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UTILIZATION OF GEOTHERMAL ENERGY FOR AGRIBUSINESS DEVELOPMENT IN SOUTHWESTERN NEW MEXICO

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New Mexico Energy Research and Development Program

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Technical Completion Report
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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

Page

LIST OF EXHIBITS

LIST OF EXHIBITS (continued)

SUMMARY

This report presents an evaluation of the direct heat utilization from geothermal resources for agribusiness uses in the Animas Valley, Southwestern New Mexico. The analysis includes an evaluation of the groundwater and geothermal resources in the Animas Valley, monitoring of an existing geothermal greenhouse, and evaluation of two potential agribusiness applications of geothermal waters (greenhouses and meat precooking).

Geothermal Resource Assessment

A Regional geothermal and geohydrological investigation was conducted in the Animas Basin of southwestern New Mexico. Water table levels and well log data, obtained from the State Engineer Office in Deming, New Mexico, were used to assess the change in the geohydrological regime over a period of 22 years from 1955 to 1977. The analysis indicated that the water table declined up to 53.6 feet in one well and about an average of 20 feet over the entire basin. The declining water table and excessive pumping in some areas has also resulted in a change in the direction of movement of water from a generally northward direction to a northwesterly direction. The change in direction of flow is fairly complex with creation of local mounds and basins due to variability in the rate of discharge and hydrologic properties of the aquifers.

The basin also contains the Lightning Dock Known Geothermal Resource Area (KGRA). Hot water, at boiling temperatures with approxi-

mately 1,105 ppm dissolved solids, rises in a relatively small area are primarily confined to one section in the north-central part of the Basin. This deep-circulated meteoric water mixes with the cold groundwater decreasing temperature of the geothermal waters in the area surrounding the center of the geothermal anomaly. The coefficient of transmissibility for the geothermal aquifer near the surface has been computed to be approximately 26,595 gallons per day per foot.

A shallow thermal survey covering an area of about 50 square miles with its center at the "hot wells" was conducted as part of this study. The survey shows that the area of the anomaly has increased since 1965 perhaps due to heavy groundwater pumping. The resulting water table decline has apparently allowed geothermal water to spread in a wide area.

Greenhouse Monitoring

The practical use of geothermal energy for greenhouse heating is presently being demonstrated by the operation of a commercial facility near Cotton City situated near the center of the KGRA. A monitoring program on energy use and temperature maintained in the greenhouse was conducted to evaluate the use of geothermal energy under actual greenhouse conditions. In periods of extreme cold, the greenhouse system was able to hold temperature differences up to 30° F because of the larger temperature difference between the geothermally heated water and the air in the building. These results indicate that considerably better designs are available for greenhouses than the design currently being used at Cotton City. Hopefully this information will be useful to engineers designing greenhouses in the future. Some gain in efficiency of heat use could be made through improved design of the heat exchange equipment. With such changes, the heating in this greenhouse system may be adequate. Without such changes, it was concluded that the heating system was only about one-half the capacity needed for a production-type greenhouse. The quantity of hot water available appears to be adequate to support a large greenhouse industry in the area.

Two experiments were performed to evaluate the effect of floor heating on plant growth in the geothermally heated greenhouse; one with poinsettias and another with Ponderosa pine seedlings. One inch thick rigid styrofoam insulation 2' x 8' boards were placed below poinsettia and pine seedlings. The poinsettia test was initiated October 10, 1979, when four inches of rigid insulation was placed between the pots and the soil. One inch of styrofoam was placed under the seedlings and approximately five inches above the greenhouse soil on January 28, 1980, after the germinants had begun growing.

The results show that insulating plants from the floor results in a slightly accelerated plant growth response, particularly during the winter period. This result is rather modest considering the problem that conventional greenhouse growers have had with cold soils and extremely slow growth when plants are placed on or near the soil. It is probable that there is a heat contribution from the soil (geothermal source) to the plants. The results of 1979-80 tests confirm that the soil temperatures in the rose growing area were remarkably uniform from day to night. This suggests a heat flow from the deep earth to the soil surface. While the heat contribution to the entire greenhouse area is undoubtedly modest, plants growing directly on the soil receive a substantial benefit. The results suggest that lower air temperatures generally occurring in the cold winter period are not as detrimental as one would predict.

Agribusiness Potential

In investigating potential agribusiness industries, two basic characteristics were considered desirable: resource-based industries, and industries that can utilize hot water in an integrated system of industries, i.e., those that jointly use the available hot water. Hot water flows from industries that need high temperature water to industries that need water at a lower temperature. The system would take maximum advantage of the temperature difference between the intake water and the discharge water. The system could possibly include a vegetable and fruit freezing plant (300° F + temperature), a vegetable canning plant (250 to 300° F), an onion and chile dehydrating plant (200° F +), greenhouses (150° F +), and a meat processing and precooking plant (200° F +).

Developing such industries would stimulate the local economy by increasing the demand for the raw products, which, in turn, would encourage farmers to increase production levels. Resource-based industries typically have fewer undesirable effects on the surrounding region and community. It was concluded that adequate social infrastructure facilities exist in the area to support the agribusiness industries analyzed in this report.

For purposes of this report, only the feasibility of greenhouses and beef precooking were examined. The feasibility analysis was based on profitability, ability to meet cash needs, financial strength, and rate of return on investment.

Greenhouse Feasibility

The proposed greenhouse complex would utilize existing techniques and equipment to produce either tomatoes or potted chrysanthemums. Four greenhouses would cover approximately five acres. Approximately 725 tons of tomatoes or one million potted chrysanthemums would be produced each year. The complex would include land, sitework, greenhouses, offices, equipment, water systems, and loading docks. It was expected to cost $2.5 million for tomato production facilities and $2.7 million for chrysanthemum facilities.

This study was based on an "average" year. It did not account for a start-up period and the potential problems associated with cash flow and lack of employee training. Phasing in an operation over a period of months or years could lower profits.

Estimated total annual operating expenses for the greenhouse would be $508,236 for tomatoes and $1,772,083 for potted chrysanthemums. Expected revenues from the sale of tomatoes was estimated at $580,000 and about $2,200,000 for chrysanthemums.

The financial analysis indicated that tomato production was unprofitable. The net income before taxes was estimated to be a negative $85,350 annually, and a negative $51,210 after taxes due to a tax credit of $34,140. The rate of return on total assets for tomatoes was about 1.3 percent, while the rate of return on equity was negative 7.1 percent. In addition, greenhouse tomatoes face significant competition from both foreign and domestic sources.

Potted chrysanthemums were modestly profitable. The net income before taxes was estimated to be $165,685 annually and $99,411 after taxes. The rate of return on total assets for potted chrysanthemums was reasonable at 7.7 percent and the return on equity was estimated to be 7.2 percent.

For heating greenhouses, substantial savings are expected to be realized by use of geothermal resources rather than traditional fuels. The net savings due to the use of geothermal resources was estimated to be nearly $143,000 annually over heating with natural gas.

Meat Precooking Feasibility

The proposed geothermal hot water meat precooking facility would use the most modern techniques and plant facilities to slaughter, bone, package, precook, cool, dry, and freeze the meat. The proposed plant would take advantage of pre-rigor meat, on-the-rail hot boning, etc.

The plant's maximum capacity would be 120 head per hour. For this study, a "phase-in" of 60 percent capacity in the first year, 70 percent in the second year, 75 percent in the third year, and 80 percent in the fourth year and beyond, was assumed.

Each boned carcass was expected to weigh 450 pounds. About 12 percent of the carcass would be sold in the fresh meat market. 30 percent will be precooked as 10 pound roasts; the chucks, plates, shanks, briskets, flanks, and trimmings, are expected to be fabricated, with the remaining 9 percent being lost in the cutting and cooking process.

The proposed $7.73 million dollar plant would include the land, sitework, buildings, equipment, water systems, sewage treatment, paved areas, corrals, and vehicles. Total estimated operating expenses including depreciation were expected to range from $84,748,335 in year 1 to $110,878,758 in year 4. Total estimated operating revenues were expected to range from $90,689,850 in year 1 to $120,919,800 in year 4.

The financial analysis indicated the plant was very profitable. The net income after taxes for the fourth year of operation was estimated to be about $4.6 million. The rate of return on total assets was estimated to be 42 percent, and the return on equity was estimated to be about 56 percent. However, there is a great deal of risk associated with this new technology and product. The profit also was very sensitive to changes in live cattle and precooked meat prices.

The analysis presented in this report indicated that the facility proposed would be expensive using geothermal water for precooking beef compared with a similar plant using natural gas. The cost of the geothermal supply and reinjection system would more than outweigh the savings in natural gas at today's natural gas prices. Given the above, a complex such as described in this report would probably locate in an area where adequate quantities of fed beef exists and other slaughtering and beef processing facilities exist.

XX

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by

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INTRODUCTION

Development of the Lightning Dock Known Geothermal Resource Area** (KGRA) in Southwestern New Mexico may provide major economic impacts in Southwestern New Mexico and Southeastern Arizona (Figure 1). The agricultural economy of Southwestern New Mexico and Southeastern Arizona is declining due to rising energy costs associated with the production of traditional low value crops. This cost-price squeeze has resulted in increasing unemployment, and farmers having increased difficulties in obtaining operating capital. It has been suggested that by utilizing the geothermal resource of the Lightning

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**An area is classified as a Known Geothermal Resource Area (KGRA) by the U.S. Geological Survey when the indications of potential geothermal resources in the area are strong enough to guarantee expenditures of money for its exploration. One of the eight KGRA's in New Mexico is the Lightning Dock KGRA, which is located in the Animas Valley. It encompasses an area of about 96 square miles.

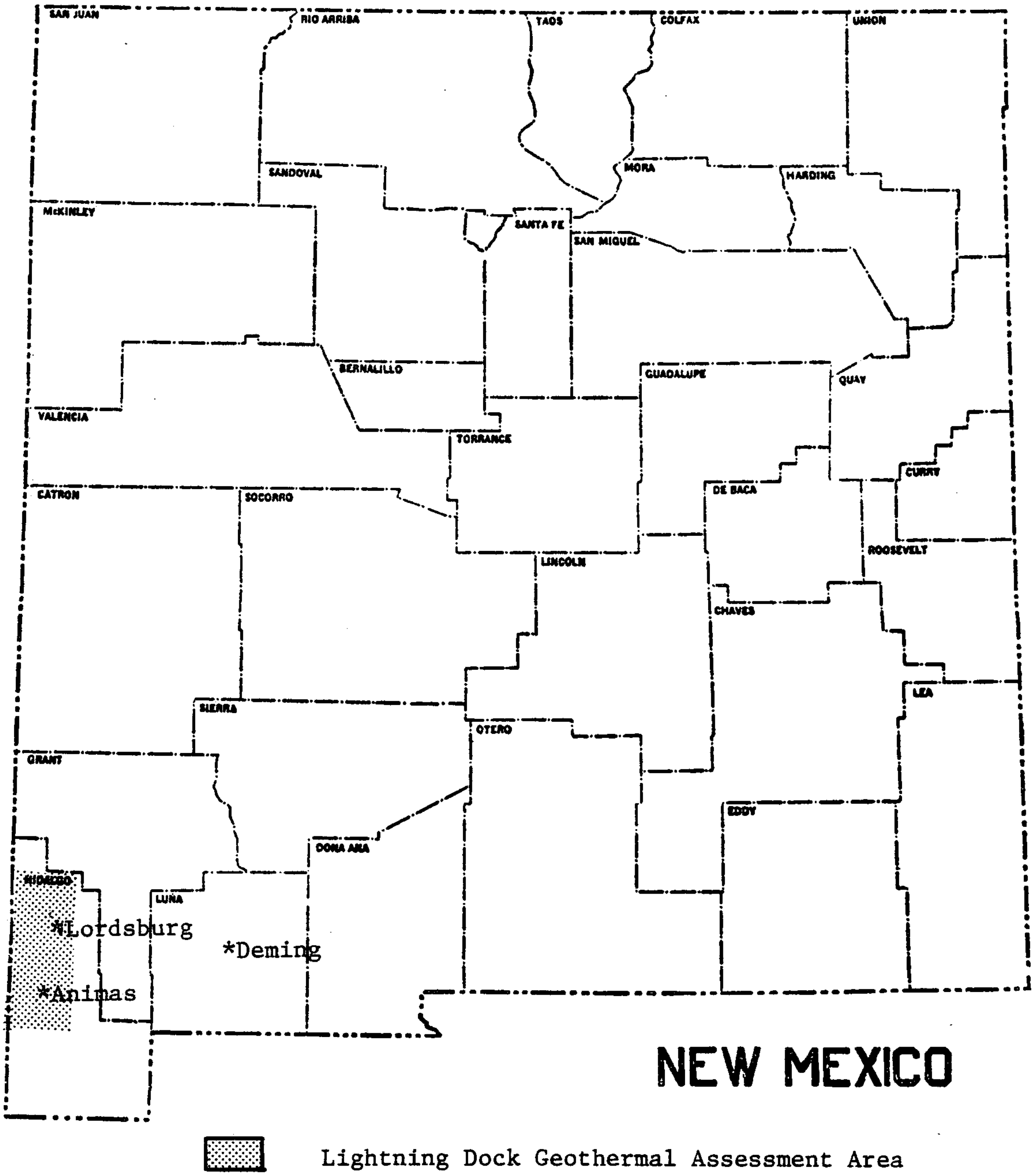


Figure 1. The Animas Valley Geothermal Assessment Area in relation to the state of New Mexico

Dock KGRA for agricultural processing facilities, the cropping pattern in Southwestern New Mexico and Southeastern Arizona could be changed to produce higher valued crops and to provide employment opportunities for citizens in the region.

Because of the interest created in the Lightning Dock KGRA, the Southwest New Mexico Council of Governments (COG) and the Southwest New Mexico Resource Conservation and Development Area Council contacted New Mexico State University seeking assistance in formulating a plan for orderly development of the Lightning Dock geothermal energy resources that would enhance economic growth in Southwestern New Mexico and Southeastern Arizona. The primary interest of the group was to evaluate the feasibility of utilizing the geothermal resource for agribusiness purposes, such as dehydrating or canning fruit and vegetables, and drying chile, onions, alfalfa and other suitable crops.

There are many possible ways of applying geothermal energy to agriculture. Hot water appears to be readily available at the Lightning Dock KGRA at a temperature near, or slightly above, boiling. This is too low a temperature for major power production, but could easily be used for some types of processing applications and for space heating. Possible processing applications may include freezing, canning, and the drying of fruits, vegetables and other crops, meat precooking, and greenhouse space heating.

Food processing plants have traditionally used natural gas as a primary energy source. The canning industry typically uses natural gas to heat water and make steam for cooking in conventional boilers. However, natural gas has been held by the Federal Power Commission at a low price in interstate commerce since the mid-nineteen fifties. But, in 1974, severe shortages forced the government to ease price controls in order to stimulate gas production. Escalating prices are expected to continue until it becomes economically feasible to substitute other fuels for natural gas. This may put the canning industry in an economic squeeze forcing them to move their operation to areas having lower cost energy. The possibility exists that the use of natural gas as a boiler fuel will be outlawed altogether in the 1980's. If geothermally heated water in the temperature range of 240 to 260° F (116-127° C) can be located and obtained at a reasonable expense, the vegetable canning industry should certainly be interested in the Lightning Dock KGRA.

If geothermally heated water can be located in the 260 to 300° F range and obtained at a reasonable cost, vegetable and fruit freezing would become a viable alternative. This type of processing facility would probably be the most intensive in terms of agricultural stimuli to the economy (income and employment). Freezing would most likely attract the greatest industry attention. Ore-Ida has recently obtained a matching grant from the United States Department of Energy to retrofit a potato freezing plant in Oregon (Corddry, 1977). Freezing has required enormous quantities of energy either in the form of electricity or natural gas. With energy costs continuing to rise faster than inflation, the food freezing industry is looking for alternative energy sources in conjunction with locally available agricultural production. The Lightning Dock KGRA may offer a substitute in the form of geothermal energy and irrigated agricultural lands with a desirable growing season.

The food-crop drying industry, which also uses natural gas, is caught in the same cost-price squeeze as other food processors. They enjoy a higher priority on gas supply since the heat source comes into contact with a food material. Substitution of alternative energy sources such as fuel-oil is impossible. If driers are curtailed, they will have to substitute propane which is the most expensive heating fuel available. The shallow geothermal groundwater presently being used in the area appears ideal for this application, but the characteristics and cost of equipment needed to utilize it for drying must be determined. When the cost and life of this equipment has been estimated, processors can be informed about possible cost-savings through the use of geothermal heat. The only crop normally dried in the area is red chile. Long season multiple crop use is highly desirable since the investment in facilities will be large and a stable labor demand would be more beneficial to the community.

The practical use of geothermal energy for greenhouse heating is presently being demonstrated by the operation of a commercial facility situated at the center of the KGRA near Cotton City. A monitoring program on energy use and temperature maintained in the greenhouse is needed to optimize the use of geothermal energy. The quantity of hot water available appears to be adequate to support a large greenhouse industry in the area.

Another possibility is to utilize the hot water directly in pre-cooking beef and possibly pork. This operation involves the pre-cooking of meat using geothermal waters of approximately 150° F. This process does not require the immediate chilling and aging of beef immediately after slaughtering. The pre-cooked meat can be re-cooked with no loss in quality.

Objectives

The primary objective of this report is to present partial results of a plan for evaluation and utilization of the geothermal resource in the Lightning Dock KGRA for an agribusiness complex to enhance the economic development of Southwestern New Mexico and Southeastern Arizona.

This report presents preliminary findings for one year's research effort for a proposed two year study to evaluate the direct heat utilization from the geothermal resource for agribusiness uses. The proposed first year effort was to evaluate the geothermal resources in the Animas Valley, assess potential crops that could be grown in the region, monitor an existing geothermal greenhouse, and evaluate potential agribusiness uses with the known geothermal water temperatures. The potential uses evaluated in this report are space heating for greenhouse and direct utilization of geothermal resources for meat precooking.

The proposed second year effort was to drill a geothermal well about 500 feet deep and to evaluate the resource for higher temperatures, to continue the greenhouse monitoring, to examine low level geothermal applications, and to evaluate food freezing and canning industries if water of sufficient temperature is located. In addition, a community impact analysis of an agribusiness complex was proposed. Data were obtained for dehydration of chile and onions, but the analysis was not completed as the study was funded for only one year.

Description of the Region

The Animas Valley is a closed topographic basin in Hidalgo County in southwestern New Mexico (Figure 2). The valley lies southwest of Lordsburg, the county seat, and extends from the Mexican border northward about 80 miles to the vicinity of Summit, northwest of Lordsburg. The Lightning Dock KGRA is located in the northern part of the Animas Valley, encompassing about 96 square miles (Figure 2).

Physiography

The Animas Valley lies between two chains of mountains which extend in a general north-south direction and reach elevations of 1,000 to 2,000 feet above the valley floor. The Animas and Pyramid Mountains are to the east, and the Peloncillo Mountains to the west of the valley. North Pyramid Peak and South Pyramid Peak reach elevations of 6,008 and 5,910 feet above mean sea level, respectively. Several peaks in these ranges reach altitudes of more than 5,700 feet above mean sea level. The part of the valley north of Animas is known as the Lower Animas Valley, and encompasses about 700 square miles; the part of the valley south of Animas is known as the Upper Animas Valley, which encompasses about 500 square miles.

There is a marked difference in topography between the Upper and Lower Valley. The Upper Animas Valley, from the head of Animas Creek to a point within four miles of Animas, is well-drained through a definite axial stream that flows northward. It extends from the vicinity of Animas southward into Mexico. Its length measured from Animas to the Mexican border is about 42 miles and its width, between the bases of the bounding ranges is about 8.5 miles. It drains north-

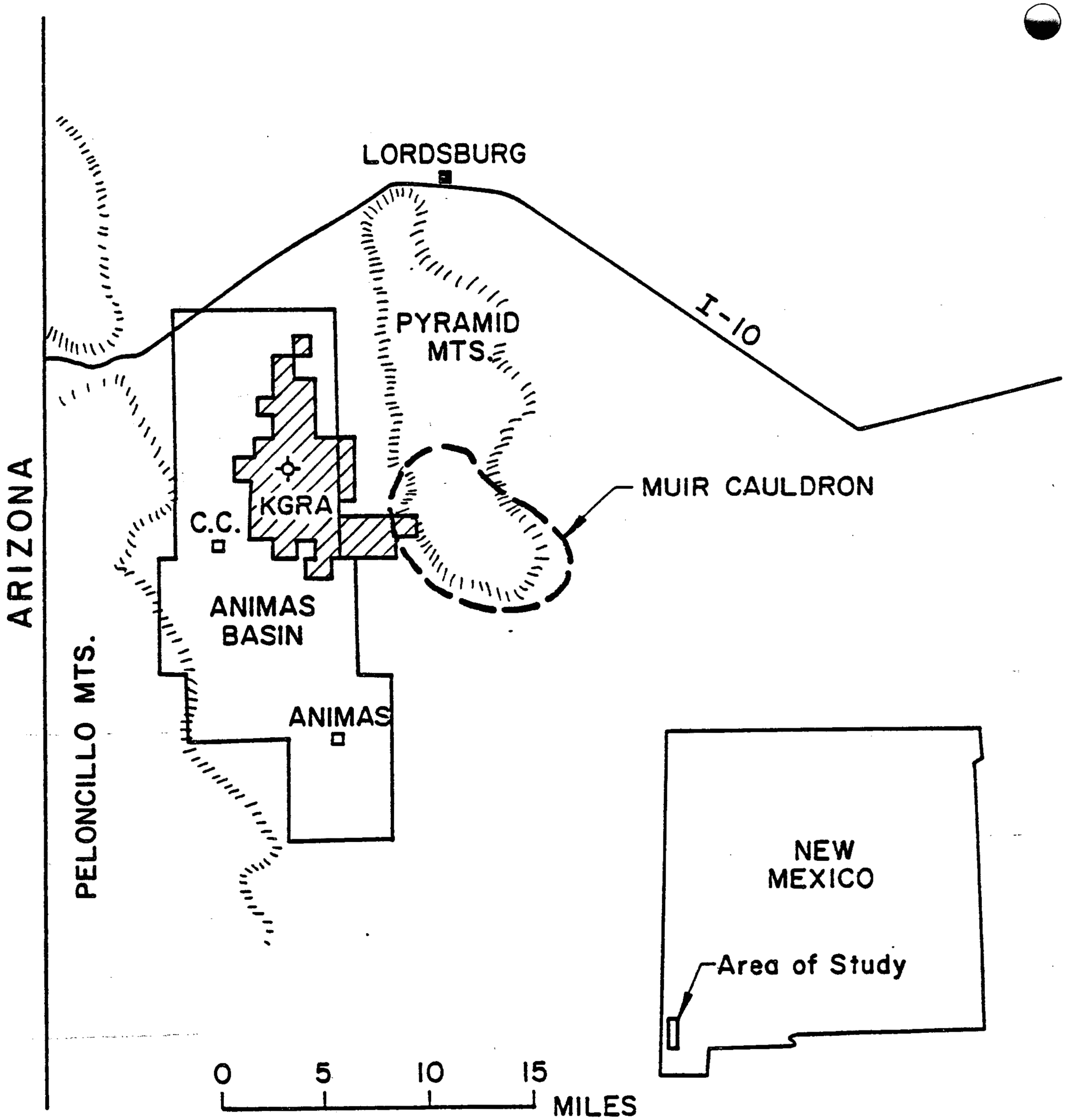


Figure 2. Location of the Animas Basin and Lightning Dock KGRA with respect to some physiographic and geologic features

ward into the Lower Animas Valley. The land surface dips north, the altitude ranging from about 5,500 feet above mean sea level near the Mexican border to about 4,405 above mean sea level at Animas.

