry Creek
DENVER AND RIO GRANDE WESTERN
UNION PACIFIC
SALT LAKE AND JORDAN
STATE ST
MAIN ST
9000 SOUTH ST
9400 SOUTH ST
10000 SOUTH ST
10600 SOUTH ST
7500 SOUTH ST
7800 SOUTH ST
8000 SOUTH ST
EAST CENTER ST
GARDEN VIEW DR
EAST WASATCH ST
PIONEER AVE
REDWOOD ROAD
WEST JORDAN CORPORATE BDY
BM 4326
BM 4359
BM 4380
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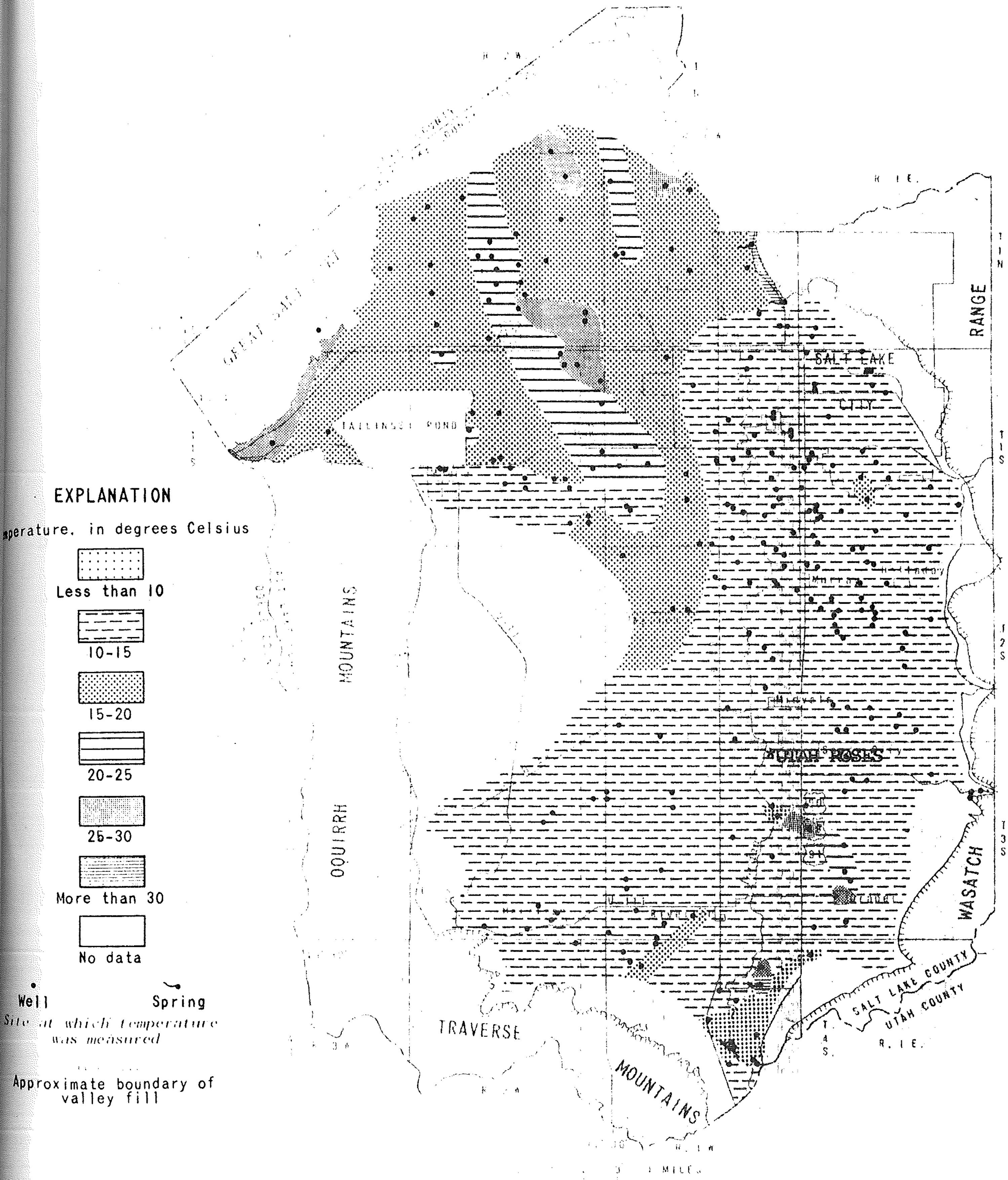