The Lower Animas Valley, on the other hand, has a broad and nearly level floor with no definite drainage lines. The flood waters discharged from the Upper Animas Valley and from the gullies that head in the mountains on both sides spread in thin sheets over the valley floor or find their way through broad, shallow draws to the alkali flat that occupies the center of the Lower Animas Valley. The floor of the valley is nearly flat and is about five miles wide and about 30 miles long. The altitude of the valley floor ranges from about 4,405 feet at Animas to about 4,150 feet in the lowest part of the valley about 24 miles to the north. The slope of the valley ranges from eight to 15 feet per mile and averages 11 feet per mile. Irrigation is carried on mainly in the area where the slope is at a minimum, about five to 15 miles north of Animas.

Geological Setting

Detailed gravity data and driller's logs of water wells suggest that a fault with a vertical displacement of perhaps several thousand feet exists between wells 25.19.07.133 and 25.19.07.234 (Summers, 1976). The hottest wells penetrate a red rhyolite welded tuff which is an extremely difficult rock to drill (Summers, 1976). The hot water discharging from the hottest wells in the area contain approximately 1,100 ppm of total dissolved solids. The geochemistry of the hot water suggests that chiefly meteoric water, which has circulated deep underground, finds its way up through a fault zone that runs northeast-southwest through Section 7, T. 25 S., R. 19 W. The proximity of a fault to the hot wells and the similarity in trend of the fault to the area of abnormally high groundwater temperatures are further indications of structural control of the hot water system.

The geologic history of the Animas Valley area consists of four main periods of volcanic activity and two main periods of intrusive activity. During the Createaceous period (100 million years), about 2,000 feet (610 m) of basalt was erupted, followed by a granodiorite stock during the early Tertiary (60 million years) time. A thickness of about 2,500 feet (762 m) of andesite eruption was followed by a small monozonite stock. During late Tertiary times, volcanic activity was renewed and a 2,200 feet (671 m) sequence of rhyolite flows, tuff, welded tuffs, and basalt was erupted. The latest (most recent) volcanic eruption consisted of basalts which are exposed southwest of Cotton City.

A detailed geological survey in the valley during recent years has been conducted by Deal, et. al, (1978). Deal correlated the occurrence of the geothermal anomaly with the location of an ancient cauldron named "Muir Caldron" (Figure 2) and associated fracture patterns.

Electrical resistivity and magnetottelluric surveys conducted by Jiracek (1977) indicated the presence of a high resistivity ridge underlying the hot wells in Section 7, T. 25 S., R. 19 W. A low resistivity layer, most likely indicating hot water, appears on both sides of the ridge, according to Jiracek's interpretation.

Land Use

Hidalgo County has 2.2 million acres of land with animal grazing and crop production being the most important land uses. They comprise about 98 percent of the land uses in Hidalgo County (Table 1). The Animas Valley accounts for about 42 percent of the total irrigated land in Hidalgo County. The important irrigated crops are cotton, corn, wheat and grain sorghum. These four crops accounted for about 85 percent of the total crops in Hidalgo County in 1978. Crop production in the valley requires irrigation, with groundwater being the most important source of water (Table 1). The pumping of irrigation water depends almost totally on petroleum based fuels as the source of energy. The valley is semi-arid, with a mean annual rainfall of about 10 inches and an average annual temperature of 65° F.

Groundwater

In most of the Animas Valley, groundwater is the only dependable source of water supply, since there are no perennial streams in the valley. The water occurs primarily in the valley fill, which consists of deposits of sand and gravel with beds and lenses of clay and silt. In the Animas Valley, several sand and gravel aquifers occur at different depths. The water yielding properties, the thickness, and the number of aquifers vary from place to place in the valley.

Groundwater tapped by most wells in the northern part of the basin is generally from unconfined aquifers. In the southern part, mostly confined aquifers have been tapped.

The water table varies in form and slope across the valley, depending upon the areas of heavy pumping from wells and laterally

Table 1. Hidalgo County land use and source of water for irrigation, 1974

Land Use	Source of Water: Surface	Ground	Ground and Surface	Acres
	-------	-acres-	-------	
Total Land Area				2,206,080
Inland Water				16,074
Urban & Build-up				10,470
Roads				10,217
Crop Land Total				35,230
Irrigated	0	32,370	2,860	35,230
Dryland				0
Parks and Forests				40
Commercial Timber				11,666
Grazing Land				2,122,383

Source: New Mexico Interstate Stream Commission and New Mexico State Engineer Office, 1974.

varying permeability. The regional slope of the water table generally follows the slope of the ground surface which is to the north.

A groundwater system nearly in balance is indicated by water levels that do not change appreciably or that vary rhythmically. This was the case in the Animas Basin prior to intensive use of groundwater for irrigation (Reeder, 1958). The amount of discharge must have been nearly equal to recharge. With the development of groundwater for irrigation use, adding to the rate of discharge from the groundwater reservoir, water levels have declined noticeably in the irrigated areas and the equilibrium of the natural groundwater system has been modified.

The State Engineer defined an area of 205 square miles in the Animas Valley as the Animas Valley Underground Water Basin on May 5, 1948, and closed it to further appropriation of groundwater on June 14, 1948. The boundaries of the declared basin were extended and the additional area was closed for further appropriation by the State Engineer on February 23, 1956 (Reeder, 1958).

Economic Characteristics of Hidalgo County

The population of Hidalgo County has decreased by 361 people between 1950 and 1970, while the population of the state of New Mexico increased by 240 percent. The population of Lordsburg, the largest city in the region, decreased only by 96 people between 1950 and 1970 (Table 2). This implies that the population is moving out of the rural areas at a faster rate than out of the urban areas. The net result has been a shift out of production agriculture for many people. Agriculture was once the primary economic activity in the county, but

Table 2. Population of Hidalgo County

Year	County	Lordsburg
1950	5,095	3,525
1960	4,961	3,436
1970	4,734	3,429

Source: New Mexico Interstate Stream Commission and New Mexico State Engineer Office, 1974.

in recent years has declined, due to increasing energy costs and relatively low farm prices. Lordsburg, largely because of its location on the main east-west transcontinental Interstate Highway 10, has experienced an increase in tourism. This highway is a major route particularly in winter when roads further north are icy. The extent of the increase in tourism can, in part, be measured by employment in the trade and service sectors. In 1972, the trade and service sectors together employed 783 people, while in 1973 they employed 814 people. This represented 47 percent of the total non-agricultural employment in 1972 and 42 percent in 1973 (N.M. Interstate Stream Commission and N.M. State Engineer Office, 1974).

Manufacturing is almost absent in the economy of Hidalgo County, with only three manufacturing firms, one printing and publishing firm, and two firms that produce stone, clay, and glass products. Because of disclosure problems and the limited number of firms, employment figures for manufacturing are unavailable (N.M. Department of Development, 1974).

The ability of an agricultural processing industry to stimulate employment has been found to be second only to that of manufacturing (Table 3). The multiplier effects of other industries are presented in Table 3.

Utilization of Geothermal Hot Water

The utilization of geothermal hot water depends to a large extent on the temperature and quality of the water. High quality water of more than 400° F is considered good enough for the generation of electricity. It is the intermediate to low temperature geothermal water (less than 350° F) that presents a challenge in energy resource development. Low to intermediate hot water has several possible uses ranging from fish hatching, which requires water at about 70° F, to evaporation of highly concentrated solutions requiring water at about 350° F (Gordon et al., 1978). Figure 3 shows the possible uses of geothermal water at various temperatures.

GEOTHERMAL RESOURCE ASSESSMENT

When farmers began developing the Lower Animas Valley in 1948, several wells were drilled in the valley for irrigation. One hit steam and boiling water at a depth of 88 feet. The temperature of the discharging water was 240° F (115.56° C) as indicated in the State Engineer's files. The first hot well is located at T. 25 S., R. 19 W., 7.234 in Animas Valley. By 1955, two other wells drilled within 2/3 mile of this well also produced boiling water and steam at a shallow depth. All the hot or warm wells in Sec. 7, T. 25 S., R. 19 W., are shown in Figure 4. Most other wells south of the hot wells in

Table 3. Multiplier impact of one dollar increase in business activity

Business Sector	Total Increases in Business Volume	Total Increase in Personal Incomes	Total Increase in Jobs
	- - - - - - - -	dollars	- - - - - - - -
Agricultural Processing	2.50	4.32	2.82
Manufacturing	2.15	3.35	2.93
Livestock Production	2.25	2.81	--
Services	1.76	1.58	1.33
Mining	1.65	1.57	2.56
Crop Production	1.55	1.40	--
Real Estate, Finance and Insurance	1.54	1.46	1.55
Transportation	1.46	1.44	1.45
Retail and Wholesale Trade	1.46	1.28	1.32

Source: United States Department of Agriculture, July 1978.

Degrees Fahrenheit	
356	Evaporation of highly concentrated solutions Refrigeration by ammonia absorption
338	Drying of diatomaceous earth
320	Drying of fish meal, drying of timber
302	Alumina via bayers processing
284	Drying farm products, canning of food
266	Evaporation in sugar refining, extraction of salts by evaporation
248	Fresh water distillation, refrigeration by medium temperatures, multiple effect evaporation
230	Making cement slabs
212	Drying organic materials, washing and drying wool
194	Drying of stock fish, de-icing operations
176	Space heating, greenhouses heating
158	Refrigeration at low temperatures
140	Animal husbandry, greenhouses by combined space and hotbed heating
122	Mushroom growing, balneological baths
104	Soil warming
86	Swimming pools warm water for year around mining
68	Hatching of Fish, fish farming

Saturated steam (356 to approx. 230)

Water (approx. 248 to 68)

Source: Gorden et al., March, 1978

Figure 3. Temperature range of conventional power production.

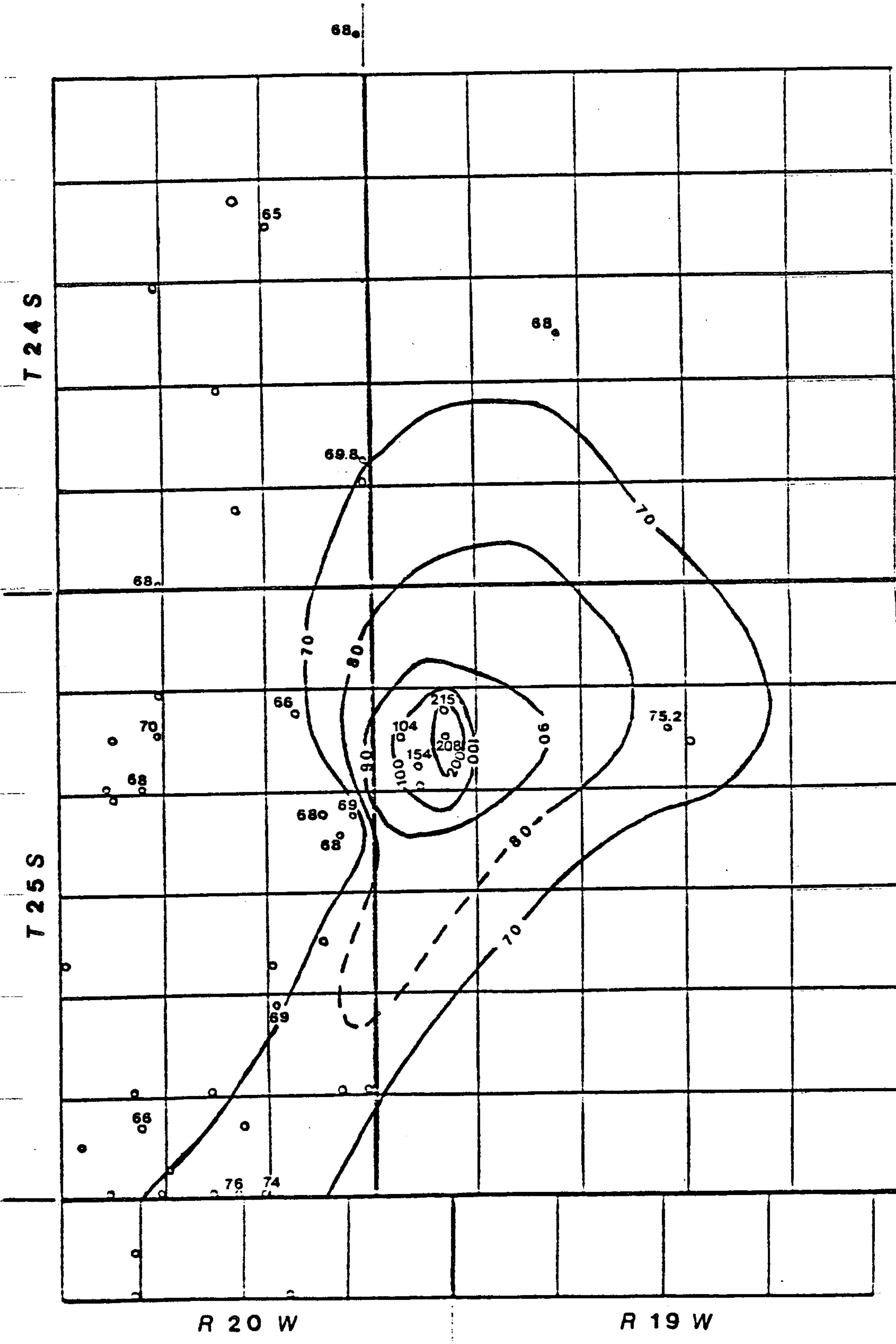


Figure 4. Map of the area of the thermal anomaly in the Animas Valley, showing the temperature of the groundwater in degrees Fahrenheit.

Section 7, T. 25 S., R. 19 W. are normal temperature wells. However, in two wells just southeast of the town of Cotton City, the water temperature was found to be 76° F (24.4° C) and 75° F (23.9° C). The location of these two wells are 25.20.35.433, and 25.20.35.444, respectively. Another well, which is east of the hot water wells in Sec. 7, T. 25 S., R. 19 W., and is located in the center of NE 1/4 SE 1/4 Sec. 9, T. 25 S., R. 19 W. shows a temperature of 75° F (23.9° C) at 194 feet below the land surface.

The hot water wells in the valley penetrated a red rhyolitic rock which is highly silicified. The water has a total dissolved solids value of about 1,150 parts per million. It is enriched in silica and chloride, but depleted in bicarbonate, as compared to the non-thermal water of Animas Valley.

During the first year of research work, the following tasks have been completed in the Geothermal Resource Assessment category.

Geohydrological Analysis

As part of the overall study, a geohydrological investigation of the Animas Valley for the 22-year period between 1955 to 1977 was completed. The research procedures consisted of:

1. All published literature on the geology and geography of the area and reports of previous work done in groundwater hydrology were collected. Main sources of this information are Schwennesen, 1918, Reeder, 1958 and Deal, et. al, 1978. The only comprehensive work on groundwater hydrology of the Animas Valley to date was done by Reeder (1958).

2. The State Engineer Office in Deming, New Mexico, has maintained records of water levels of wells in the valley for the past 24 years (since 1955). These records were collected by going through several files and records on single pages kept by the State Engineer Office.

3. The driller's logs for several wells, which were on file at the State Engineer Office in Deming, were obtained and analyzed.

4. Location of wells for which the above-mentioned data was available was plotted on a topographic map of the valley.

5. Water level records for selected wells were analyzed and profiles were prepared to show water level fluctuations over the past 24 years.

6. By using a computer program, SYMAP, developed by the Harvard Center for Computer Graphics, water level decline (or rise) maps were prepared for approximately three-year intervals. Direction of groundwater flow for each of these years was estimated. Change of direction of flow further indicates the overall changes in the groundwater regime due to heavy pumping for irrigation in the valley.

7. Data on depth to water for the years between 1955 and 1977 was used to prepare maps showing the change in depth to water table. This was done by visual contouring of water level data reduced to show the depth to water table. These maps were useful in documenting the total change in groundwater table in the valley.

The results from the geohydrological analysis indicates a continual decline in water levels in the Animas Valley for the 22-year period) between 1955 and 1977 (Figures 5 and 6).

The depth to the water table in 1955 was less than 20 feet under an area of 5.5 square miles which includes most of the northcentral part of T. 24 S., R. 20 W. (Figure 5). The depth to water increased outward in all directions from this area, thus making this area a water mound. The maximum slope was toward east and west, that is, toward the steeper side slopes in the basin. Figure 6 shows the depth to water in feet below the land in January 1977, after 30 years of large-scale pumping for irrigation. In general, the depth-to-water contours have been displaced northward throughout the valley, indicating a greater depth to water during the period from 1955 to 1977. This is also shown by the profiles across and along the axis of the valley (Figures 7 and 8).

Southward from Sec. 3, T. 28 S., R. 19 W. in the Upper Animas Basin where the water was 190 feet below the land surface in January 1955, the depth to water increased substantially to about 220 feet below the ground surface in 1977.

The water level in some of the wells in T. 28 S. and T. 29 S. indicates the presence of perched water. The north edge of this perched zone is apparently near well 28.19.34.133. About 1.05 miles south of this well is well 29.19.04.233 in which the depth to water was only 17.58 feet (5.36 m) below the land surface in 1977. About 2/3 mile (1.08 km) north of well 28.19.34.133, there is well 28.19.27.314, which is 1,000 feet deep and the water level stands 184 feet below the ground surface and corresponds with the main zone of saturation.

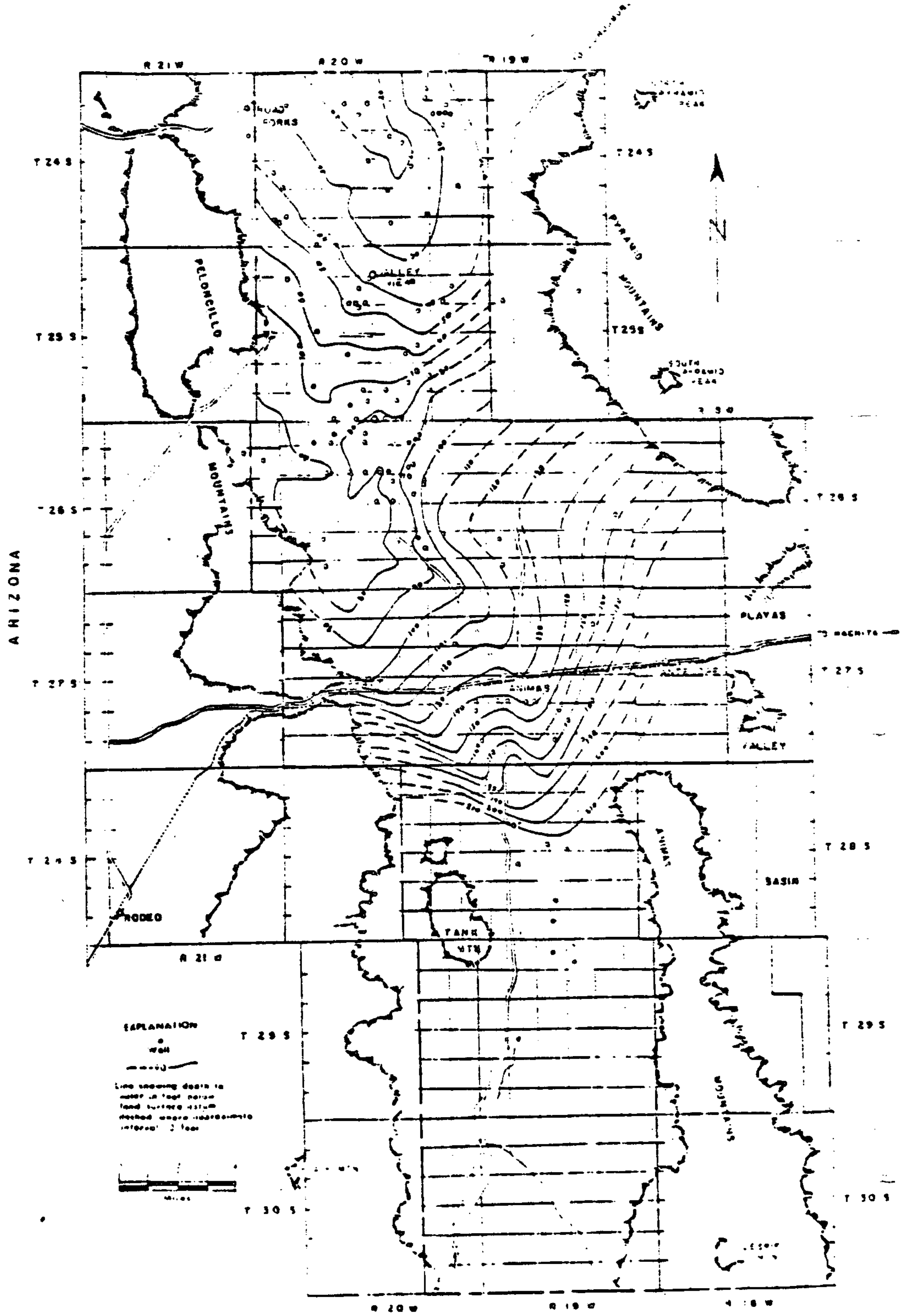


Figure 5. Depth-to-water table contour map, January 1955, Animas Valley, Hidalgo County, New Mexico.

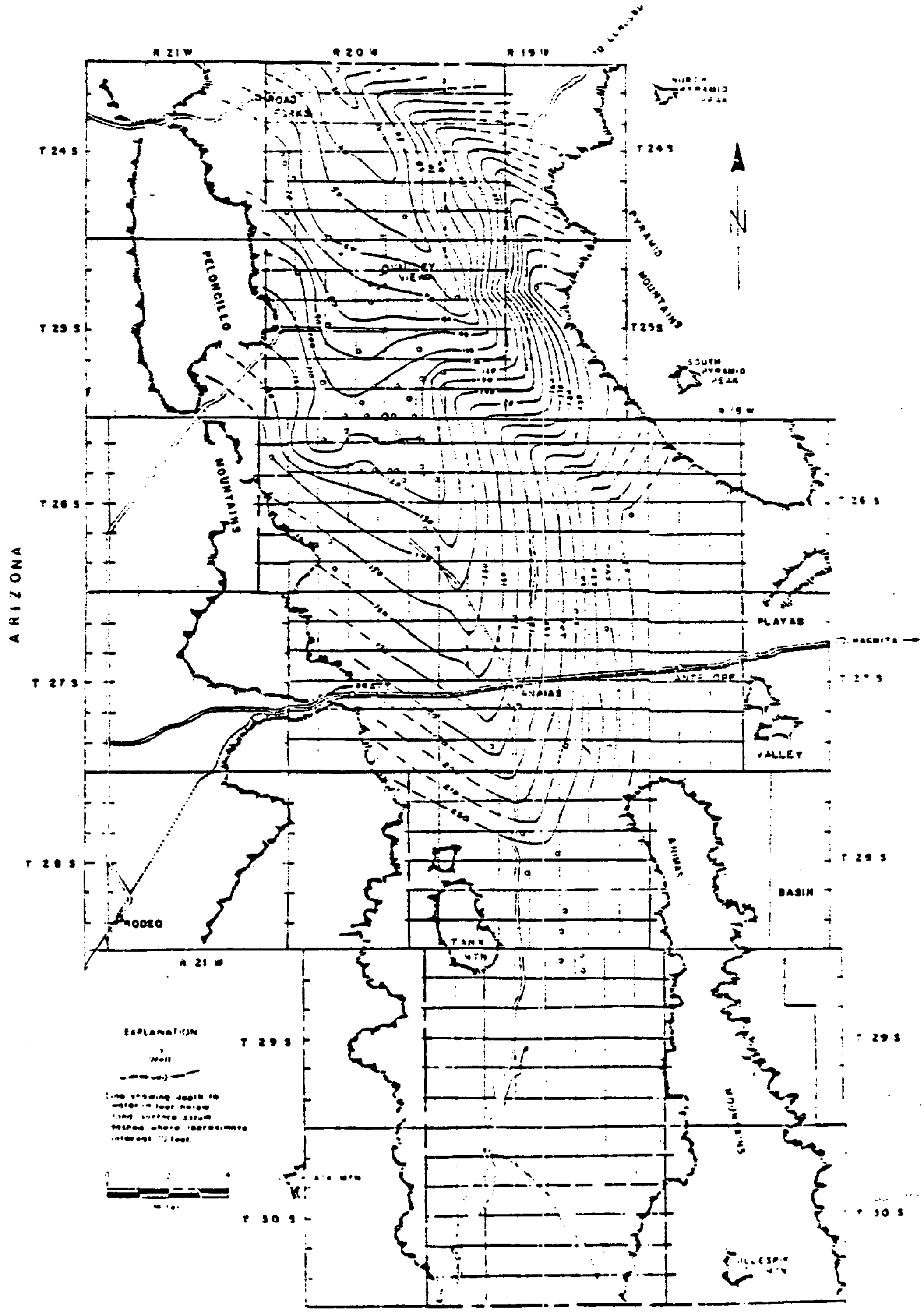


Figure 6. Depth-to-water-table contour map, January 1977, Animas Valley, Hidalgo County, New Mexico.