Figure 12.—Areal distribution of water temperature in the principal aquifer in Jordan Valley.
(Technical Publication No. 31, Utah Dept. of Natural Resources, 1971)

D.5.e. THERMAL SPRINGS AND WELLS - Temperature and Geochemistry

Nearly all the thermal springs are near or in fault zones in the Jordan Valley. Table VIIlists the springs and wells of interest and relevance to this project. Total dissolved solids content of these thermal "seeps" range from 214 to 45,000 ppm (parts per million). Most of the ions are sodium chloride, usually containing greater than 3000 parts per million. Most of the wells are relatively pure, probably because they have been diluted by meteoric ground waters.

Thermal springs within the area of interest number nine, mostly associated with the Wasatch Front. All of the springs appear to be associated with a fault zone (See figure 8). Table VII describes the location and some of the geochemical properties of these springs. Note that there appears to be a trend of degrading water quality of the thermal springs from south to north. Geochemical indicator of temperature are all very encouraging, indicating reservoir temperature well above boiling (212° F).

D.5.f. GEOTHERMAL RESOURCE SETTINGS

Although thermal springs and wells in the area indicate the existence of the geothermal resource at some depth, they do not indicate the depth and magnitude of the source of heat, or the optimum location for subsurface exploration and possible development of the geothermal resource. The detailed information and data is not available concerning the movement of the geothermal water at depth in the study area. The structural geology is only generally understood as inferred from the evidence exposed on the surface. However, several facts are known concerning the geothermal resource that can be used to evaluate the resource potential.

The majority of the hot or warm springs are associated with or occur along faults. (See figure 8.) The dissolved chemicals in the water coming to the surface are a key to the temperature of the reservoir from which that water originated. The silica geothermometer indicates that the hot and warm springs waters have been at a temperature of at least 160°F (Saratoga Hot Springs) to 215°F (Crystal Hot Springs) somewhere at depth. See Table VII. By applying the well-known dilution model to match enthalpy (heat-content) and chemical content, reservoir temperature of at least 250°F are indicated. Most of the water temperatures observed are probably the result of the normal geothermal gradient (∿2 C/100 feet) for the area. Considering the reservoir indicated temperature of 250 to 350 F, this would necessitate at most a migration depth of approximately 8,000 feet below the source area. If the source area is in the Wasatch Mountains (∿8,000 feet elevation) the reservoir could be nearly at the level of the valley floor. It is, however, suspected that the reservoir is at depth in the floor of the valley, within interbedded volcanics and sediments. If cold water mixing occured during the upward movement of the geothermal water (which seems likely due to the presence of cold runoff from the mountain), then the observed discharge temperatures at the springs would be much

TABLE VII A

THERMAL SPRINGS AND WELLS IN THE JORDAN VALLEY PART A

SUR TEMP. *	NAME	LOCATION	TEMP. DIRECTLY FROM SILICON	TEMP. DIRECTLY FROM NA/K/CA	MIXING MODEL TEMP.	FRACTION IN COLD WATER
131	BECK HOT SPRINGS	20 MILES NORTH	180	253	248	0.60
136	UTAH HOT SPRINGS	60 MILES NORTH	184	978(!)	248	0.56
137	CRYSTAL HOT SPRINGS	6 MILES SOUTH	215	**	347	0.76
111	SARATOGA HOT SPRINGS	16 MILES SOUTH	162	**	248	0.70
106	WASATCH HOT SPRINGS	18 MILES NORTH	175	438	338	0.75
175	PRISON WELL (290 FT)	6 MILES SOUTH	252	351	320	0.60
77	MIDVALE WELL	2 MILES NORTH	**	**	**	
90	SANDY CITY WELL 106 S (1150 FT)	2 MILES SOUTH	(SHUT IN, NOT IN USE)			
76	CONSERVANCY WELL 915(800 FT)	150 YDS	(SHUT IN, NOT IN USE)			

* ALL TEMPERATURES ARE DEFINED IN DEGREES FARENHEIT.

**INSUFFICIENT DATA AVAILABLE FOR CALCULATION FOR RESULTS MEANINGLESS BECAUSE OF TOO MUCH DILUTION.

TABLE VII B

THERMAL SPRINGS AND WELLS IN THE JORDAN VALLEY
PART B

NAME	DATE OF WATER ANALYSIS	SILICON	NA (PPM)	K (PPM)	CA (PPM)	TDS (PPM)
BECKS HOT SPRINGS	7/67	32	4250	156	746	7163
UTAH HOT SPRINGS	5/67	34	6870	932	1040	22260
CRYSTAL HOT SPRINGS	5/58	50	330*	--	142	1430
SARATOGA HOT SPRINGS	3/66	25	214*	--	190	---
WASATCH HOT SPRINGS		31	2001	195	608	7163
PRISON WELL	6/78	60	566	49	140	1600
MIDVALE WELL	6/78	16	61	1.86	15.8	150
SANDY CITY WELL		(SHUT IN, NOT IN USE)				
CONSERVANCY WELL		(SHUT IN, NOT IN USE)				

* NA PLUS K REPORTED AS NA.

lower than the reservoir temperature. It appears that the development of geothermal resources within the study area will depend first on the correct selection of faults that provide a conduit for the geothermal water from depth and good permeability for a production well. The dip of the Wasatch Fault is largely an unknown. Though most faults created by vertical compression dip about 65°, the block faulted graben situation ofthe Wasatch Fault could result in it being very steep. Neither is the dip of the east-west fault through Sandy (Utah Roses) known. However, its mere presence suggests a higher permeability than normal within a geothermal aquifer.

D.5.g. SUMMARY OF GEOTHERMAL DRILLING STRATEGY

There are very few deep (>800 feet) wells near the proposed drilling site to serve as guides for geothermal resource drilling. The greatest potential for tapping the resource would appear to be along the surface expressions of the major faults comprising the Wasatch Fault zone, provided these are not also affected by cold water influx. The Utah Roses site is about six miles from the Wasatch Fault and directly on an intersecting east-west fault. The drilling location appears to be ideal if the reservoir is deep below the valley floor.

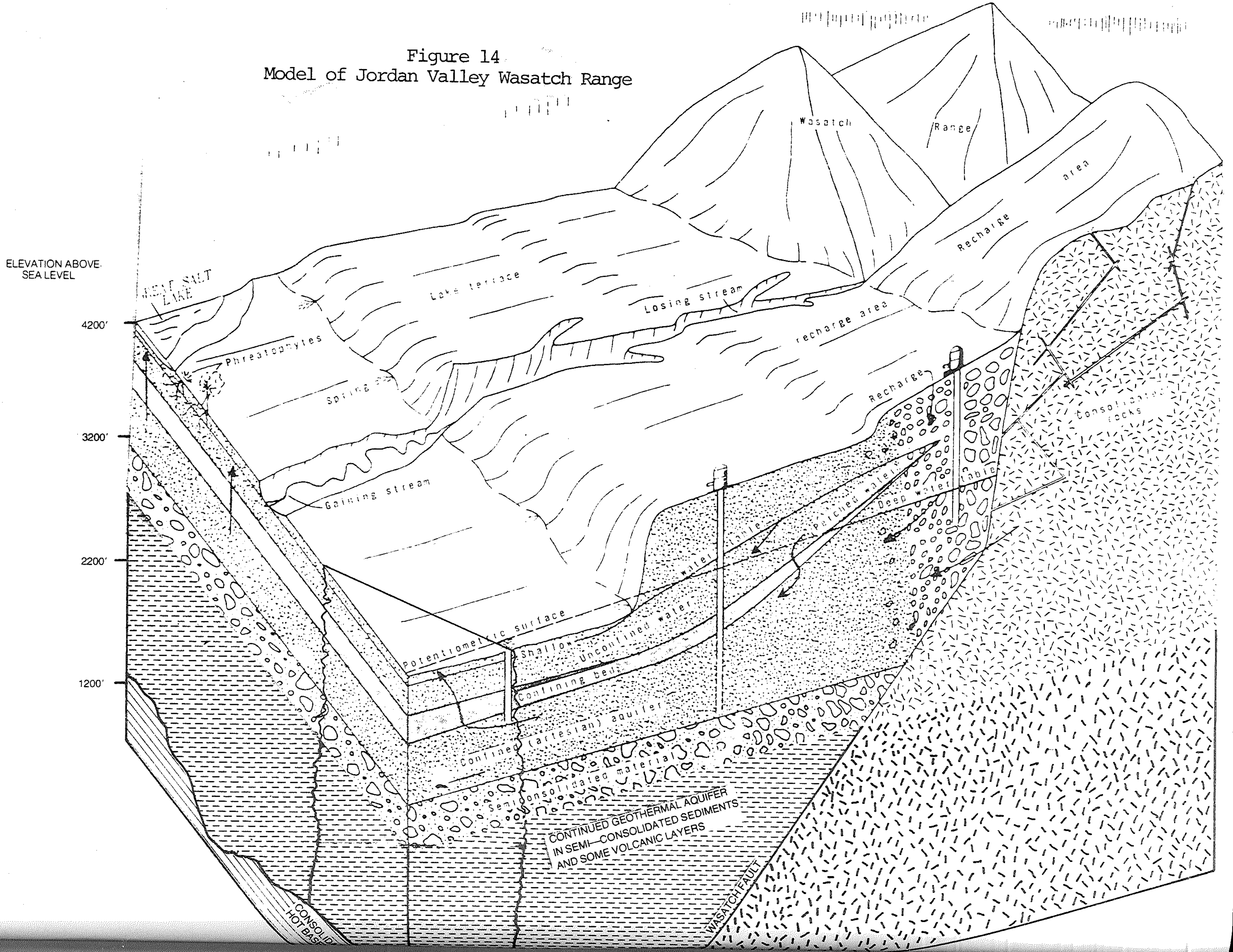
Figure 14 shows a model of the Jordan Valley - Wasatch Mountains hydrology. Since virtually no wells penetrate more than 1000 ft. (3200 ft. above sea level), the model below this level is based on indirect evidence and the facts and conclusions discussed above.