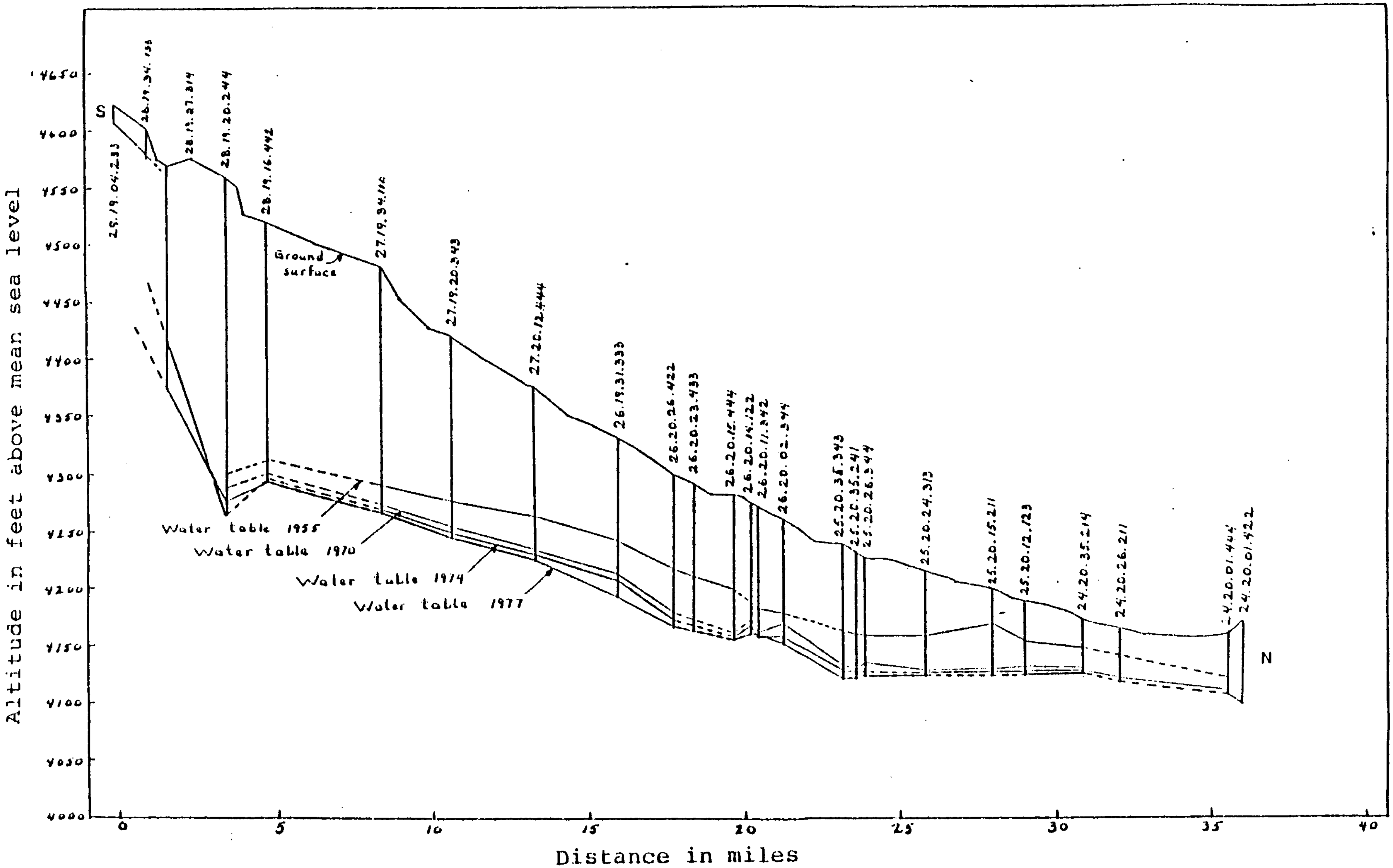


Figure 7. Profile of the water table in January 1955, 1970, 1974 and 1977, along the S-N axis of Animas Basin, Hidalgo County, New Mexico.

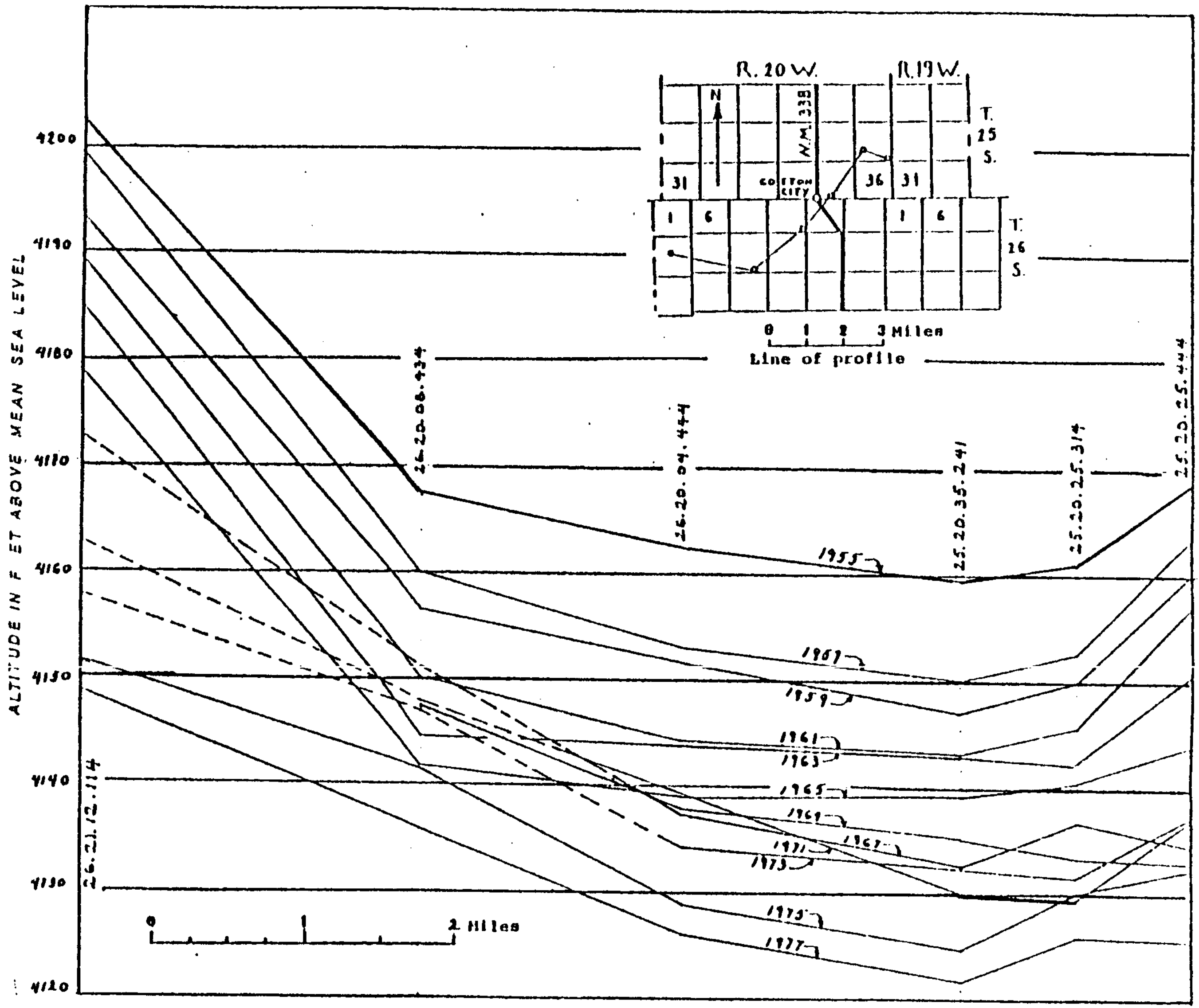


Figure 8. Successive profile of water levels measured biannually, in wells across Lower Animas Valley, Hidalgo County, New Mexico.

The relation of the main groundwater body and the perched zone about eight miles south of Animas is shown in the profile along the axis of the valley in Figure 8. The perched aquifer south of well 19.19.04.233 is not shown in the profile in Figure 8, because data is not available on the wells in T. 29 S. and T. 30 S. of R. 20 W. and R. 19 W. The existence of this perched water body was described by Reeder, 1958.

Groundwater movement in the valley has been changing direction with time since the introduction of irrigation. Prior to 1948, groundwater movement in the valley was essentially south to north. Irrigation wells have been drilled in the valley, heavily taxing the groundwater aquifers. As a consequence, the direction of groundwater movement has been continuously changing. This can be seen in the water-level-contour maps for the years 1955 to 1977 (Arras, 1979). Continuous water level records for wells are available only from 1955 onward. In 1955, the predominant groundwater movement was from southwest to northwest (Figure 9). In 1977 the direction of groundwater movement seemed to be as follows (Figure 10). In T. 24 S., northernmost part of the study area, groundwater appears to fan out in all directions. In the center of the basin, it appears to move from southeast to northwest. In the Upper Animas Valley (southern part of the basin) the groundwater movement direction is still south-southwest to north-northwest, indicating that in this part of the valley the groundwater movement has been less altered, and that there has been less pumping than in the central and northern part of the valley.

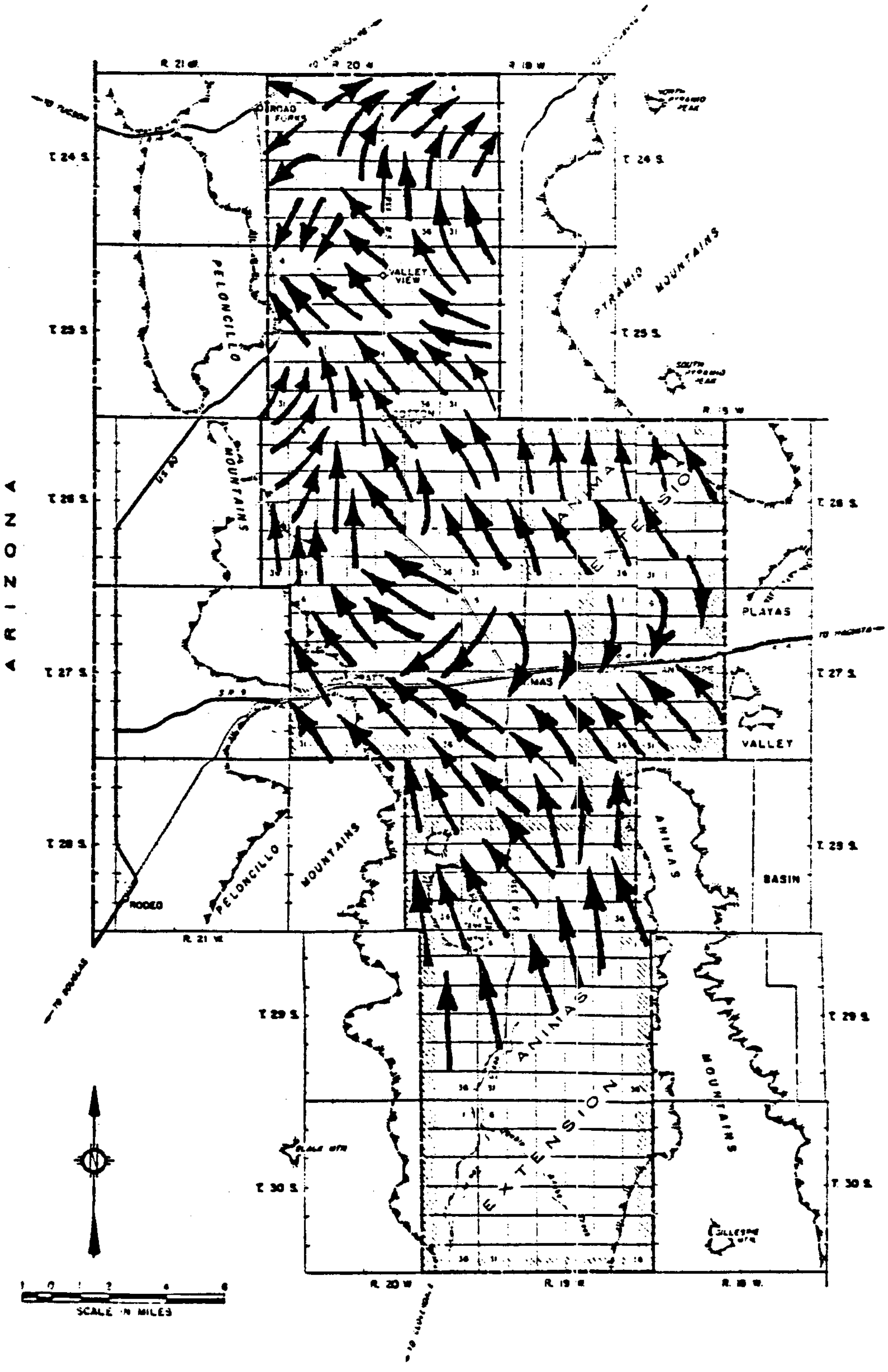


Figure 9. Direction of groundwater flow in January 1955 in Animas Basin, Hidalgo County, New Mexico.

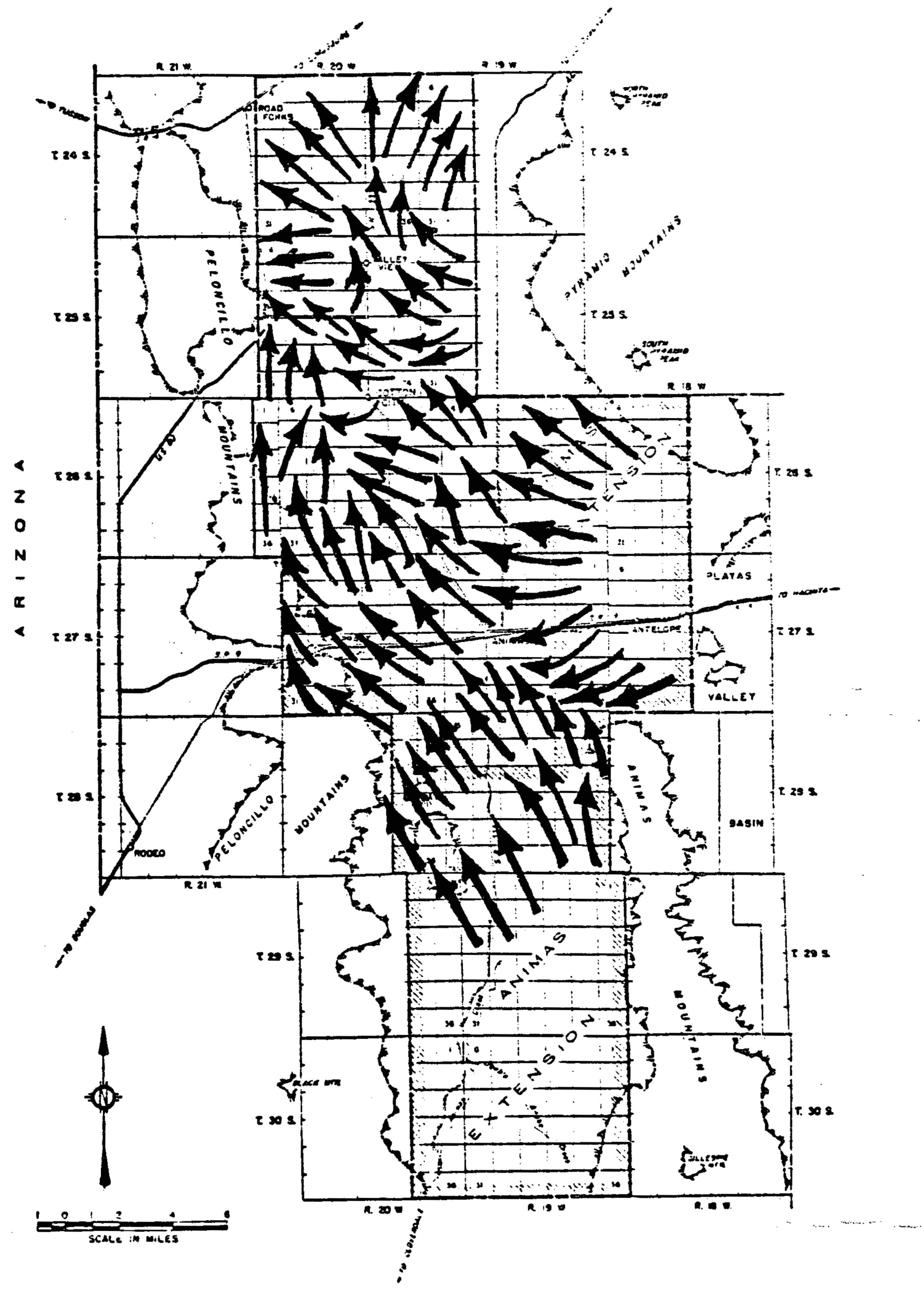


Figure 10. Direction of groundwater flow in January 1977 in Animas Basin, Hidalgo County, New Mexico.

Water-level profiles are useful for depicting the fluctuations in the water table and for showing the hydraulic gradient associated with the movement of groundwater (Figures 7 and 8).

Depth to Water Table

Throughout the Lower Animas Valley the water table is less than 180 feet below the land surface. In the northern part of the basin, in well 24.20.14.214, the water table was about 18 feet below ground level in 1955 and about 55 feet below ground level in 1977. Southward along the axis of the basin, the depth to water increases progressively, but there has been much less decline from 1955 to 1977. In well 28.19.16.422, the water table was 220 feet below ground surface in 1955 and about 225 feet in 1977.

Fluctuations of the Water Table

The relation of the ground surface and water level at wells on a line approximately along the axis of the basin is shown in Figure 7. In January 1955, the water table sloped northward from Section 16, T. 28 S., R. 19 W. to Section 15, T. 26 S., R. 20 W. at a rate of about 7.6 feet per mile. From Section 16, T. 26 S., R. 20 W. to Section 24, T. 25 S., R. 20 W., the gradient of the water table was about 9.2 feet per mile. From Section 15, T. 25 S., R. 20 W. to Section 1, T. 24 S., R. 20 W., the gradient of the water table was about 5.6 feet per mile. In 1955 the water table in the Animas Valley Underground Water Basin sloped northward at an average gradient of about 7.5 feet per mile as compared with about 13 feet per mile of the ground surface. Figure 7 also shows the position of the water table in January 1970, January 1974, and January 1977 along the same profile.

Geothermal Hydrology

The following procedures were used in this study:

1. Existing data on geothermal hot water occurrence was collected. This consists of geological and geophysical exploration data. New data on geothermal hydrology of the Known Geothermal Resources Area (KGRA) was collected by conducting pumping tests in the valley.
2. Groundwater temperatures at the water table were measured in all available wells in a 96-square-mile (248 square kilometers) area surrounding the hot water wells in Section 7, R. 19 W., T. 25 S. This gave an estimate of the area of geothermal anomaly.
3. Water level fluctuations in wells around the geothermal anomaly were used to compute the change in direction of flow of hot water and its mixing with the groundwater.
4. A shallow thermal survey was conducted to assess the change in the extent of the geothermal anomaly since 1956.

Figure 4 shows the distribution of temperatures of water in the wells and the locations of these wells in the area of the geothermal anomaly.

Heat Flow

Dellechaie (1977) reported heat flow determinations from 31 observation wells. These reveal a two-mile-long elliptical anomaly in the area of hot wells. Well depths used for this determination averaged less than 200 feet.

Water Table and Direction of Flow of Groundwater

After irrigation development, a center of pumpage apparently developed south and west of the anomaly. As a consequence, the direction of groundwater movement over the geothermal anomaly has altered. Figure 11 shows how the direction of groundwater movement over the anomaly appears to have changed between 1955 and 1977.

The groundwater discharge associated with the anomaly has been greater than recharge; as a consequence, water levels are falling. The water table at the anomaly has declined by about 20 feet between 1955 and 1977. Figures 12 and 13 show the water-table-contour maps for the geothermal area for 1955 and 1977, respectively.

Aquifer Characteristics

Transmissibility and storage coefficient are two parameters which quantify the behavior of groundwater in an aquifer. The coefficient of transmissibility indicates the capacity of an aquifer to transmit water through its entire thickness, and is defined as the rate of flow of water in gallons per day (gpd), through a vertical strip of the aquifer one foot wide and extending the full saturated depth of the water. The coefficient of storage is defined as the volume of water the aquifer releases from or takes into storage per unit surface area of the aquifer per unit decline or rise of head. The field-coefficient of transmissibility and storage can generally be determined by controlled aquifer tests.

A well test was conducted on hot wells. A group of hot wells located in Section 7, T. 25 S., R. 19 W. were used (Figure 11).

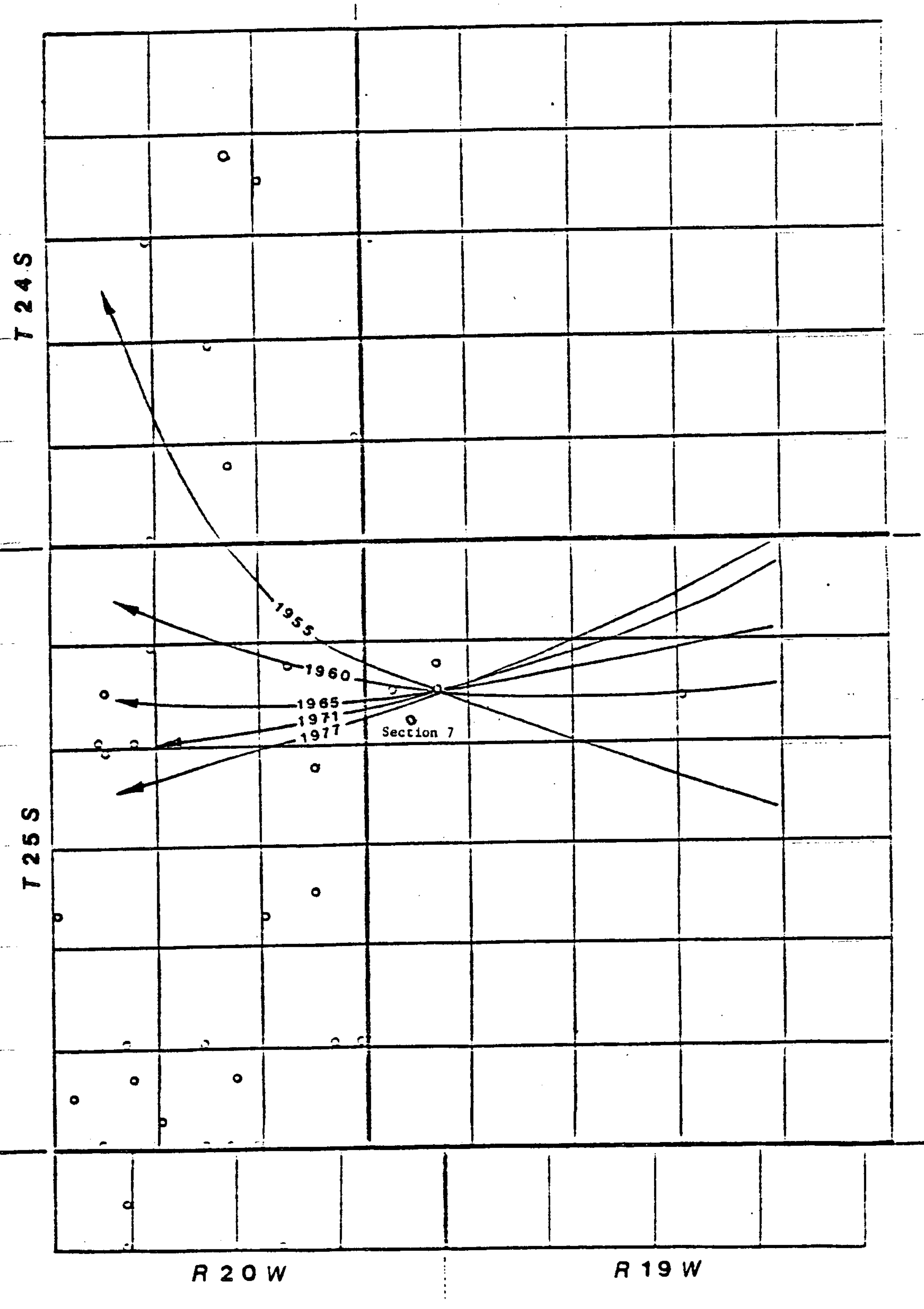


Figure 11. Direction of groundwater movement over the thermal anomaly in the Animas Valley.

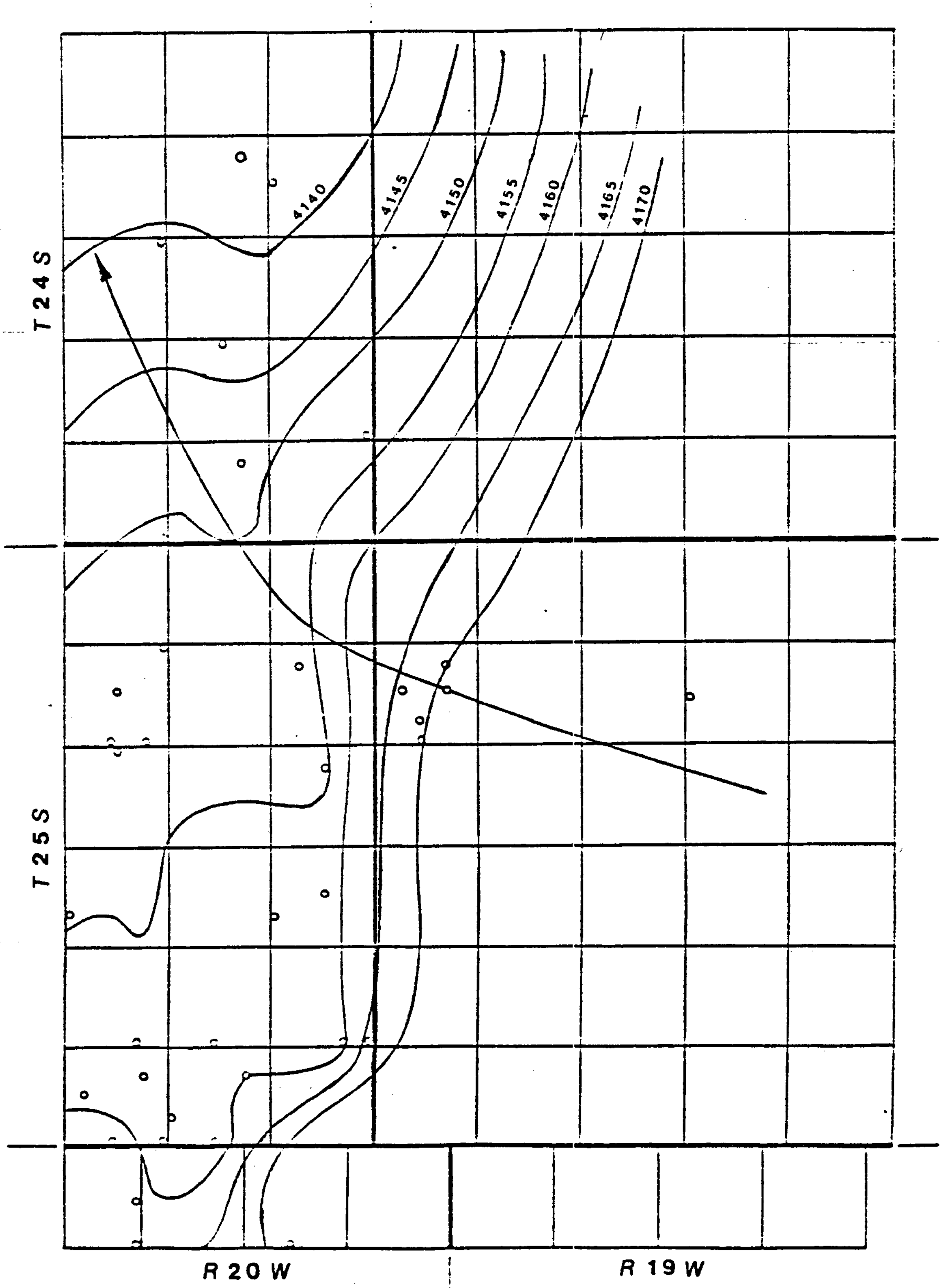


Figure 12. Water table, 1955, in the vicinity of the thermal anomaly in the Animas Valley.

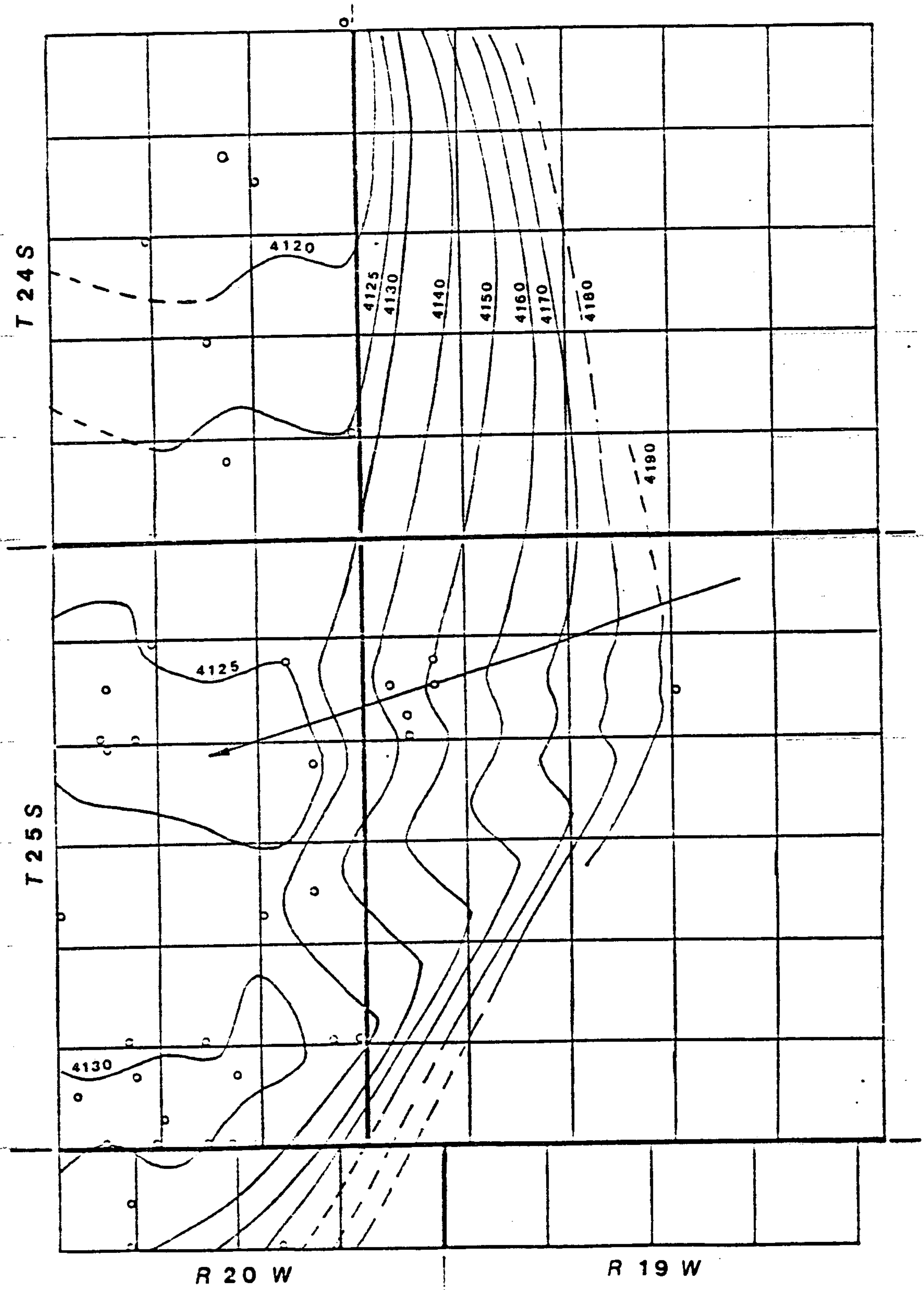


Figure 13. Water table, 1977, in the vicinity of the thermal anomaly in the Animas Valley.

Pumping started at 3:33 p.m. on February 10, 1979, and was continued at a constant rate of 42.31 gpm for about 16 hours until 6:30 a.m. the next day. The flow was measured by timing the water to fill up a 55 gallon (208 liter) tank. Observation wells 1 and 2 (Figure 14) were measured during the test, but no change in the water level was observed, indicating that the pumping well did not affect the two observation wells. Drawdowns in the pumped well were plotted against time on semilogarithmic paper. The time-drawdown field-data for the pumped well is shown in Figure 14.

The computed coefficient of transmissibility is 26,595 gpd/ft. The coefficient of storage of the aquifer could not be determined from the results of the test, because the effect radius of the well was unknown, due to the observation wells not having been affected.

Shallow Thermal Survey

A reconnaisance shallow thermal survey covering aproximately 50 square miles surrounding the hot wells in section 7, T. 25 S., R. 19 W. was conducted in April, 1980. The results of this survey shown as isothemus at 2 meters (6 feet) depth are given in Figure 15. The results of a shallow thermal survey conduted by Kintginnzer (1956) are shown in Figure 16. There is an apparent increase in the area of the geothermal anomaly between 1956 and 1980. Complete structural and geohydrological significance of this apparent increase in the extent of the geothermal anomaly will require additional field and analytical work and will be attempted as part of a future research project.

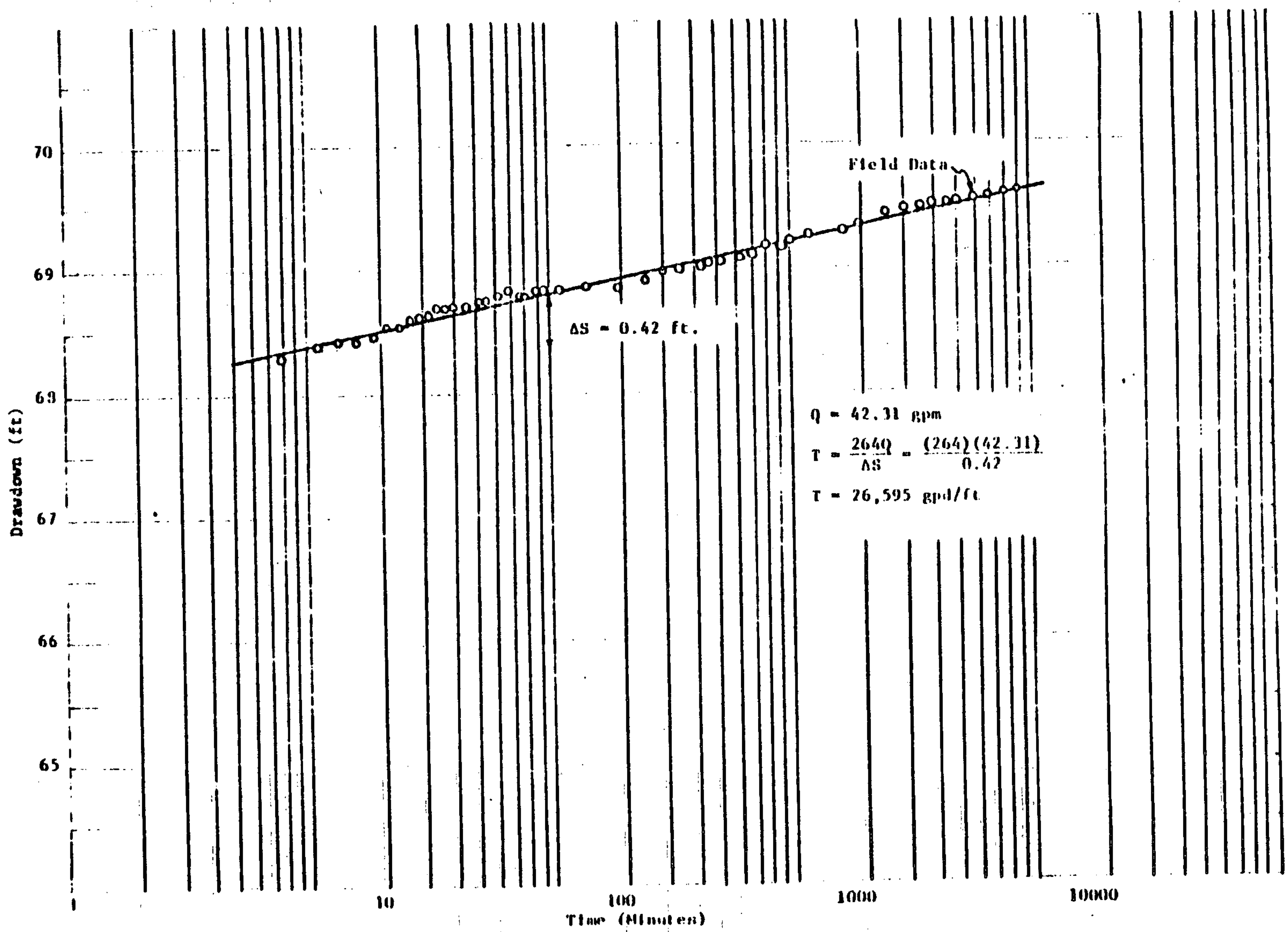


Figure 14. Time-drawdown graph for pumping well at Animas Valley, New Mexico.

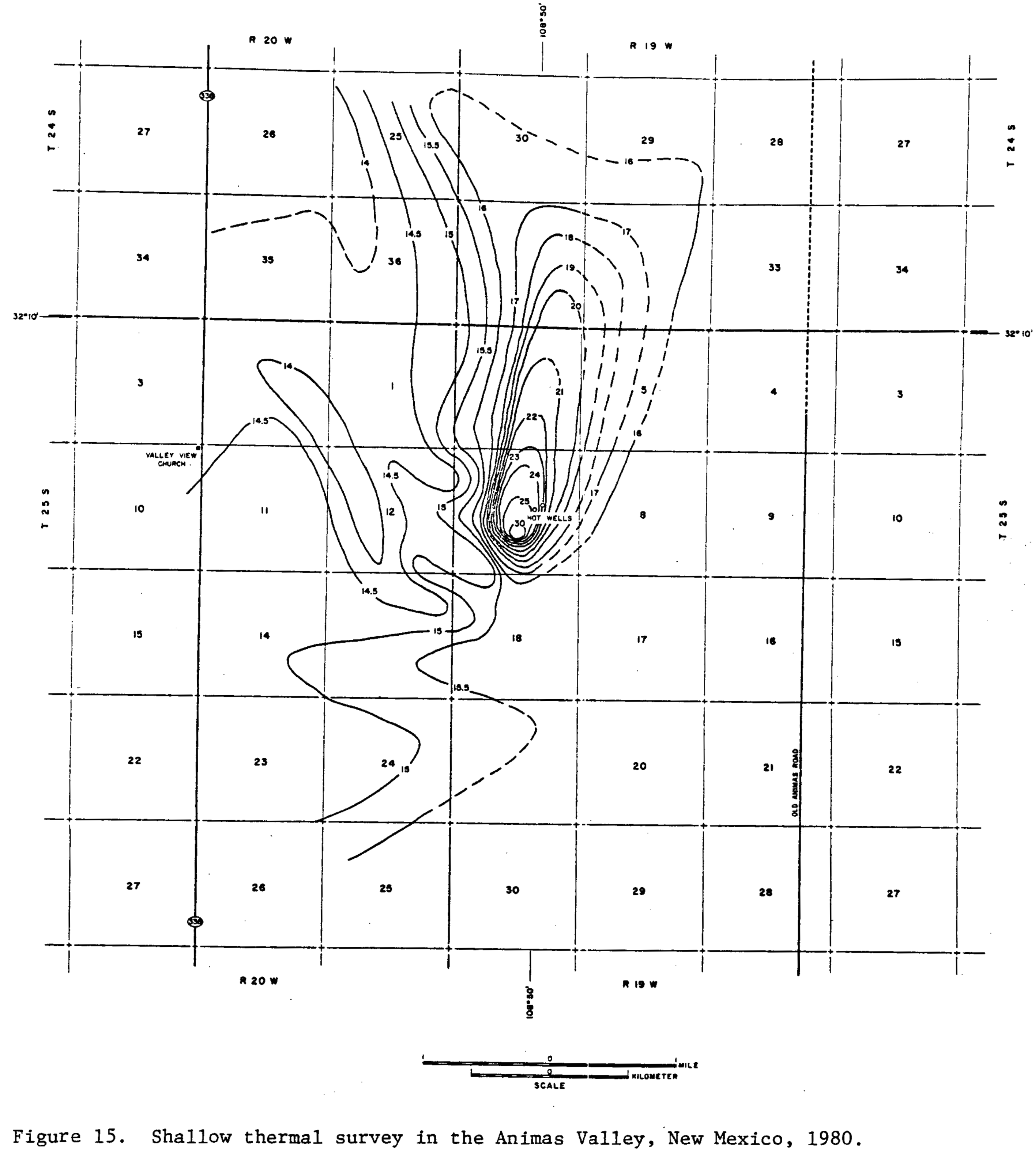


Figure 15. Shallow thermal survey in the Animas Valley, New Mexico, 1980.

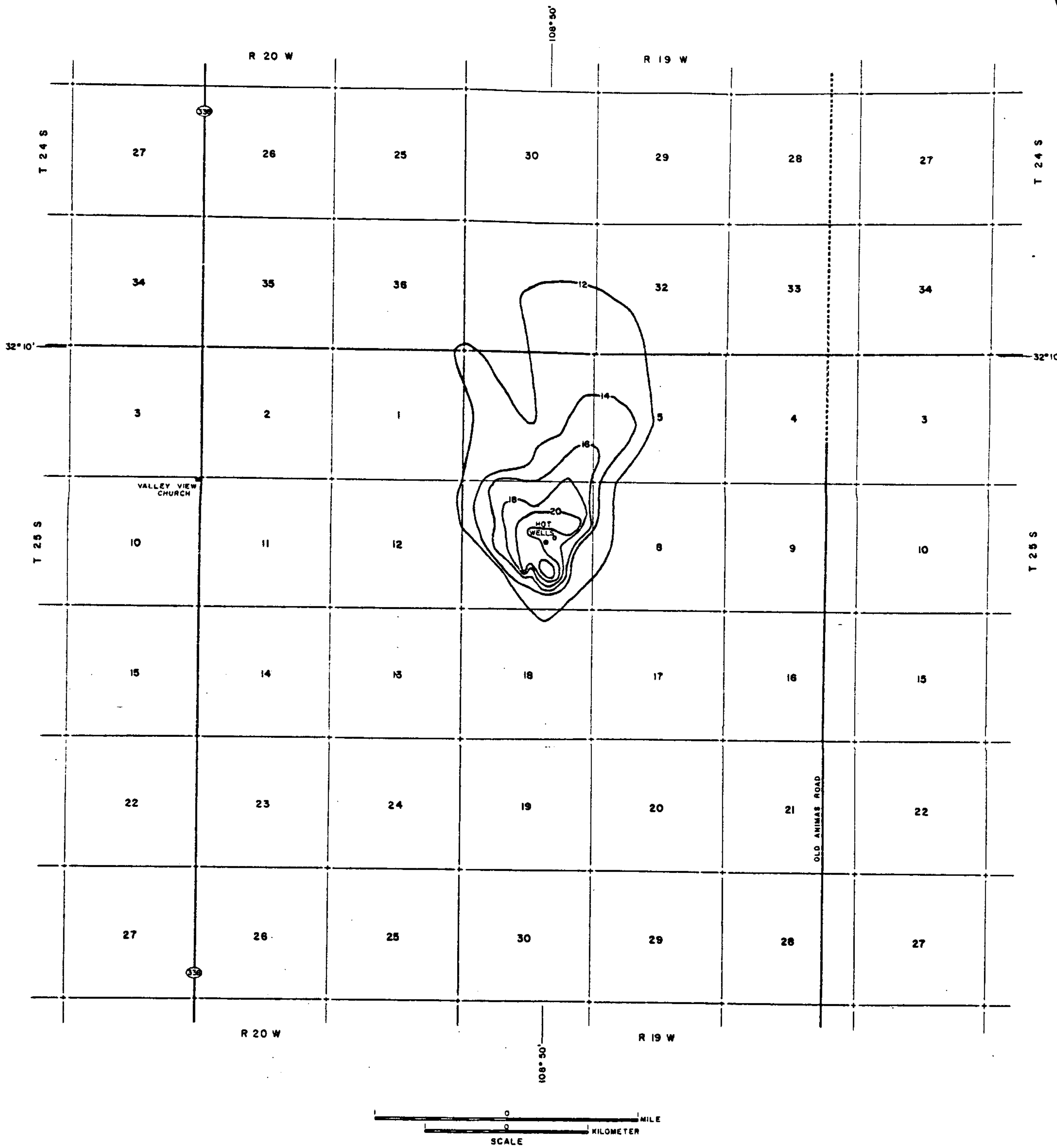


Figure 16. Shallow thermal survey in the Animas Valley, New Mexico, 1956.

AGRIBUSINESS POTENTIAL

In investigating potential agribusiness industries two basic characteristics were considered highly desirable: agriculturally related industries and industries that can utilize hot water in an integrated system of industries. Agriculturally related industries are those that would use locally produced commodities. Developing such industries would stimulate the local economy by increasing the demand for the raw products, which in turn may encourage farmers to increase production levels. Agriculturally related industries often have fewer undesirable effects on the surrounding community, assuming that the processing of a locally produced crop does not have a severe cultural impact on the surrounding society.

An integrated system of industries are those that jointly use the available hot water. Hot water flows from industries that need high temperature water to industries that need water at a lower temperature. This permits a greater amount of energy to be extracted from the water, and ensures that water discharged from the plants is at a low enough temperature to not have serious adverse environmental effects. A different basis for integrating industries also exists, where industries are aggregated so they use the resource at different times of the day or year.

The agribusiness processes selected for analysis in the Animas Valley were to form an integrated system of industries. The system would take maximum advantage of the temperature difference between the intake water and the discharge water. The system could possibly include a vegetable and fruit freezing plant, a vegetable canning plant, an onion and chile dehydrating plant, greenhouses and a meat processing and precooking plant.

The vegetable and fruit freezing plant, vegetable canning plant, and the dehydration plant would require water in excess of 150° F. The discharge water would then be used to heat the greenhouse which would discharge the water at about 80° F. Greenhouse space heating would peak at night during the winter, while vegetable and fruit processing would require constant heat with the peak use in the summer and fall.

A freezing, canning, or dehydration plant and the greenhouse would fit into the cascaded system of industries very well, whereas meat precooking does not fit into the pattern. Meat precooking requires water between 90° and 150° F, and should operate all year. These five uses of geothermal hot water may be developed individually or in combination, with the ultimate constraint being the heat resource available (Lansford et al., September 1978, p. 16).