The geothermal aquifer lies at depth below a confining bed, which may be cemented sedimentary fill. Leakage occurs out of the aquifer through faults. However, these same faults sould be conductive paths for recharge water. The latter is more likely to be the case which heavy run-off from mountains occurs, such as at the mouths of Big and Little Cottonwood Canyons.

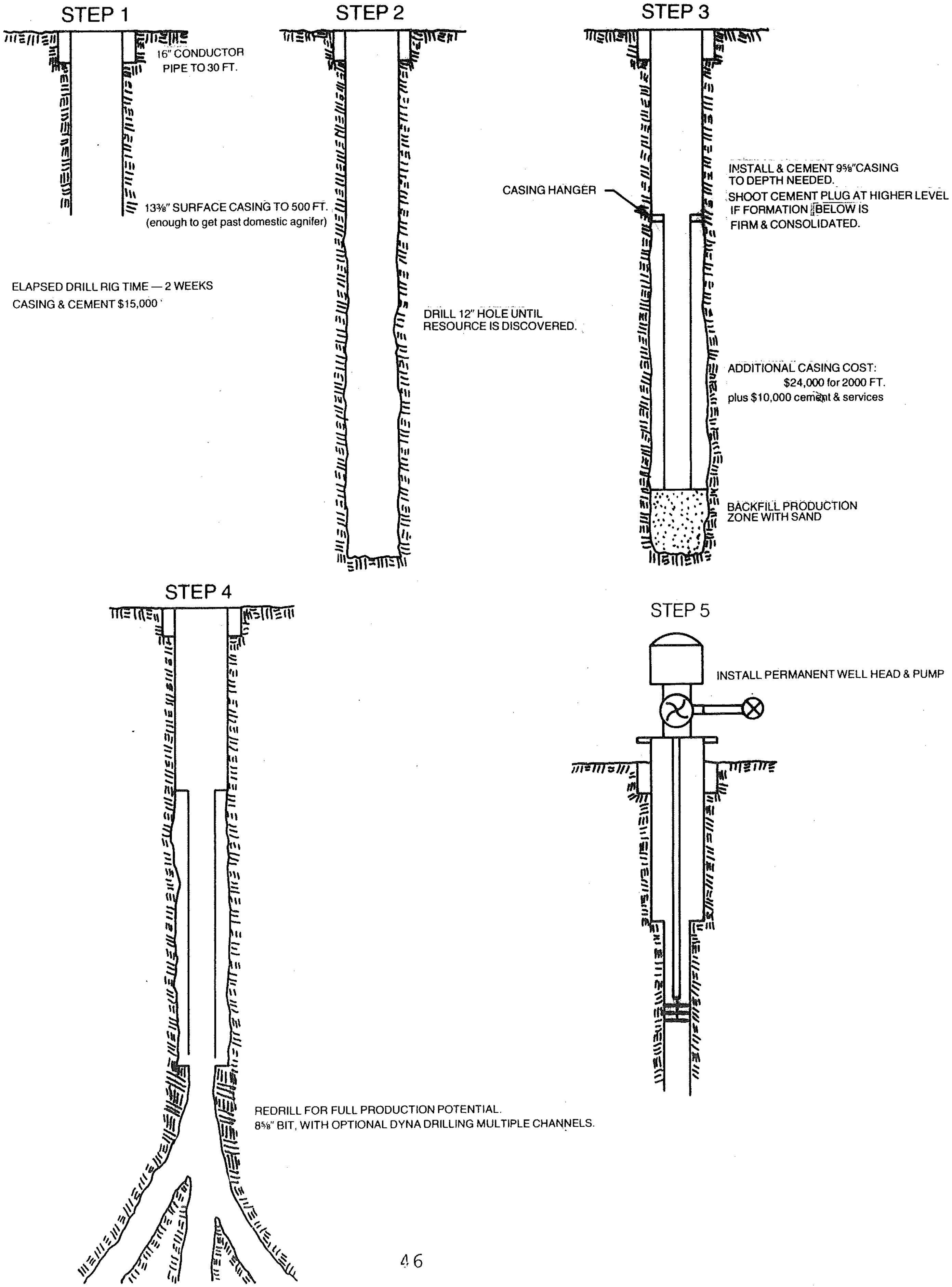
The east-west fault through Sandy could be a major conduction channel bringing geothermal water slowly to the surface where it quickly mixes with cool surface water. Recharge could be occurring at the Wasatch Fault in the region of the Big and Little Cottonwood Canyons. Successful drilling and discovery of geothermal water in such a setting (typical of much of the Jordan Valley), would be most encouraging for the prospects of tapping geothermal waters at many fault locations in the valley. The result would be the availability of geothermal to an area with a population of nearly one million.