Currently, none of the agricultural crops to be processed are grown in the region, but there are over 150,000 acres of irrigated cropland that are adaptable to vegetable growing in Southwestern New Mexico and Southeastern Arizona. It is assumed that these crops would be produced once an industrial system which offers a market is established.

The Animas Valley and Hidalgo County, in general, do not have a large population of cattle on farms. The county had only 3.2 percent of the state's total cattle on farms as of January 1977, even though the county devoted 97 percent of its agricultural land to animal grazing. With the establishment of the meat precooking plant, there is a possibility that feedlot(s) will be attracted to the county. Currently, there are none. Feedlots form the major source of beef cattle for a processing plant.

Though it is expected that an integrated system of industries will be established, only the feasibility of the greenhouses and beef precooking plant are examined in this report. The beef processing plant can be operated independently of the others, an unprofitable vegetable processing plant or greenhouse can be eliminated without having serious effect on the beef precooking plant.

Heat Extraction

Two possibilities exist for heat extraction from the resource reservoir. These are direct pumping and down-hole heat exchange. In direct pumping, the water is drawn from the underground reservoir, utilized and disposed. This method permits a larger energy extraction rate, which is limited only by the flow rate, temperature, and rate of recharge of the underground water system (Gordon et al., 1978).

In the down-hole heat exchange method of extraction the hot water is not pumped to the surface. The thermal heat energy is transferred to another liquid or gas which is circulated from the well to the surface and back to the well. Though this method eliminates problems of disposing of used water, it does not permit as large an energy extraction rate as a pumping system (Gordon et al., 1978). Apart from being limited by the flow rate, temperature, and recharge rate of the underground water, it is limited further by heat exchange areas within the bore well.

In the Animas Valley, it is expected that the direct pumping system will be used to extract the hot water. For this study it was assumed that wells about 100 feet deep would be drilled, which are expected to produce between 400 and 600 gallons per minute at an assumed temperature of between 150-200 degrees F.

Disposal of Used Water

There are also two ways of discharging used geothermal water: surface disposal and reinjection into the ground. Surface disposal has several options. Infiltration through sand and gravel pits, disposal through irrigation, collection in a reservoir, and discharging into streams are some of the possibilities. Surface disposal has some problems however, these include environmental pollution in the event that the discharged water has a high level of mineral content, and the destruction of surrounding plant and animal ecology if the water is of high temperatures. There is also a problem of failure to sufficiently recharge the aquifer below the ground.

Reinjection wells involve pumping the discharged water into the ground. Reinjection does not have the same problems that are associated with surface discharge; however, it has its own problems to be considered. These include locating the reinjection well so that inter-flow between reinjection and the production well is prevented. Other problems are preventing mineral deposits in the well, and the effect of reinjection wells on adjacent aquifers (Gordon et al., 1978).

To avoid environmental pollution and the destruction of surrounding plant and animal ecology, reinjection wells are projected to be used. This will reduce the draft on the declining groundwater supply.

Equipment for Utilization

The equipment required to utilize geothermal water for specific agribusiness complexes depends upon the final selection of the type of operation to be analyzed, which in turn depends on the temperature of the geothermal resource. The types of equipment needed for greenhouses and beef precooking are described later in this report.

Locational Factors

Since the potential agribusiness enterprises will utilize geothermal hot water, the location is necessarily limited to an area where this natural resource occurs. In this instance, the proposed facility must be located in or near the Lightning Dock KGRA. The question then becomes one of examining whether or not other locational factors support the establishment of agribusiness enterprises such as a greenhouse complex or beef precooking plant.

The location of the proposed agribusiness facilities is affected by such factors as the existence of adequate transportation, the availability of sufficient labor, the existence of utilities, the attitude of the community and local officials towards the enterprise in question, and the adequacy and existence of social infrastructure. Other relevant factors relating solely to either the greenhouse facility or beef precooking plant will be evaluated separately in later sections.

Transportation

The Lightning Dock KGRA is situated some 13 miles from Interstate Highway 10, which is a major east-west trancontinental thoroughfare. It is located approximately 25 miles from Lordsburg. The Southern

Pacific Railway Line serves Lordsburg with an estimated 26 freight trains daily (N.M. Dept. of Development, 1975). Lordsburg is also served by three interstate motor freight carriers.

The number of motor freight carriers may well increase with the establishment of a beef pre-cooking plant due to the heavy movement of raw materials, finished products, supplies, and by-products. A spur line from the railway to the plant site would provide more than adequate transportation for the processing facilities.

Labor

The labor requirements vary greatly for the processing facilities considered. The beef precooking operation would employ more individuals than the greenhouse operations. Labor requirements to produce potted chrysanthemums are greater than for tomatoes. It is anticipated that there will be no problems in recruiting adequate personnel for the processing facilities, as the unemployment in Hidalgo County is presently over 300 individuals. It is assumed that employees can be recruited from surrounding regions as well.

Utilities

Adequate utilities exist in the Animas Valley to support either of the agribusiness enterprises at the levels considered. Electrical service, natural gas, and telephone service exist at present in the area. Currently, Lordsburg is served by three electric transmission lines of 69 kilovolts each. Should more electricity be needed, it can be obtained easily since the major power lines from the Four Corners power generating center are nearby.

Cold water requirements can be met by the drilling of wells. Sufficient high quality water is available for either of the alternatives considered. The use of geothermal hot water for beef pre-cooking and for heating the greenhouses eliminates the need for natural gas.

Attitude of the Community and Local Officials

No problems are anticipated in the accceptance of the greenhouse by the community or by local officials. No offensive odors are produced or pollutants emitted, making this operation relatively inexpensive from a social cost viewpoint, while contributing rather substantially to the economic base of the area.

The odors from a slaughterhouse and a sewage treatment system are unpleasant, therefore, it is essential to get the approval of the community and officials before the plant is established. The somewhat isolated location of the proposed plant would be favorable to its acceptance. The Hidalgo County Commissioners and the Southwest New Mexico Conservation and Development Area Council are aware of these aspects. Since the officials would tend to look at the plant in terms of its employment and income effects on the community, they are expected to overlook the negative effects, therefore it is assumed that the plant would not be opposed.

Other Social Facilities

Other social facilities needed include banking, insurance, post office, public school, hospital and recreation facilities. Currently, nearly all of those are available at Lordsburg and/or Animas. With the establishment of the plant, additional service industries including additional recreational facilities should be attracted to the area.

Feasibility Assessment

The feasibility of both the greenhouse and meat precooking enterprises has been evaluated on the basis of profitability, ability to meet cash needs, financial strength and rate of return on investment. Proforma income statements have been prepared to evaluate the profibility of each enterprise. A proforma income statement is a forecast of the expected profit or loss of an enterprise for a given time period.

Cash flow budgets have been prepared to evaluate the ability of each enterprise to meet cash needs. A cash flow budget is a complete listing of the timing and amount of cash received and disbursed. Its major purpose is to determine the amount of working capital required during specific time periods.

Proforma balance sheets have been prepared for both operations. The balance sheet presents a picture of the financial position of a firm at a specific time, allowing a determination to be made as to the financial strength of the firm. A proforma balance sheet is used to determine whether or not a firm has sufficient assets to pay liabilities.

The rate of return on investment has been measured by two different financial ratios: the return to total assets, and the return to equity or net worth. The rate of return on total assets is the ratio of net profit to total assets. The rate of return on equity is the ratio of net profit to owner equity.

Geothermal Greenhouses

One of the most successful applications of geothermal resources at present seems to be space heating. Some 50 percent of the population of Iceland live in geothermally heated homes, and it is expected that this percentage will increase to between 60 and 65 percent in the next few years. Other low level applications of geothermal energy include the heating of public buildings, greenhouses, and swimming pools (Einarsson, 1976).

Currently in Iceland there are more than 140,000 square meters (34.6 acres) in greenhouses utilizing geothermal space heat. The temperature of the resource being utilized for greenhouse heating lies between 80 and 120° C (Einarsson, 1976). An economic evaluation of 33.5 hectares (82.8 acres) of greenhouses in Iceland showed that the cost of heating with geothermal water was approximately two percent of total operating cost as opposed to between 35 and 40 percent for traditional hydrocarbon sources (Ludviksson, 1976). The savings due to the use of geothermally heated water will vary in relation to the temperature, chemical composition and accessibility of the resource, and local climatic conditions, as well as the cost of other fuels.

In the United States there are presently very few documented geothermally heated greenhouses. Three operations are known to exist, all of them being relatively small (less than two acres in size). The three are located in diverse regions of the country and produce a variety of crops. At Hobo Wells, near Susanville, California, tomatoes and cucumbers are grown in six greenhouses covering nearly half an acre. In Green River, Idaho, a variety of ornamental and vegetable crops are grown in a facility of nearly an acre in size. The greenhouse located near Cotton City, Animas Valley, New Mexico, produces a variety of roses as well as bedding and potted plants. This operation covers approximately 1.6 acres.

In the past 25 years in the United States, there has been a tendency to shift greenhouse production from major marketing areas to areas with climates favorable to the production of greenhouse crops. This shift is due to the development of a more efficient transportation system and improvements in technology. Recently, the rapidly escalating costs of traditional fuels used for heating has accelerated the relocation of commercial greenhouses.

The greenhouse industry is experiencing substantial growth at present, although new entrants into the business are experiencing difficulties in becoming established. Most of this increased greenhouse capacity is due to the expansion of existing operations. The marked increase in greenhouse vegetable production from 1967 to 1971 had nearly leveled off by 1974. Increased competition from vegetable crops grown in warmer climates and shipped to greenhouse production areas is being encountered. These vegetables come from both foreign and domestic sources with domestic production decreasing and foreign imports increasing (Green, et al., 1977).

Climatic Conditions

Climatic factors which would affect the siting of a greenhouse complex include temperature, precipitation, sunlight and wind. The mean annual air temperature recorded at Animas is 60.4° F, while the monthly air temperatures range from a mean high of 79.4° F in July to a mean low of 41.3° F in January. There are an average of 187 days above 32° F yearly, with the average frost-free period lasting from April 24 to October 28.

Average annual precipitation in the Animas Valley is 10 inches (New Mexico Interstate Streams Commission, 1974). Precipitation occurs most frequently in the late summer months through early fall (United States Department of Commerce, 1978). The reduction in solar radiation due to cloud cover accompanying any precipitation would be minimal as the majority of precipitation is received during the light-intensive summer months.

Sunlight received in the Animas Valley has been estimated at slightly less than 12.03 hours per day on an annual basis. A high of 13.92 hours per day in June and a low of 10.08 hours per day in December is estimated. The sunlight measurement of most interest to greenhouse operators is average daily solar radiation, often expressed as Langleys. A Langley is equal to one gram-calorie per square centimeter or 3.687 BTU per square foot. In general it may be said that the more solar radiation received, the more favorable the growing conditions for greenhouse plants. The amounts of average daily radiation received for the two closest measurement points to the Animas Valley are among the highest in the United States (Table 4). Growing conditions are especially favorable in the winter months in comparison to other domestic greenhouse production areas.

Heating degree days, which are defined as the summation of the number of Farenheit degrees that the mean daily temperature is below 65° F, are used as an estimate of the energy required to heat a structure. As the number of heating degree days increases, more energy is

Table 4. Long term monthly averages of daily solar radiation (In Langleys*).

Month	El Paso	Silver City
January	337	389
February	436	471
March	549	559
April	659	698
May	718	744
June	727	727
July	671	634
August	631	588
September	562	509
October	463	488
November	360	353
December	306	313

*1 Langley = 3.687 btu per square foot.

Source: Adapted from Visher, S. S., Climatic Atlas of the United States, Cambridge, Harvard University Press, 1954.

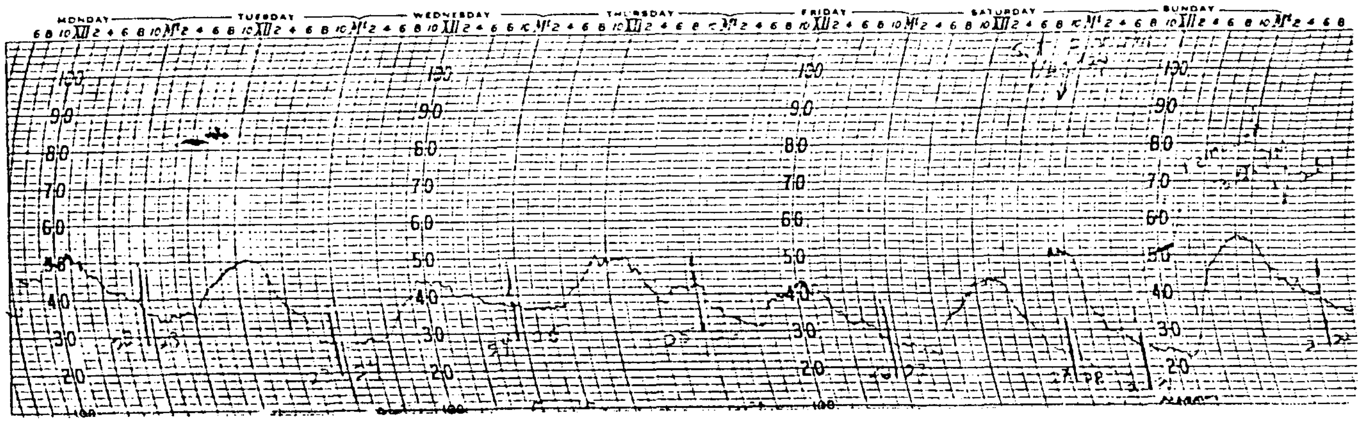
required to heat a structure. The nearest measurement station to the Animas Valley, located in Hachita (approximately 30 miles distant), records 364 average annual heating degree days (U. S. Department of Commerce, 1973). This represents one of the lowest values recorded in New Mexico, and is lower than many national values.

While wind is an important factor in the layout of a greenhouse complex, no information was found to be available for the area under consideration at the time this study was made.

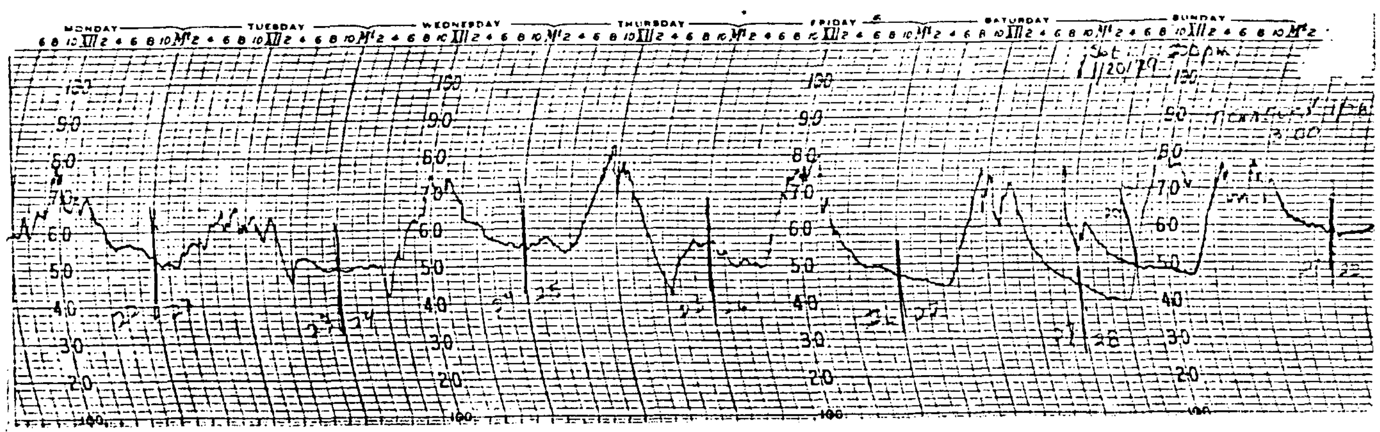
Greenhouse Monitoring -- 1978-79

A commercial, geothermally heated greenhouse near Cotton City, New Mexico, devoted to growing roses and bedding and potted plants, was monitored from December 22, 1978 until mid-May, 1979. Monitoring consisted of two data collection methods. The first method utilized a pair of hygrothermographs. One was placed in a weather enclosure about one hundred feet southwest of the greenhouse and the other was placed inside the greenhouse to monitor air temperatures at about the six foot level. These two hygrothermographs provide a continuous recording of temperature. Although the readings are not precise, they do give a good idea of what happened on a daily basis relative to the outside temperatures.

Sample hygrothermograph charts are shown in Figure 17. The upper recording shows the outside air temperature recorded during the period from January 20 through January 28, 1979. The average temperature was about 40° F during this period with exterior highs averaging 40° to 50° F and lows in the 20 to 30° F range. Interior temperatures, as shown in the lower reading, varied over a wider range than exterior



Outside Temperature



Inside Temperature

Figure 17. Sample Hygrothermograph charts, exterior and interior temperatures, January 20-28, 1979, Animas Valley, New Mexico.

temperatures because of solar heating during the day. Even in this late January period, interior temperatures frequently reached 80° F even though the outside highs were only about 50° F. Nighttime temperatures were considerably moderated inside the greenhouse, normally being about 20° F above exterior temperatures. In periods of extreme cold, the greenhouse system was able to hold temperature differences up to 30° F because of the temperature difference between the heating water and the air in the building.

The second method of collecting data for the Cotton City facility was the use of a 10 channel data logging system. This equipment is relatively expensive and more complex than hygrothermographs. The readings are more precise but the recording system was not as dependable. Data was obtained using this equipment from January 21 until March 11, 1979. Much useful data was obtained, but the record was not complete. Two interruptions occurred. In one case, a data system failed and had to be replaced. In the second case, several power failures interrupted the data logger and time of data recordings could not be established with certainty.

Temperatures recorded hourly by the data logger system included the temperature of hot water coming into the building, cold water exiting from the building and the temperature of air that was injected into the heating ducts to heat the building. A one week sample of data appears in Appendix A. Incoming water temperature (Figure 18) averaged about 200° F when the heating system was in operation. Outgoing water temperature averaged about 90° F and the heated air going down the ducts averaged only about 60° F. Considerably beter

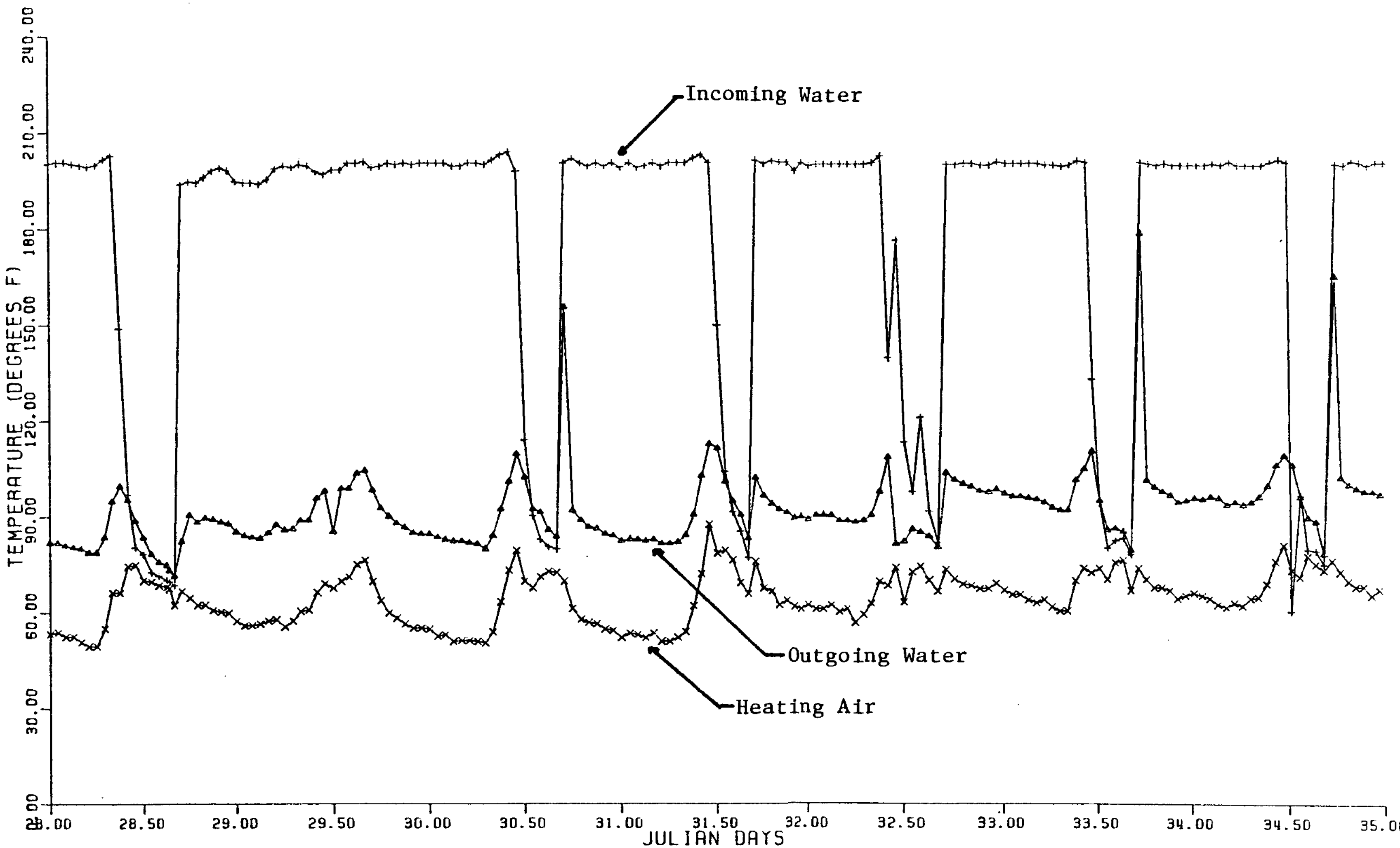


Figure 18. Sample data, incoming water, outgoing water, heated air, for geothermal greenhouse, Animas Valley, New Mexico.

heat transfer could be made using improved design and installation of the heating equipment.

A probe was used to record soil temperatures within the building on the soil surface and at a depth of one foot. A sample week of data appears in Figure 19. The average soil temperature was slightly in excess of 60° F at the one foot depth, but the temperature of the soil surface was quite dynamic, varying between about 40° and 65° F during the period of sampling. Two thermocouples were placed above and below a styrofoam block that was approximately one foot square and about one and a half inches thick, placed on the soil surface. The purpose of this test was to determine whether or not a heat flux existed between the soil and the air in the greenhouse. The temperature below the styrofoam very closely paralleled that at the one foot soil depth, except that it was about 3° F colder (Figure 20). This may show that a soil flux is apparent in moving heat up through the soil and into the greenhouse. However, it is a very minor contribution to the heating requirement. The temperature above the styrofoam block was comparable to the soil surface temperature.

Two thermocouples monitored greenhouse air temperature: one six feet (head height) and another three feet (approximately plant level) above the soil. A one-week sample of these temperatures appears as Figure 21. These data show that there was very little differences in the temperature at head level and that at plant level, demonstrating that adequate air mixing was taking place.

A sample log of temperatures relative to the greenhouse operation appears in Table 5. These temperatures consist of the outside low temperature, average inside air temperature, inside soil temperature

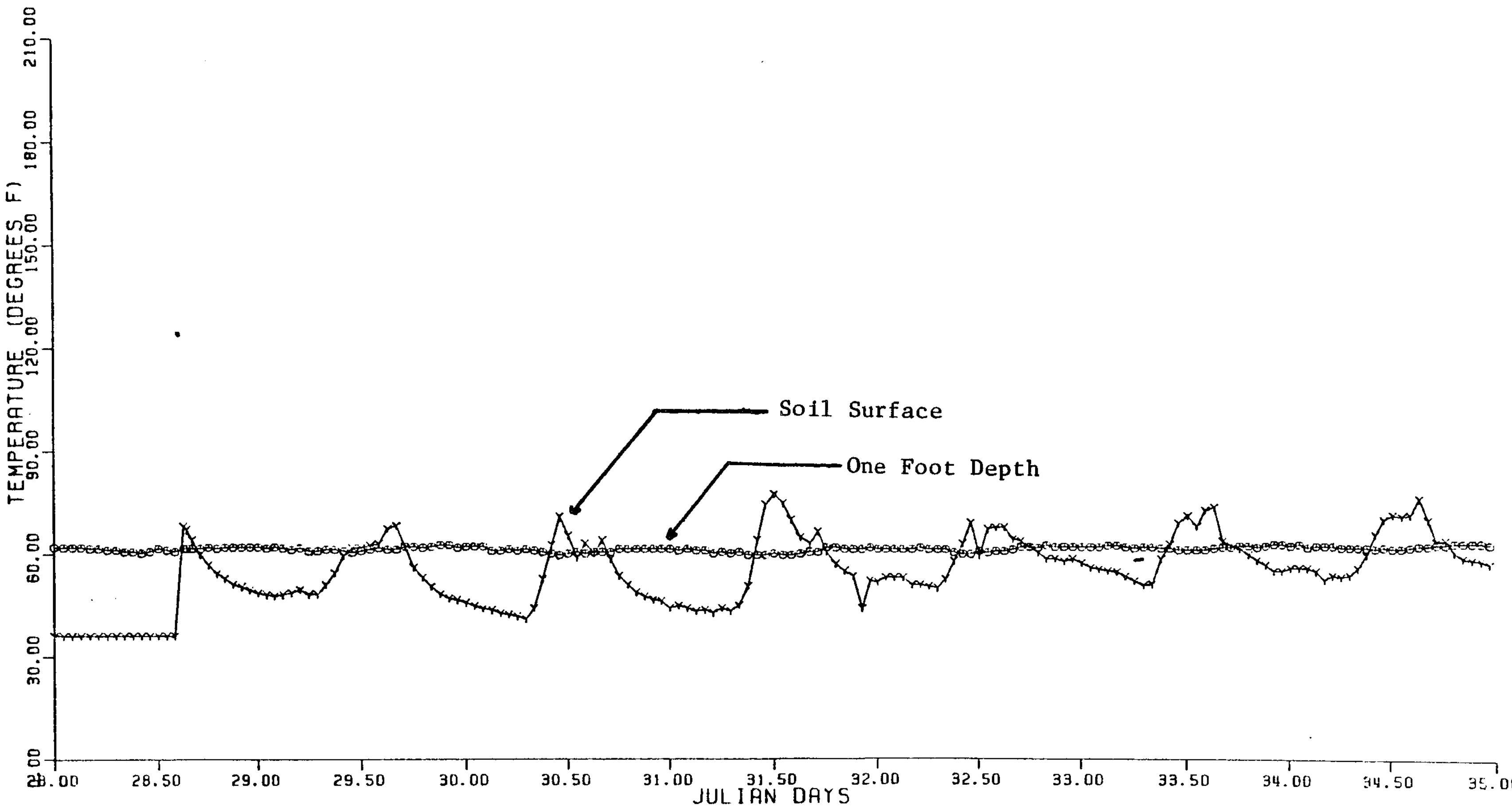


Figure 19. Sample interior soil temperature data, geothermal greenhouse, Animas Valley, New Mexico.

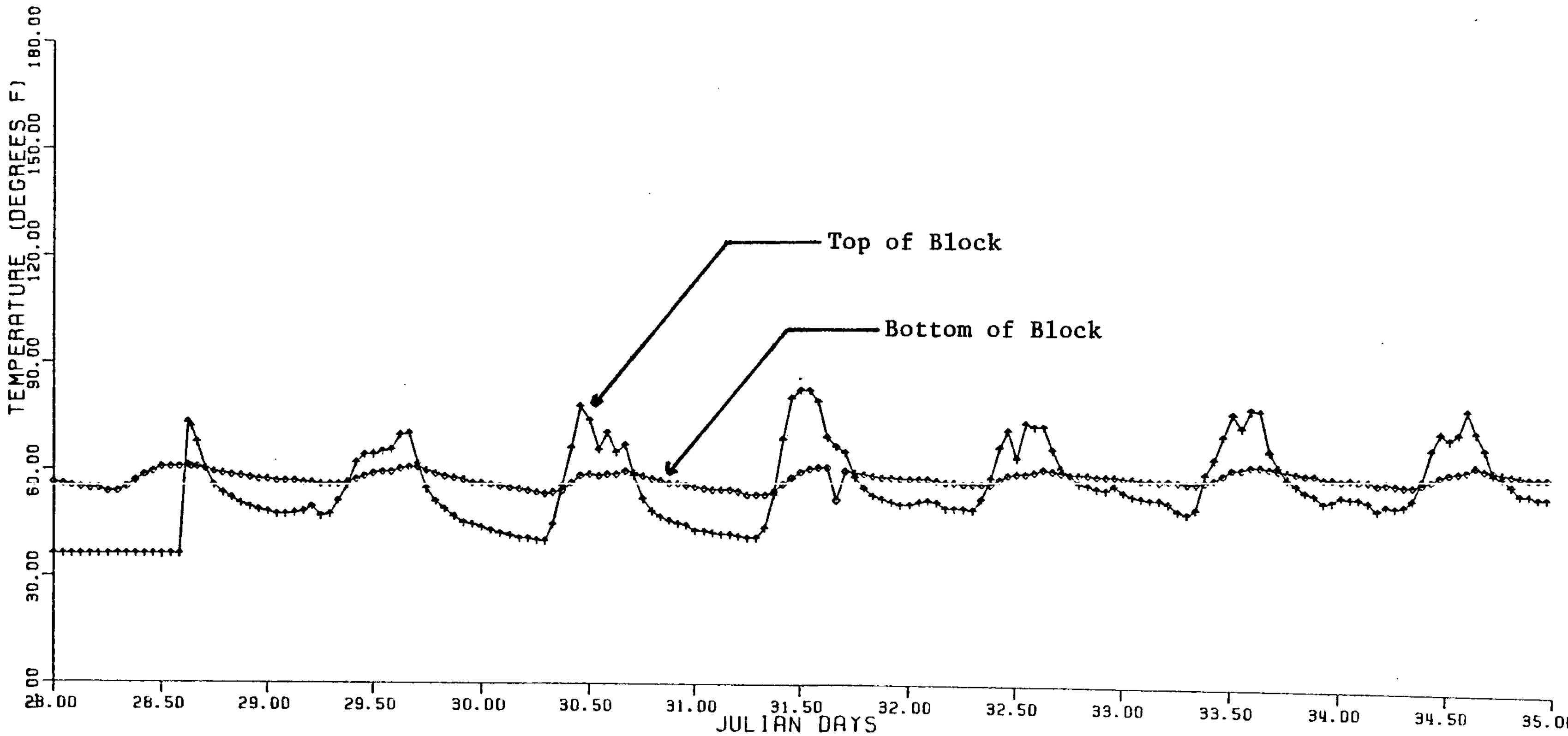


Figure 20. Sample interior soil temperature, geothermal greenhouse, Animas Valley, New Mexico.

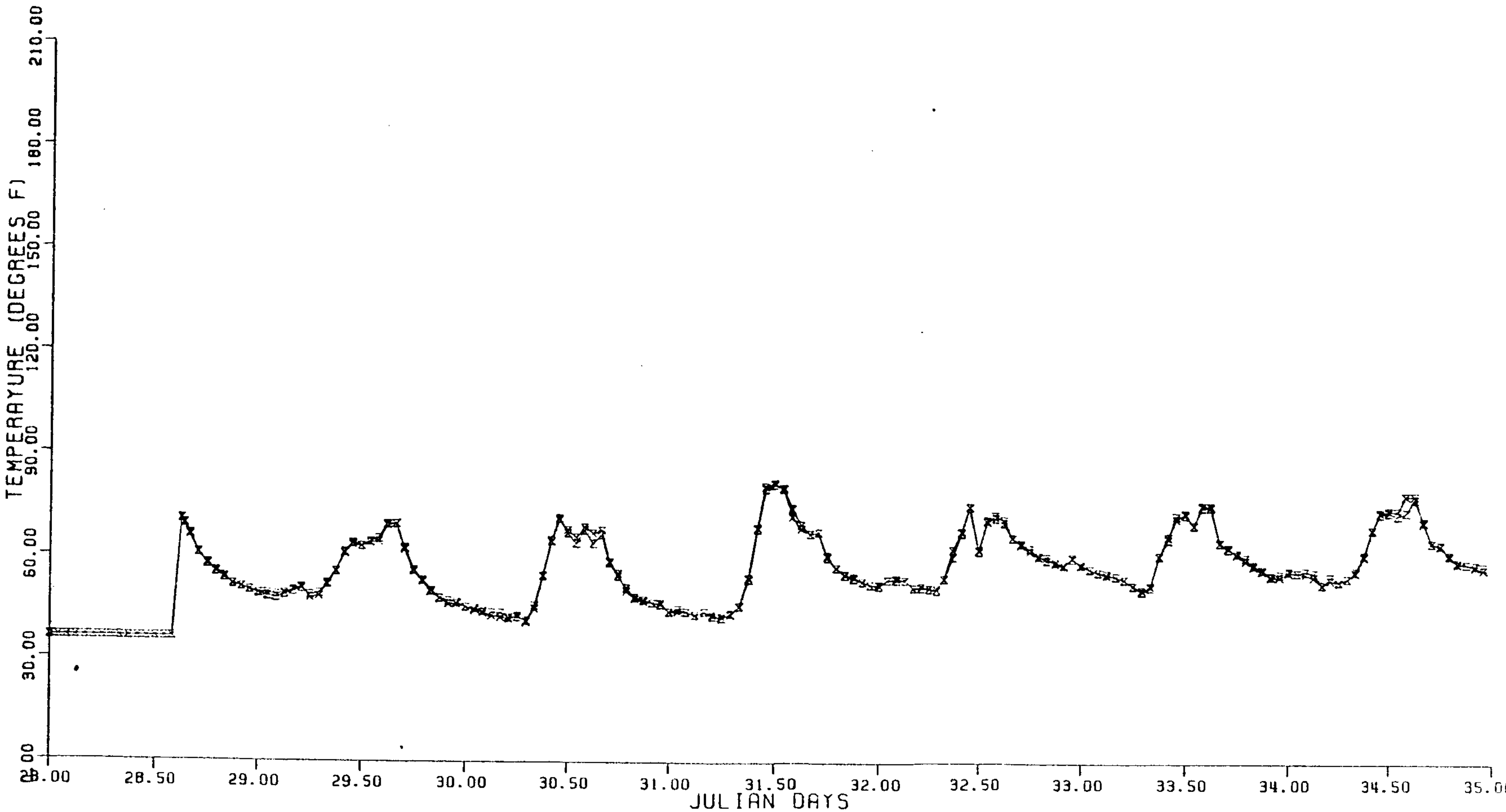


Figure 21. Sample interior temperature data, six foot and three foot level, geothermal greenhouse, Animas Valley, New Mexico.

Table 5. Weekly average temperatures, Cotton City Greenhouse, 1979 season.

Week	Outside Low	Inside Air	Inside Soil	Heating Air
		Temperatures (°F)		
21 - 28	30	50	60	65
28 - 35	22	50	60	60
35 - 42	27	60	62	75*
42 - 49	32	(Data System Failed)		
49 - 56	31	65	65	80
56 - 63	33	(Power Failure)		
63 - 70	30	62	70	80

*Geothermal system reconnected.

and heating air temperature. The inside low temperature was found to be somewhat lower than would be recommended for a production-type greenhouse. It was in the neighborhood of 50° F during mid-to-late January. The difference between the low inside and low outside was normally around 20° F but slightly higher in some instances. Data beyond Julian Day 40 indicate that temperatures inside the greenhouse were high enough for good production. Early in the collection period, most of the greenhouse space was being used for potted-plant production. The temperatures recorded in mid-winter may be somewhat low for that purpose. At the end of the data collection season, the greenhouse was being changed over to a cut-rose operation. Optimum temperatures for roses include 60° F at night and up to 85° F during the day. For temperatures below 60° F at night, growth is slow and yields are lower. Above 60 degrees, yields increase with increasing growth rate, but floral quality is often reduced, especially if grown in low light. Daytime temperatures above 85° F usually result in reduced photosynthesis and carbohydrates, necessary components for plant growth.

Growth of rose plants at the greenhouse was judged to be excellent. Plants were vigorous with large leaves and thick stems. Flower production was minimal, but those produced had long stems and large buds.

Winter and spring night temperatures were lower than optimum, soil temperatures were ideal, and air temperatures were on the upper side of optimum. While the lower night temperature would suggest less than satisfactory growth, observations show this was not the case. It is possible that a 60° F soil temperature during day and night and the optimum day temperature compensated for lower than optimum night regeneration.

Some gain in efficiency of heat use could be made through improved design of the heat exchange equipment. With such changes, the heating in this greenhouse system may be adequate. Without such changes, it was concluded that the heating system is only about one-half of the capacity needed for a production-type greenhouse.

Greenhouse Monitoring -- 1979-80

Monitoring was carried on in the geothermally-heated Cotton City greenhouse from October 30, 1979 to April 2, 1980. The principal temperature monitoring consisted of a hygrothermograph placed inside the building and another hygrothermograph placed in a weather enclosure outside the building. These two instruments gave an indication of the relative temperature inside the greenhouse as compared to the ambient air temperature outside the greenhouse. The hygrothermographs were operated (more or less) constantly. The hygrothermographs only run about nine days without service. There are some gaps in the record because visits to the site were not frequent enough due to limited funds.

The second monitoring system consisted of time-run meters installed on fans, and heating devices to determine the amount of electrical operating time for the various instruments. This was correlated with the meter reading to determine total power input in the form of electricity during the heating season.

The third method of temperature monitoring was by the installation of a 10-point data system that collected temperatures in the greenhouse during the period of January 22 through March 20, 1980. During this period, no severe weather was experienced; however, it was a fairly normal winter for Southern New Mexico. Only one time during the period was the heating system used continuously throughout a daylight period. Otherwise, the heating system only operated at night.

A set of observations were made on the plant growth response in the greenhouse. Data from the hygrothermograph charts indicate that the maximum inside temperature of the greenhouse was 92.0° F, while the minimum inside temperature was 44° F, and the average inside temperature was 66.2° F. The hygrothermograph data from the outside unit indicated a minimum temperature of 14° F, a maximum outside temperature of 76° F, and an average of 46.4° F. The average minimum temperature was 30° F higher inside the greenhouse than outside during the fall and spring heating seasons. During the coldest week of the winter, the heating system was able to hold a minimum temperature difference of 30° F above the outside temperature. Maximum temperatures were about 13° F higher inside than outside in the fall and spring. During the coldest week, maximum temperatures were 35° F higher inside than outside.

Timing devices monitored 32 vent fans and 12 heat-distribution systems. The 32 vent fans were each powered by a 1 hp electric motor. Eight of the fans were inoperative during the monitoring and four others were not used, leaving a total of 20 vent fans that were actually monitored over the test period. Each of the 12 heat-distribution systems consisted of two unit heaters and a jet fan. The unit heaters each used a 1/6 hp motor to blow ambient air through the radiator in the greenhouse interior. The heated air was then drawn by the 3/4 hp jet fan and into plastic ducts for distribution throughout the greenhouse.

The vent fans were controlled individually at each vent by a single switch. The heat distribution systems, however, were not controllable individually--rather, they were controlled in groups of three for a total of four switches to operate the entire 12 units.

Heating took place approximately 19 1/2 hours per day during the coldest ambient temperature and decreased to approximately 13 1/2 hours per day towards the end of the monitoring phase. It should be noted that the unit heaters and jet fans comprising the heat-distribution system were on approximately three hours longer than the heat circulation, which would indicate that those systems were used to mix the air in the greenhouse.

Hot water was pumped from the geothermal well by means of two 2 hp submersible pumps. These pumps were operated individually rather than simultaneously, and the averge operation per day amounted to approximately 16 hours. This resulted in a power consumption of 29.1 kwh/day. The operation of the unit and jet fan heat-distribution system resulted in an average daily power of 310.2 kwh and the operation of the vent fans resulted in daily power consumption of 32.9 kwh, or a total power consumption for the well pump, the vent fans, and the heat-distribution system of 372 kwh/day. The two commercial electric meters were monitored during this test, and indicated site power usage of 481 kwh/day. The 109 kwh/day difference is due to consumption by the residential trailers at the greenhouse site, and by other devices at the greenhouse such as a refrigeration unit, soft-drink cooler, electric tools, electric lights, and small pumps for irrigation and cooling water. Some savings in power consumption could be obtained by providing separate controls for the jet fans and the unit heater fans on each of the heat-distribution systems, and possibly further by individual control of the heat-distribution systems rather than the grouping control for three-unit blocks. The main advantage to individual control of the jet fans is the power saving by not using the unit heater fans when a purely air-circulating mode is desired to mix the air in the greenhouse. Furthermore, individual control of the jet fans could be used to provide changes in heat distribution in the greenhouse. The present system of air mixing, using all 12 jet fans and 24 unit-heater fans, consumes 29.1 kwh/day; individual control using every other jet fan (6) would consume 11.1 kwh/day, saving 18.1 kwh/day. The use of thermostats to control heating and cooling would result in labor savings, a more closely controlled temperature, and considerable energy savings.

An automatic scanning data system was used to record temperatures at 10 points in the greenhouse on hourly intervals during the monitoring period. These hourly observations were then plotted to show a diagram of the temperature changes in the greenhouse.

The temperature of water entering the greenhouse was slightly cooler than the previous year, about 190° F. However, temperature observations in the well have indicated that the temperature in the well was exactly the same as the previous year; therefore, any changes are due to instrumentation errors rather than temperature differences. Water exhausting from the greenhouse was about 90 to 120° F. The variation in outlet temperature was caused by the operation of different numbers of fans at different times. Graphs showed heating times used during the season at the beginning of the recording season in January. Average operational hours during the week were about 19 1/2 hours for the heating system. By the end of the recording season (the end of March) the heating time was down to about 13 1/2 hours per day.

Temperature measurements in the vicinity of the heating fans indicated that the average air temperature near the heating equipment during a typical night was about 60° F, which is approximately the operating temperature of the greenhouse. As air passed through the heating units, the temperature was raised to about 100° F. However, the temperature of air going down the ducts was only about 80° F. Design of the heating system leaves much to be desired in that much of the heat that is produced in the vicinity of the fans is not properly circulated through the greenhouse and is lost along the south well rather than being used to heat the interior of the greenhouse. These temperatures were consistent throughout the period of recording.

Soil temperature probes were installed at the one, two, and three foot depths inside the greenhouse, and, in the beginning, showed considerable reduction in temperatures near the surface. These reduced temperatures near the surface indicated that considerable heat was entering the greenhouse from the soil. However, this large difference only existed for about one week during the heating period and after that, temperatures were within about 5 degrees at the three depths. Considerable recording difficulties were experienced at this location due to damage to the thermocouples. It was difficult to keep thermocouples working properly in the environment of the soil since moisture from irrigation infiltrated the fittings and made the recordings somewhat tentative.

Longitudinal air temperature distribution in the greenhouse indicated about a 20° F difference between the middle of the greenhouse and the north one-third of the greenhouse. This temperature difference was not noticeable in the quality or growth of the plants; however, it might be a factor with more temperature sensitive crops than cut roses. The reason for the temperature differences is that north winds tend to be cold. The north wall has doors and cooling screens. Therefore, wind infiltration is quite high, but the heating units are placed against the south wall. This indicated that a reverse design would be highly desirable where the heating units were near the north wall and the end of the heating ducts then would be at the south wall which is the easiest portion of the greenhouse to heat.

These results indicated that considerably better designs are available for greenhouses than the design currently being used at Cotton City.

Two experiments were established in an attempt to evaluate the effect of floor heating plant growth in the geothermally heated greenhouse at Cotton City, one with poinsettias and another with Ponderosa pine seedlings. One inch thick rigid styrofoam insulation 2' x 8' boards were placed below poinsettia and pine seedlings. The poinsettia test was initiated October 10, 1979, when four inches of rigid insulation was placed between the pots and the soil. One inch of styrofoam was placed under the seedlings, and approximately five inches above the greenhouse soil, on January 28, 1980, after germination.

In both cases, plant heights were measured periodically and statistical differences between treatments were obtained by averaging plant data within a replicate (one 32 sq. ft. area), and comparing the insulted versus a non-insulated with a student t-test comparison.

The results of the poinsettia plant height are summarized in Table 6. While there was a trend for increased growth where the plants were growing above insulated boards, the results were not statistically significant. The leaf length (on November 21) and the overall diameter of the bract ring (on December 4) were larger for the plants growing above the insulated boards. However, neither difference was significant. Observations by the researchers and the greenhouse manager agreed that the bract development and red color pigment production proceeded more rapidly in plants that were growing over the insulated board. Results do not show significance partly because plants over the insulation were ready for sale first. These plants

Table 6. Effect of four inches of insulation between pots and soil surface on March 10, 1980, on growth of poinsettias in a geothermal heated greenhouse near Cotton City, N. M.

	Height Change (inches) During Time Indicated		Leaf Width	Bract Width
	21 days	17 days	(inches)	(inches)
Insulated	2.53	0.65	2.25	11.12
Non-insulated	2.44	0.75	2.17	9.28
Significant	NS*	NS	NS	NS

*Non-signicant at the 10% level.

were sold first which resulted in the removal of the plants in the insulated zone.

The results of the Ponderosa pine growth evaluations are summarized in Table 7. The initial size of plants at the beginning of the experiment on January 29 were not significantly different. Mean growth in all cases was greater where plants were growing above the insulated board. In two periods, differences were significant at 5 percent and 1 percent; and in the other data, the difference was significant as a probability less than 10 percent. The overall plant height of seedlings growing above the insulated board was taller and the difference was significant.

The results show that insulating plants from the floor results in a slightly accelerated plant growth response, particularly during the winter period. This result is rather modest, considering the problem that conventional greenhouse growers have had with cold soils and extremely slow growth when plants are placed on or near the soil. It is probable that there is a heat contribution from the soil (geothermal

Table 7. Effect of one inch insulating board under containers with Ponderosa Pine seedlings germaints, January 20 to March 26, 1980, in a geothermally heated greenhouse near Cotton City, New Mexico.

	Original Height	Height Change during Consecutive Growth Periods (Period Length in Days) 17	17	15	14	Final Height
	(inches)	-----inches of growth-----				(inches)
Insulation	1.95	2.81	0.82	1.34	1.09	7.69
Non-insulated	2.12	2.51	0.80	1.09	1.00	7.68
Significant	NS	*	NS	@	**	**

NS Not Significant
* Significant at 5% probability level.
@ Significant at 10% probability level.
** Significant at 1% probability level.

source) to the plants. The results of 1979-80 tests confirm that the soil temperatures in the rose growing area was remarkably uniform from day to night. This suggests a heat flow from the deep earth to the soil surface. More careful examination in 1980-81 would verify this heat gradient. While the heat contribution to the entire greenhouse area is undoubtedly modest, plants growing directly on the soil receive a substantial benefit. The results suggest that lower air temperatures, generally occurring in the cold winter period, are not as detrimental as one would predict.

Greenhouse Feasibility

Heating for the proposed complex would be provided by geothermal resources in the area. Existing cultural technology would be utilized in crop production. The crops to be produced, tomatoes and potted chrysanthemums, were selected as representative of common vegetable and ornamental greenhouse crops.

Greenhouse Size and Description

The size of the proposed greenhouse was determined by examining existing greenhouse operations in the western United States. La France (1979) compiled a list of the greenhouses in the state. The average size observed was 75,200 square feet with a range from 5,000 to 254,000 square feet. Many of the greenhouses were rather small, with only two operations over 200,000 square feet. Due to the remote location of the proposed facility, it is probable that a relatively large commercial greenhouse operation, whether it be tomatoes or potted plants, would be necessary to enter the market and compete with those operations already in existence. Therefore, a greenhouse of five acres in size (217,800 sq. ft.) was chosen as best representing a large commercial-sized operation.