The design of the well is merely preliminary at this time. A probable design is shown in Figure 15. It plans for multiple channels at the bottom of the well, in the production zone. These will enhance production for but little increase in cost (about 20%) of the well.

Figure 14
Model of Jordan Valley Wasatch Range



WELL DESIGN (preliminary) Fig. 13



D.5.h. SOURCE AND USER MATCH-UP

Nearly 100% of Utah Roses heating energy needs can be met with 170°F geothermal water. Approximately 5% of these needs would be supplied by fossil peaking on the coldest days. This then is nearly a perfect match between source and user. Furthermore, more than 50% of the energy needs - space heating as well as process heat - for the industrial community along the Wasatch fault zone could be met with this same 170°F geothermal water.

D.6 SITE/FACILITIES/EQUIPMENT DATA

Utah Roses has ownership of the 8 acres of land on which the geothermal wells are to be drilled. The six acres of greenhouses to be heated and other uses of geothermal energy are all located on this same property and there are no access or right-of-way problems. The greenhouses are all less than 8 years old and in good condition.

Items of equipment which are essential to the success of this project and with which Utah Roses proposes to obtain on a cost-sharing basis jointly with the DOE for this project are:

Equipment and Materials for the Geothermal Fluid Production:

Well casing
Well heads (2)*
Deep well pump
Reinjection (surface) pump
Main Pipeline
Flow Meter
Temperature Monitors

Equipment and Materials for the Utilization of Geothermal Fluid:

Primary Heat Exchanger
Secondary Loop Circulation Pump
Automatic control system (additions to present system)
Additional water-to-air, forced-draft space heaters

The additional water-to-air heater are required because the output of the present units will be reduced substantially when operations on geothermal water(170°F) instead of 50 psig (298°F) steam, their present operating mode.

All other new equipment are standard items associated with geothermal wells and heat exchangers.

D.7 PLANS FOR CONTINUED USE

Utah Roses envisions the use of geothermal energy as a substitute for scarcer, higher priced fuels. It is the intent of this project to verify that the operating cost of the system is substantially less than heating with conventional fuels. If this is verified (as design indicates clearly it will be) then Utah Roses will use it until the economics change. Proper maintenance is part of their physical plant program. The geothermal system will be maintained and worn-out components replaced as long as it is economically sound to do so.

Cost estimates also predict substantial savings when business or private groups drill their own well - compared to conventional systems. The cost they cannot stand is that of a dry well. The more successful wells that are brought into existnece, the more probably the success of a new one. And that is a major part of the justification of a program like this that has its setting in a large industrial and urban area - where the potential number of geothermal wells and the associated savings in cost and scarce fuels are great.