The proposed greenhouse complexes would be located on 20 acre sites on or adjacent to the Lightning Dock KGRA in the Animas Valley. The land necessary for the plant under either production alternative was estimated to cost approximately $125,000. Preparation of the site was estimated to cost $25,000.

Facilities to be included in the complex would include four 1.25 acre (54,450 square feet) greenhouses, a 1,000 square foot office-storage building, and a loading dock.

The greenhouse units were assumed to be a steel pillar and truss construction with reinforced corrugated fiberglass roof and side walls. The ends were assumed to be flat, allowing for doors and ventilation equipment.

The roof was assumed to be of arched design with six arches across the width of each greenhouse unit. Cement walkways were assumed to be included in each greenhouse unit to ensure easy access to the growing crops. The greenhouses were estimated to cost $7.50 per square foot to construct. In addition to the basic construction cost, a six percent architectural fee was added to the building costs.

The office-storage building was assumed to be a pre-fabricated metal structure. Movable partitions would allow the interior to be allocated to the most appropriate use. The office building would be expected to serve a dual role, as part of it would be used for storage. The office building was estimated to cost $30 per square foot plus a six percent architectural fee. Heating and cooling of the office-storage building was assumed to utilize conventional energy sources.

Greenhouse Equipment

The fixtures included such permanent items as water storage tanks, water lines, heating, cooling, and air flow control systems, photo period control system, and a loading dock. These permanent fixtures which included a six percent architectural fee were estimated to cost $87,980.

Equipment necessary to the operation of the greenhouse included the individual plant water distribution system, plant tables for the potted plants, office equipment and irrigation water pumps. The irrigation system was assumed to be a drip system. The use of such a system would allow for ease of maintenance and flexibility of the type of crop to be grown. A storage capacity of approximately 10,000 gallons per acre was included to provide an adequate reservoir of water (Cotter and Gomez, 1979). Water is required not only for irrigation, but also as a carrying medium for the plant nutrients.

One three-quarter ton truck and one two-ton covered truck were assumed to be required. The light truck is expected to be used for local travel and light hauling jobs. The larger truck is to be used for transporting supplies and locally sold produce. Loading and unloading bulk supplies will be done by a fork lift.

One well drilled to a depth of 100 feet producing 500 gpm of 200° F water was assumed for geothermal heating purposes. The greenhouse would require 29,439,066 BTU per hour assuming an exterior temperature of -5° F; five hundred gallons per minute of hot water at 200° F would produce 29,880,000 BTU per hour, as would 600 gpm of 180° F hot water. It is possible to adequately heat greenhouses with many different flow and temperature combinations. A flow of 500 gpm of 200° F water would be more than adequate to heat the greenhouse facilities under most temperature conditions. After use, the water would be re-injected into the ground through the re-injection well system. In extreme temperature conditions, conventional electric heat sources built into the building would aid the geothermal system.

A separate cold water system is expected to be required for irrigation and other fresh water uses.

Electricity is expected to be used for lighting, pumping both fresh and geothermal water, and for emergency heating purposes. The electric costs were based on the following current commercial rates, including purchase power fuel adjustments, from the Columbus Electric Cooperative:

12.5 cents per kwh for the first 100 kwh per month

7.5 cents per kwh for the next 200 kwh per month

6.0 cents per kwh for the next 200 kwh per month

5.0 cents per kwh for the next 500 kwh per month

4.0 cents per kwh for the next 2,000 kwh per month

3.3 cents per kwh for each additional kwh per month

Financial Arrangements

The greenhouse was assumed to have a corporate business structure due to the large initial capital requirement. One half of the necessary investment cost was assumed to be obtained from the sale of stock, with the balance to be borrowed from lending institutions at 10% interest. The corporate structure allows for more flexibility in the raising of capital, i.e., a selected group of investors may raise the needed capital, or it may be raised through a public stock sale. Short term financing will be obtained as necessary from conventional lenders at 12% interest.

Marketing Greenhouse Products

Prospective markets are somewhat distant from the proposed greenhouse location; however, excellent access to transportation facilities should ensure market accessibility. Market prospects for both tomatoes and potted chrysanthemums should include El Paso, Albuquerque, Phoenix, Tucson, and markets to the east, such as Dallas.

The economics of greenhouse tomato production was assumed to be heavily dependent upon the prices received for the product. In the past, substantial consumer resistance has been encountered at the retail level when tomato prices have reached or exceeded approximately 60 cents per pound. At that point, consumers apparently switch their produce consumption pattern away from tomatoes to other fresh fruit and vegetable products.

Greenhouse production of tomatoes is basically a viable enterprise only during the winter and spring seasons. During the winter season, the principal competition with greenhouse tomato production in the southwestern United States is the importation of field grown tomatoes from Mexico through the Nogales port of entry. The potential location of greenhouse tomato production near Lordsburg, New Mexico would most likely not be considered by buyers as coming from a point of origin substantially different than Nogales. The principal competitive difference between the two sources of production would be that of field-grown tomatoes versus greenhouse grown tomatoes. It appears that it would be extremely difficult for greenhouse produced tomatoes to compete with the imported field grown tomatoes from Mexico on a price basis. However, the greenhouse produced tomatoes could possibly compete with the imported tomatoes on a quality basis. The potential for increased tomato production from Mexico certainly exists. Therefore, production of greenhouse tomatoes from near Lordsburg, New Mexico is not expected to fulfill a major market deficiency, but could provide an alternative source for high quality tomatoes for a limited market, which is the primary purpose of producing greenhouse tomatoes.

Greenhouse production of potted green plants is a very competitive business. There has been a substantial increase in greenhouse production capacity, which serves to function as a barrier to entry to new firms into the potted plant business. An existing producer of potted plants, who now has a substantial market share and is interested in expanding his business even further, would be one of the most likely candidates to be attracted to the Lordsburg area. A new market entrant would find entry into this business exceedingly difficult without first having an existing market share, reputation, or appropriate market contracts. Existing producers of greenhouse potted plants hold much of their market share through contractural or "gentlemen's business" agreements. New market entrants are left with picking up the less profitable market fringe areas and with attempting to enter into the occasional "fire sales" of products that are common for this industry.

Greenhouse Tomato Production and Feasibility

Tomatoes were assumed to be grown at floor level in a soil-free medium such as builder's sand, gravel, or volcanic scoria. A soil-free medium, though often expensive, is much easier to manage than a conventional soil medium.

Two crops of tomatoes were assumed to be produced annually. Plantings at the rate of 10,000 plants per acre, would take place in January and August. The first harvest was assumed to be from mid-April to mid-June and the second harvest in November and December. The projected yield per plant space per year in a well managed tomato operation has been estimated to be 29 pounds (Cotter and Gomez, 1979). The total yield, then, would be approximately 145 tons per acre per year. Approximately three truck loads of tomatoes would be shipped weekly during the harvest season. Tomatoes were assumed to be sold f.o.b. the greenhouse.

Investment Requirements

The total investment cost for the greenhouse tomatoes was estimated to be $2.5 million (Table 8). Buildings represent about 71 percent ($1.76 million) of the total investment costs, land and site preparation about six percent, wells about seven percent, fixtures four percent and equipment less than two percent of the total investment (Table 8). In addition, a 10 percent contingency fee was added to the investment cost.

The estimated $2.5 million investment was assumed to be financed by owner investment of $1.2 million and a 30 year loan of $1.2 million. The estimated beginning cash needs of $70,000 to start business operations was assumed to be a short-term operating loan (Appendix Table A-1).

Operating Expenses

Operating expenses were grouped into the following categories: administrative expense, labor expense, office expense, fixed costs, materials and supplies and utilities.

Administrative expense, labor expense and office expense were estimated to be $186,900 (Table 9). The total administrative salary expenses were $44,500 (24% of the total expenses). Included in this category were the salary of the general manager, a wage differential of $12,000 paid to four hourly employees classified as greenhouse supervisors, and the salary of a part-time secretary. Labor expenses were $93,400 (50% of the total expenses), which included eleven full-time workers and part-time workers as needed during harvest. The wage rate paid was assumed to be $3.50 per hour. Eleven full time labor

Table 8. Geothermal greenhouse total investment, tomato production, Animas Valley, New Mexico, 1979

Item	Life Expectancy	Salvage Value	Cost	Cost
	Years	Percent	Dollars	Dollars
Site				
Land			$ 125,000	
Site preparation			25,000	
SUBTOTAL				$ 150,000
Buildings				
Greenhouses: 4 @ 54,450 sq. ft. each, 217,800 sq. ft. @ $7.50/sq. ft. Includes: steel pillar & truss construction, reinforced fiberglass roof panels, concrete walkways. Office: 1000 sq. ft. @ $30.00 sq. ft.	20	20		$1,763,310[a]
Fixtures				
Storage tank and external distribution lines, exhaust fans and wet pads, heating equipment, fan jet & louvers, photo period control system and loading dock	10	20		$ 87,380[a]
Equipment				
Irrigation well pump	20	20	$ 2,800	
Miscellaneous implements	10	15	5,500	
Office equipment	5	20	4,000	
Individual plant irrigation facilities	5	0	30,000	
SUBTOTAL EQUIPMENT				$ 42,300
Vehicles				
Trucks:				
2 ton covered	5	30	$ 12,000	
3/4 ton pickup	5	40	6,400	
Forklift	10	20	16,000	
SUBTOTAL VEHICLES				$ 34,400
Wells				
Geothermal wells	20	20	$ 30,000	
Reinjection well	40	15	150,000	
Cold water well	20	20	5,000	
SUBTOTAL WELLS				$ 185,000
TOTAL INVESTMENT				$2,262,990
Contingency				$ 226,299
TOTAL COST				$2,489,289

[a] Includes a six percent architecture fee on the estimated cost.

Table 9. Estimated wages, salaries, and office expenses, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Item	Cost	
Administrative Expense		
General Manager Salary	$30,000	
Greenhouse Supervisors	12,000	
Secretary (part-time)	2,500	
SUBTOTAL		$ 44,500
Labor Expense		
Greenhouse Workers	$71,300	
Greenhouse Workers (part-time)	22,100	
SUBTOTAL		$ 93,400
Office Expense		
Administrative Travel	$12,000	
Telephone	12,000	
Office Supplies	10,000	
Computer Services	6,000	
Dues, Subscriptions, Public Relations	4,000	
Rental and Depreciation of Office Equipment	5,000	
SUBTOTAL		$ 49,000
TOTAL		$186,900

equivalents based on a 167 hour average work-month were needed along with seasonal part-time help (Table 10). The 167 hour (21 day) work-month includes an allowance for time off and sick leave. The month of July was assumed to be used for major maintenance of the greenhouse facility and for vacations for the employees. Total office expenses were estimated to be $49,000 or 26 percent of the total expense. Major items included were travel expense, telephone expense and office supplies (Table 9).

Annual fixed operating expenses associated with the fixed investment included depreciation, insurance expense, property taxes and maintenance expenses. Depreciation on an annual basis for the greenhouse enterprise was $103,495 (Appendix Table A-2). Depreciation was calculated on a straight line basis, given the data presented in Table 8. Annual average insurance expense was estimated to be $13,978 (Appendix Table A-3). Average annual property taxes were estimated to be $12,919 (Appendix Table A-4). Estimated annual maintenance costs were assumed to be 2.5 percent for buildings and 10 percent for fixtures, equipment, vehicles and wells, which totaled $86,159 (Appendix Table A-5).

Materials and expendable supplies necessary for the production of two tomato crops were estimated to be $66,100 annually (Table 11). Cartons and packages accounted for about 60 percent of the materials cost; fumigants and equipment, fertilizer, and pesticides accounted for an additional 18 percent, fuel, seven percent, and tomato plants only four percent.

The total plant utility bill, which included only electricity, was estimated to be $18,000 annually.

Table 10. Estimated labor requirements by months and operation, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Operation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	man hours												
Bed preparation	50	--	--	--	--	--	50	--	--	--	--	--	100
Growing medium sterlization	100	--	--	--	--	--	100	--	--	--	--	--	200
Planting	230	--	--	--	--	--	--	230	--	--	--	--	460
Prepare and hang support strings	650	--	--	--	--	--	--	650	--	--	--	--	1300
Prune and train (once weekly, 20 weeks)	615	1230	1230	615	--	--	--	1230	1230	1230	--	--	7380
Pollinate, vibrator (3 times weekly, 16 weeks)	--	530	530	265	--	--	--	265	530	530	--	--	2650
Fertilizer and irrigation	8	16	16	16	16	8	--	16	16	16	16	16	160
Pest control	15	30	30	30	30	15	--	30	30	30	30	30	300
Harvest (grade and pack)	--	--	--	1694	3388	1694	--	--	--	--	3388	3388	13552
Postharvest plant removal	115	--	--	--	--	115	--	--	--	--	--	--	230
Equipment repair	6	6	6	8	10	6	5	7	6	6	10	10	86
Miscellaneous	18	18	18	26	34	18	15	24	18	18	34	34	275
MONTHLY TOTAL	1807	1830	1830	2654	3478	1856	170	2452	1830	1830	3478	3478	26693
Number of workers required[a]													
Full time	11	11	11	11	11	11	1	11	11	11	11	11	
Part time	--	--	--	5	10	--	--	4	--	--	10	10	

[a] Based on 167 hours per month.

Table 11. Estimated materials and expendable supplies, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Item	Cost
Fumigant and equipment	$ 4,500
Tomato plants	2,500
Twine	900
Water	1,400
Fertilizer	6,800
Pesticides	900
Cartons and packages	39,900
Implements, miscellaneous	4,500
Equipment allowance	200
Fuel	4,500
TOTAL	$66,100

Interest Expense

The total interest paid annually was estimated to be $117,094; this included $15,341 of interest on short term loans and $101,753 of interest on long term loans (Table 12).

Sales and Revenues

Returns to the tomato greenhouse operation would be comprised of revenues from the sales of tomatoes during the two harvest periods (winter and spring). During the winter months of November and December, 725,000 pounds of tomatoes would be sold, and during the spring months of April, May, and June, an additional 725,000 pounds of tomatoes would be sold. Tomatoes were assumed to be sold at an average price of $0.40 per pound. The annual gross sales were expected to be $580,000 (Exhibit 1).

Profitability

From the annual adjusted gross income of $539,980, cash expenses of $404,741 were subtracted, leaving $135,239 for depreciation, interest expenses and profit. Depreciation was estimated to be $103,495 annually, yielding a gross profit of $31,744 (Exhibit 1). Annual interest expenses were estimated to be $117,094, leaving a net profit before taxes of a negative $85,350. A tax credit of $34,140 reduced the actual loss to $51,210 annually.

Harvest was assumed to cover a total of four months, creating a seasonal cash flow. Cash receipts were assumed to lag behind shipments by approximately one week. Exhibit 2 presents a cash flow for tomatoes where a minimum cash balance of $25,000 was maintained. Short term loans during the year totaled $325,000, of which $261,439 would be

Table 12. Annual principle and interest repayment schedule, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

	Interest	Principle	Total
Short Term Loan	$ 15,341	$261,439	$276,780
Long Term Loan	$101,753	$ 29,319	$131,072
TOTAL	$117,094	$290,758	$407,852

Exhibit 1. Pro forma income statement for an average year of operation, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Sales		$580,000
Bad Debt Loss (2% of Sales)	$ 11,600	
Brokerage Fees (5% of Sales Less Bad Debt Loss)	28,420	
Total Deductions		$ 40,020
Adjusted Gross Income		$539,980
Operating Expenses		
Materials and Expendable Supplies	$ 66,100	
Labor	93,400	
Fringe Benefits	14,010	
Administrative Salaries	44,500	
Fringe Benefits	6,675	
Office Expense	49,000	
Insurance	13,978	
Property Taxes	12,919	
Repairs and Maintenance	86,159	
Utilities	18,000	
Total Cash Expenses	$404,741	
Depreciation	103,495	
Total Cost of Goods Sold		$508,236
Gross Profit		$ 31,744
Interest Expense		$117,094
Net Profit Before Tax		($ 85,350)
Income Tax (40% rate)		$ 0[a]
Net Profit After Tax		($ 85,350)

[a] Tax credit of $34,140 due to negative profit.

EXHIBIT 2. Pro forma cash flow for an average year, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

	Start-Up	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	dollars												
Cash Inflow													
Beginning Cash	1,244,644	70,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Cash Sales					33,749	101,246	67,498					101,246	101,246
Payment on Accounts Receivable						33,749	33,749						33,749
Loans	1,314,645		40,000	40,000	15,000			36,000	43,000	40,000	41,000		
TOTAL	2,559,289	70,000	65,000	65,000	73,749	159,995	126,247	61,000	68,000	65,000	66,000	126,246	159,995
Cash Outflow													
Facilities & Equipment	2,489,289												
Materials & Expendable Supplies		5,252	1,784	1,784	6,739	10,703	6,243	4,856	1,784	1,784	1,784	11,694	11,694
Labor		7,273	7,366	7,366	10,682	13,999	7,470	684	9,869	7,366	7,366	13,999	13,999
Administrative Salaries		4,265	--	--	--	--	--	--	--	--	--	--	--
Insurance		1,165	--	--	--	--	--	--	--	--	--	--	--
Property Tax												6,460	
Repairs & Maintenance		7,180	--	--	--	--	--	--	--	--	--	--	--
Office Expense		4,083	--	--	--	--	--	--	--	--	--	--	--
Utilities		1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Short Term Loan Payments		3,359	1,734	1,734	2,212	81,117	58,418	1,344	2,231	1,734	2,734	39,977	80,186
Long Term Loan Payments		10,923	--	--	--	--	--	--	--	--	--	--	--
Tax													0[a]
TOTAL	2,489,289	45,000	40,000	40,000	48,749	134,995	101,247	36,000	43,000	40,000	41,000	101,246	134,995
ENDING CASH BALANCE	70,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000

[a] A tax credit is reflected in the Income Statement (Exhibit 1).

repaid by the end of the year. A short term loan repayment schedule is included in Appendix Table A-6.

A beginning balance sheet for tomatoes is presented as Exhibit 3. Owner equity of $1.2 million is equal to long term borrowings. Upon examination of the year end balance sheet (Exhibit 4), it indicates that owner equity decreased by $85,350 to $1.16 million, which was the amount of the annual net loss. The almost constant amount of the current liabilities category in the balance sheet ($70,021) reflects cash flow problems just as the decreased equity indicates low profitability.

The rate of return on total assets for tomatoes was about 1.3 percent, while the rate of return on equity was a negative 7.4 percent (Exhibit 5). These ratios indicated the poor financial strength of this proposed operation. The current ratio of .83 in Exhibit 5 indicated an insolvent short-term financial position. When comparing the return on assets from tomato production with the returns expected from alternative investment opportunities, the 1.3 percent return realized is relatively low. Large corporations typically expect returns of over 20 percent, while public utilities expect returns of from 16 to 18 percent. In addition, a yield of from 8 to 10 percent may be obtained by investing in tax-free municipal bonds.

In summary, it may be said that the growing of greenhouse tomatoes, subject to the assumptions and limitations presented, would result in losses for the owners. Changes in factors such as price of tomatoes, technological advances resulting in increased productivity, or decreased production costs may result in more favorable results. It is not highly probable that such changes will occur in the immediate future.

Exhibit 3. Beginning balance sheet, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Current Assets		
Cash		$ 70,000
Fixed Assets		
Land	$ 150,000	
Buildings	1,970,279	
Fixtures	98,307	
Equipment	47,265	
Vehicles	38,438	
Wells	185,000	
TOTAL FIXED ASSETS		$2,489,289
TOTAL ASSETS		$2,559,289
Current Liabilities		
Short Term Loan		$ 70,000
Fixed Liabilities		
Long Term Loan		$1,244,645
TOTAL LIABILITIES		$1,314,645
Owner's Equity		$1,244,644
TOTAL LIABILITIES & OWNER'S EQUITY		$2,559,289

Exhibit 4. Pro forma balance sheet, December 31 of an average year, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Current Assets			
Cash	$ 25,000		
Accounts Receivable	33,749		
Total Current Assets		$ 58,749	
Fixed Assets			
Land	$ 150,000		
Buildings	1,891,463		
Fixtures	90,442		
Equipment	39,199		
Vehicles	34,273		
Wells	180,412		
Total Fixed Assets		$2,385,794	
TOTAL ASSETS			$2,444,543
Current Liabilities			
Short Term Loan	$ 63,561		
Accrued Property Taxes	6,460		
Total Current Liabilities		$ 70,021	
Fixed Liabilities			
Long Term Loan		$1,215,326	
TOTAL LIABILITIES		$1,285,347	
Owner's Equity			
Owner Equity	$1,244,644		
Retained Earnings	(85,350)		
Total Owner's Equity		$1,159,294	
TOTAL LIABILITIES & OWNER EQUITY			$2,444,641[a]

[a] Difference due to rounding error.

Exhibit 5. Return to assets and equity, December 31 of an average year, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Return to Assets

Net Income		($ 85,350)
Interest Expense		117,094
Net Profit Before Interest Expense		$ 31,774
Assets		
Beginning of Year		$2,559,289
End of Year		2,444,543
Average Investment		$2,501,916
Return on Total Assets	=	$\frac{\$\ 31{,}774}{2{,}501{,}916}$
	=	1.27%

Return to Equity

Net Income		($ 85,350)
Beginning Owner Equity		1,244.644
Ending Owner Equity		1,159,294
Average Owner Equity		1,201,969
Return on Equity	=	$\frac{(\$\ 85{,}350)}{1{,}201{,}969}$
	=	-7.1%
Current Ratio = $\frac{\text{Current Assets}}{\text{Current Liabilities}}$	=	$\frac{\$\ 58{,}749}{70{,}021}$
	=	.83

Greenhouse Potted Chrysanthemum Production and Feasibility

Potted chrysanthemums would be grown on plant tables in six inch pots containing a soil-free medium. Production was estimated to be one million potted plants per year or approximately 83,000 pots per month. Chrysanthemums were assumed to be in an equal rotation with the same amount harvested and started each month. Under the above assumption, approximately one truck per day would be shipped throughout the year. The plants would be shipped f.o.b. the greenhouse.

Investment Requirements

The total investment cost for the potted chrysanthemums, including a 10 percent contingency factor, was estimated to be $2.67 million (Table 13). Buildings represented about 66 percent ($1.76 million) of the total investment costs, equipment almost eight percent, land and site preparation about six percent, wells about seven percent, and fixtures less than three percent of the total investment (Table 13).

The estimated $2.67 million investment necessary to produce potted chrysanthemums was assumed to be financed by owner investment of $1.36 million and a 30-year loan of $1.36 million. A short term operating loan furnished the $70,000 cash estimated to be necessary to begin production (Appendix Table A-7).

Operating Expenses

Operating expenses for chrysanthemums were grouped into the same categories as for tomatoes: administrative expense, labor expense, office expense, fixed costs, materials and supplies and utilities.

Table 13. Geothermal greenhouse total investment, potted chrysanthemum production, Animas Valley, New Mexico, 1979

Item	Life Expectancy Years	Salvage Value Percent	Cost Dollars	Cost Dollars
Site				
Land			$ 125,000	
Site preparation			25,000	
SUBTOTAL				$ 150,000
Buildings				
Greenhouses: 4 @ 54,450 sq. ft. each, 217,800 sq. ft. @ $7.50/sq. ft. Includes: steel pillar & truss construction, reinforced fiberglass roof panels, concrete walkways. Office: 1000 sq. ft. @ $30.00 sq. ft.	20	20		$1,763,310[a]
Fixtures				
Storage tank and external distribution lines, exhaust fans and wet pads, heating equipment, fan jet & louvers and photo period control system, loading dock	10	20		$ 87,980[a]
Equipment				
Irrigation well pump	20	20	$ 2,800	
Miscellaneous implements	10	15	5,500	
Office equipment	5	20	4,000	
Plant tables, individual plant irrigation facilities & manifolds (PVC)	5	0	195,000	
SUBTOTAL EQUIPMENT				$ 207,300
Vehicles				
Trucks:				
2 ton covered	5	30	$ 12,000	
3/4 ton pickup	5	40	6,400	
Forklift	10	20	16,000	
SUBTOTAL VEHICLES				$ 34,400
Wells				
Geothermal wells	20	20	$ 30,000	
Reinjection well	40	15	150,000	
Cold water well	20	20	5,000	
SUBTOTAL WELLS				$ 185,000
TOTAL INVESTMENT				$2,427,799
Contingency				$ 242,799
TOTAL COST				$2,670,789

[a] Includes a six percent architecture fee on the estimated cost.

Administrative expenses, labor expenses and office expenses were estimated to be $758,000 (Table 14). Administrative salaries of $102,600 (14% of total expenses) included salaries of the general manager, shipping supervisor, secretaries and bookkeepers, and a wage differential paid to four hourly workers classified as growers (Table 14). Labor expenses totaled $575,200 (75% of total expenses), which included 82 full-time workers paid $3.50 per hour (Table 14). Because of the equal crop rotation, the same number of employees were required each month on a yearly basis. The 167 hour work month included an allowance for vacations and sick leave (Table 15). Total office expenses were estimated to be $81,000 (11% of total expenses). Major items included were travel expenses, telephone expenses, office supply expenses and computer expenses (Table 14).

Annual operating costs associated with the fixed investment included depreciation, insurance expense, property taxes and maintenance expenses. Depreciation on an annual basis for the greenhouse operation was $140,079 (Appendix Table A-8). Depreciation was calculated on a straight line basis from the data presented in Table 13. Annual average insurance expense was estimated to be $14,886 (Appendix Table A-9). Average annual property taxes were estimated to be $13,758 (Appendix Table A-10). Annual maintenance cost was assumed to be 2.5 percent for buildings and 10 percent for fixtures, vehicles, equipment, and wells, which totaled $104,490 (Appendix Table A-11).

Materials and expendable supplies required annually for the production of potted chrysanthemums were estimated to be $620,000 (Table 16). Plant cuttings accounted for about 73 percent of the

Table 14. Estimated wages, salaries, and office expenses, geothermal greenhouse, potted chrysanthemum production, Animas Valley, New Mexico, 1979

Item	Cost	
Administrative Expense		
General Manager	$ 32,000	
Growers	32,000	
Shipping Supervisor	10,000	
Secretaries & Bookkeeper	16,600	
Maintenance Supervisor	12,000	
SUBTOTAL		$102,600
Labor Expense		
Greenhouse Workers	$575,200	
SUBTOTAL		$575,200
Office Expense		
Administrative Travel	$ 12,000	
Telephone	30,000	
Office Supplies	15,000	
Computer Services	15,000	
Dues, Subscriptions, Public Relations	4,000	
Rental and Depreciation of Office Equipment	5,000	
SUBTOTAL		$ 81,000
TOTAL		$758,800

Table 15. Estimated labor requirements by month and operation, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Operation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	man hours												
Medium preparation	267	267	267	267	267	267	267	267	267	267	267	267	3,204
Potting	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	2,695	32,340
Moving pots	457	457	457	457	457	457	457	457	457	457	457	457	5,484
Watering	333	333	333	333	333	333	333	333	333	333	333	333	3,996
Fertilizer	41	41	41	41	41	41	41	41	41	41	41	41	492
Spraying	241	241	241	241	241	241	241	241	241	241	241	241	2,892
Pinching and disbudding	8,067	8,067	8,067	8,067	8,067	8,067	8,067	8,067	8,067	8,067	8,067	8,067	96,804
Photo period control	294	294	294	294	294	294	294	294	294	294	294	294	3,528
Manual watering	667	667	667	667	667	667	667	667	667	667	667	667	8,004
Special fertilizing	77	77	77	77	77	77	77	77	77	77	77	77	924
Equipment repair	251	251	251	251	251	251	251	251	251	251	251	251	3,012
Miscellaneous	304	304	304	304	304	304	304	304	304	304	304	304	3,648
MONTHLY TOTAL	13,694	13,694	13,694	13,694	13,694	13,694	13,694	13,694	13,694	13,694	13,694	13,694	164,328
Number of full time[a] workers required	82	82	82	82	82	82	82	82	82	82	82	82	

[a] Based on 167 man hours per month.

total; pots and packing materials comprised 15 percent; and all other items accounted for the remaining five percent.

The total plant utility bill, which includes only electricity, was estimated to be $18,000 per year.

Interest Expense

Total annual interest paid for all loans was expected to be $110,432. Only $1,261 of interest would be paid on short term loans as opposed to $109,171 for long term loans (Table 17).

Sales and Revenues

Returns to the potted chrysanthemums operation would be composed of revenues from the sale of potted plants throughout the year. Annual sales would consist of one million potted plants at an estimated price of $2.20 each or $2.2 million (Exhibit 6). Bad debt losses and brokerage fees were expected to account for $151,800, thereby leaving an adjusted gross income of $2.0 million (Exhibit 6).

Profitability

From the annual adjusted gross income of $2.0 million annual cash expenses of $1.6 million were subtracted, leaving $416,196 for depreciation interest expenses and profit. Depreciation was estimated to be $140,079 annually, leaving a gross profit of $276,117 (Exhibit 6). Annual interest expenses were estimated to be $110,432, leaving a net profit before taxes of $165,685. Taxes were estimated to be $66,274, leaving an annual net profit after tax of $99,411 (Exhibit 6). Production was assumed to be equal throughout the year, creating a stable level of cash receipts and disbursements. Collections were assumed to

Table 16. Estimated materials and expendable supplies, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Item	Cost
Potting medium	$ 45,000
Pots and packing materials	90,000
Cuttings	450,000
Water	5,400
Fertilizer	14,400
Chemicals	4,500
Implements, miscellaneous	4,500
Equipment repair	2,100
Fuel	4,500
TOTAL	$620,400

Table 17. Annual principle and interest repayment schedule, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

	Interest	Principle	Total
Short Term Loan	$ 1,261	$50,000	$ 51,261
Long Term Loan	$109,171	$31,456	$140,627
TOTAL	$110,432	$81,456	$191,888

Exhibit 6. Pro forma income statement for an average year of operation, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Sales		$2,200,000
Bad Debt Loss (2% of Sales)	$ 44,000	
Brokerage Fees (5% of Sales Less Bad Debt Loss)	107,800	
Total Deductions		$ 151,800
Adjusted Gross Income		$2,048,200
Operating Expenses		
Materials and Expendable Supplies	$ 620,400	
Labor	575,200	
Fringe Benefits	86,280	
Administrative Salaries	102,600	
Fringe Benefits	15,390	
Office Expense	81,000	
Insurance	14,886	
Property Taxes	13,758	
Repairs and Maintenance	104,490	
Utilities	18,000	
Total Cash Expenses	$1,632,004	
Depreciation	140,079	
Total Cost of Goods Sold		$1,772,083
Gross Profit		$ 276,117
Interest Expense		$ 110,432
Net Profit Before Tax		$ 165,685
Income Tax Liability (40% rate)		$ 66,274
Net Profit After Tax		$ 99,411

be made on a weekly basis with a lag time of seven days. A minimum cash balance of $30,000 per month was met, with substantial amounts of cash accumulated in the latter part of the year (Exhibit 7). It was estimated that a short term loan of $50,000 would be necessary to begin production. This loan would be retired in the fourth month of full production (Exhibit 7).

Owner equity of $1.34 million was assumed to be equal to long term loans for the beginning balance sheet (Exhibit 8). A moderate gain of $99,411 in owner's equity was shown in the year end balance sheet, due to the inclusion of retained earnings (Exhibit 9). Of significant importance was the retirement of all short term debts. This indicates a consolidation of financial position, which should result in a projected increase in profitability in the future.

The rate of return on total assets for potted chrysanthemums was reasonable at 7.7 percent. The return on equity (Exhibit 10) was 7.2 percent. The current ratio was 31.24 for chrysanthemum production. This ratio indicates the strong financial position of this enterprise, and would be higher, except for a contingent property tax liability of $6,879. The return on assets to potted chrysanthemum production of 7.7 percent was slightly lower than the return expected from other investment alternatives, such as the 8 to 10 percent normally obtained by investing in tax-free municipal bonds. In comparison to the 16 to 18 percent return expected by public utilities, or the usual return of greater than 20 percent for large corporations, the return realized by by the production of potted chrysanthemums appears relatively unfavorable.

In summary, the production of potted chrysanthemums appears to be marginally profitable and viable. This analysis utilized conventional

EXHIBIT 7. Pro forma cash flow for an average year, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

	Start Up	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	dollars												
Cash Inflow													
Beginning Cash	1,335,294	50,000	30,000	30,000	30,000	52,504	76,613	100,722	124,831	148,940	173,049	197,158	214,388
Cash Sales	·	128,012	128,012	128,012	128,012	128,012	128,012	128,012	128,012	128,012	128,012	128,012	128,012
Payments on Accounts Receivable			42,671	42,671	42,671	42,671	42,671	42,671	42,671	42,671	42,671	42,671	42,671
Loans	1,385,395												
TOTAL	2,720,790	178,012	200,683	200,683	200,683	223,187	247,296	271,405	295,514	319,623	343,723	367,841	385,071
Cash Outflow													
Facilities & Equipment	2,670,789												
Materials & Expendable Supplies		51,700	51,700	51,700	51,700	51,700	51,700	51,700	51,700	51,700	51,700	51,700	51,700
Wages, Salaries & Benefits		64,956	64,956	64,956	64,956	64,956	64,956	64,956	64,956	64,956	64,956	64,956	64,956
Insurance		1,241	1,241	1,241	1,241	1,241	1,241	1,241	1,241	1,241	1,241	1,241	1,241
Property Tax												6,879	
Repairs & Maintenance		8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708
General Office Expenses		6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750	6,750
Utilities		1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Short Term Loan Principle and Interest Payments		1,438	24,109	24,109	1,605								
Long Term Loan Principle and Interest Payments		11,719	11,719	11,719	11,719	11,719	11,719	11,719	11,719	11,719	11,719	11,719	11,719
Income Tax													66,274
TOTAL	2,670,789	148,012	170,683	170,683	148,179	146,574	146,574	146,574	146,574	146,574	146,574	153,453	212,848
ENDING CASH BALANCE	50,000	30,000	30,000	30,000	52,504	76,613	100,722	124,831	148,940	173,049	197,158	214,388	172,223

Exhibit 8. Beginning balance sheet, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Current Assets		
Cash		$ 50,000
Fixed Assets		
Land	$ 150,000	
Buildings	1,967,864	
Fixtures	98,186	
Equipment	231,348	
Vehicles	38,391	
Wells	185,000	
TOTAL FIXED ASSETS		$2,670,789
TOTAL ASSETS		$2,720,789
Current Liabilities		
Short Term Loan		$ 50,000
Fixed Liabilities		
Long Term Loan		$1,335,395
TOTAL LIABILITIES		$1,380,395
Owner's Equity		$1,335,394
TOTAL LIABILITIES & OWNER'S EQUITY		$2,720,789

Exhibit 9. Pro forma balance sheet, December 31 of an average year, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Current Assets			
Cash	$ 172,223		
Accounts Receivable	42,671		
Total Current Assets		$ 214,894	
Fixed Assets			
Land	$ 150,000		
Buildings	1,889,149		
Fixtures	90,331		
Equipment	186,463		
Vehicles	34,355		
Wells	180,412		
Total Fixed Assets		$2,530,710	
TOTAL ASSETS			$2,745,604
Current Liabilities			
Accrued Property Taxes	$ 6,879		
Fixed Liabilities			
Long Term Loan	$1,303,939		
TOTAL LIABILITIES		$1,310,818	
Owner's Equity			
Owner Equity	$1,335,394		
Retained Earnings	99,411		
Total Owner's Equity		$1,434,805	
TOTAL LIABILITIES AND OWNER EQUITY			$2,745,623

[a] Difference due to rounding error.

Exhibit 10. Return to assets and equity, December 31 of an average year, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Return to Assets

Net Income	$ 99,411
Interest Expense	110,432
Net Profit Before Interest Expense	$ 209,843
Assets	
Beginning of Year	$2,720,789
End of Year	2,745,604
Average Investment in Assets	$2,733,197

$$\text{Return on Total Assets} = \frac{\$\ 209,843}{2,733,197}$$

$$= 7.67\%$$

Return to Equity

Net Income	$ 99,411
Beginning Equity	1,335,394
Ending Equity	1,434,805
Average Equity	1,385,100

$$\text{Return on Equity} = \frac{\$\ 99,411}{1,385,100}$$

$$= 7.18\%$$

$$\text{Current Ratio} = \frac{\text{Current Assets}}{\text{Current Liabilities}} = \frac{\$\ 214,894}{6,879}$$

$$= 31.24$$

growing methods for potted plants. Recent technological developments, such as rolling plant shelves, have increased greenhouse production by as much as 25 percent. The trend for prices of potted plants in the recent past has been upward. The possibility exists for an even larger profit margin if the upward trend on prices continues and new technology can be incorporated. Any upward price fluctuation would improve the margin of profitability, while a downward movement would reduce the profit margin.

Savings Due to Geothermal Resource

The total heated surface area of the greenhouse complex was estimated to be approximately 374,599 square feet. The roof area covers nearly 329,021 square feet. The sidewalls have an exposed area of about 35,526 square feet and the endwalls some 10,052 square feet.

Heat loss was calculated utilizing the following formula:

surface area X temperature to be maintained X standard heat-loss coefficient (a)

(a) ASHRE Handbook of Fundamentals, 1972

Accordingly, 33,954,178,000 BTU per year were required to heat the greenhouses (Appendix Table A-12), based upon the climatic conditions of the area (U.S. Department of Commerce, 1973).

Substantial savings are realized when heating with geothermal resources by the exclusion of the traditional heating fuel, assumed here to be natural gas. Natural gas yields some 940,000 BTU per MCF and was assumed to be 60 percent efficient. When adjusted for efficiency, natural gas yields approximately 564,000 BTU per MCF. Therefore, slightly over 60,000 MCF of natural gas per year was estimated to be required to heat the greenhouse. At a cost of $2.5724 per MCF, $158,865 annually would be required to heat the greenhouse with natural gas. The maintenance cost of the geothermal system was estimated to be higher than that for the natural gas system by approximately $9,000. The additional electricity necessary to operate the geothermal system was estimated to be $7,000 annually for a total additional cost of $16,000. The additional cost does not include a royalty payment for use rights for the geothermal resources. The net savings due to the use of geothermal resources was estimated to be $142,865 per year. Continued realization of savings of this magnitude are contingent upon a stable price for natural gas and a constant quality and quantity of geothermal water. Changes in the price or availability of natural gas as well as flow rate, mineral content, and temperature of the geothermal water may well change the amount of any savings. In addition, the cost of the geothermal resource has not been considered.

Meat Precooking

The meat precooking plant was expected to consist of beef slaughter, boning, cooking and freezing facilities. Beef would be precooked, sized into ten pound lots, cooked in geothermal hot water, then frozen. All of the animal that is suitable would be precooked, except the choice loin cuts, which would be sold as boxed beef. The actual process of precooking is described later in this report.

The proposed plant would take advantage of the latest developments of the meat industry. These include the processing of pre-rigor meat, the adaptation of on-the-rail hot boning and the use of geothermal hot water for precooking. The advantages of using hot water for meat precooking were investigated by Ray and Stiffler (1979). In that study, three sources of heat for meat precooking were used: steam, hot water and conventional electricity. While meat cooked in hot water lost 12 percent of its weight, meat precooked in steam lost only 11 percent, and meat cooked with conventional electric heat lost 15 percent of its weight. The results of this study, though, are a subject for further investigation, and indicate that hot water is not superior to steam in meat precooking, but is better than conventional electric heat.

For cattle processors, finishing feedlots form the source of beef cattle. The feedlots have an annual turnover of 2.4 times since the cattle are fed for a period of five months (Clevenger et al., 1979). The one-time capacity of feedlots in New Mexico is estimated to be about 450,000 head of cattle. Southeastern Arizona, consisting of Greenlee, Santa Cruz, and Cochise counties has few fed beef cattle to offer. The above analysis suggests that neither the primary supply areas (within 50 miles of the plant) nor the secondary (within 120 miles of the plant) have sufficient cattle numbers to support a plant of the proposed size. However, feedlots could be established in this area. These could possibly supply the plant with part of the required cattle. The plant could supplement its cattle supply by extending its import area beyond the 120 mile radius, opening up possibilities for the importation of cattle from other states; e.g. Texas, Oklahoma, Colorado and California. The ability of the plant to import cattle from out of state would depend, in part, on the plant's profit margin.

With a high profit margin, the plant would be able to pay for transportation and allow for shrinkage of cattle.

In New Mexico, a plant has to deal with competition for beef cattle from established plants. The extent of the competition can be determined in part by considering the number and size of existing plants in the state. Currently, there are eight plants in New Mexico with annual sales of over $500,000 (Clevenger, et al, 1979). Although the number of fed cattle far exceeds the number of cattle slaughtered within the state, there are meat processing plants in adjacent states, Oklahoma and Texas, that include New Mexico as part of their supply area. They too are a competitive force in this situation.

Plant Size

An optimum plant size is defined as that scale of operation where the plant would capture all the economies of scale without encountering diseconomies. Recent studies have indicated that the minimum plant size to reach any economies of scale should have the capacity to slaughter over 100 head per hour (Capener et al., 1974), Franzmann and Kuntz (1966), Logan and King (1962) and the U.S. Department of Agriculture, (July 1970). It is at this level of operation that technological economies of scale are captured with the development of larger, more efficient machinery. For purposes of this analysis, the plant capacity was assumed to be 120 head per hour.

For this study, operation at 100 percent capacity was not assumed. Due to the new product and new technology involved, the plant was assumed to "phase in" at the following rate: 60 percent of capacity in year one, 70 percent in year two, 75 percent in year three, and 80 percent thereafter. The operating capacity of the plant was assumed to be 80 percent, which is lower then the industry average, because of the unique nature of the product. The results and economic analysis will be presented in accordance with the above described "phase-in" system.

The plant, if operating (at 80 percent) with a capacity of 120 head per hour, would slaughter 768 head per day in an eight hour working day. Annual slaughter would be 192,000 head, using a 250 working day year.

The average finished weight of slaughter steers is about 1,069 pounds, and that of heifers is 900 pounds (Clevenger and Blake, 1979). Since the plant would slaughter both steers and heifers, an average finished weight of 1,000 pounds for all animals has been assumed. The carcass weight of such an animal would be about 600 pounds, and the boned weight would be approximately 450 pounds (Appendix Table B-1).

Product Flow

The flow of the products through the beef precooking plant from the slaughter of the live animal to shipment is shown in Figure 22.

From a holding pen located outside the slaughter section, the animals would be driven to a restraining pen, then to a knocking pen. In the knocking pen, about two animals per minute would be rendered unconscious. Then, the animal would be hoisted to an overhead power-driven rail system and moved to a bleeding area. The carcass would then be skinned and dressed, after which it would be split, washed, shrouded and weighed. Inedible by-products would be moved to a

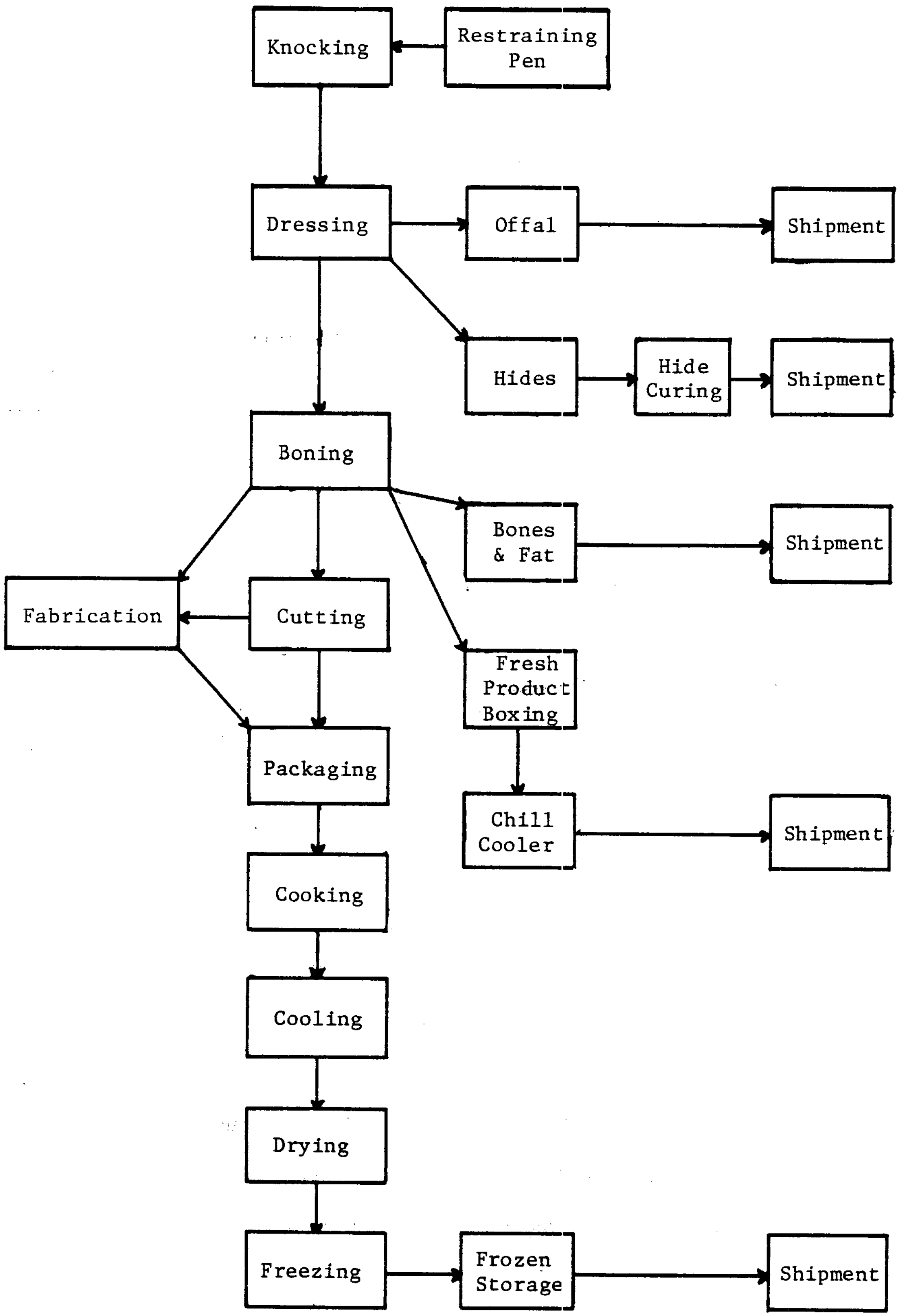


Figure 22. Product flow, beef slaughtering and meat precooking, Animas Valley, New Mexico.

due to cutting and boning. Trimmings from the sizing of the rounds and ribs would to be sent to the fabrication section. About 12 percent (54 pounds) of the carcass (the loins) would be sold as fresh, boxed beef. The loins would be trimmed, boxed, and sent to a cold storage facility for shipment.

About 49 percent of the carcass, consisting of chucks, plates, shanks, briskets, flanks, and trimmings, was expected to be fabricated. The process involves grinding the meat, spicing if desired, and then pressing to the desired shape. An additional four percent would be lost in the fabrication process. From the press, the product is taken to a stuffer where it would be vacuum-packaged in cryovac bags and sent to the cooking section.

The cooking and cooling section was expected to utilize vats filled with geothermally heated water to cook, then cool the meat. Each cooking vat would be 120 feet long, 4 feet wide and 1.5 feet deep. The vat would be filled with hot water that flows in an opposite direction to that of a moving conveyor belt. The water temperature would rise gradually from 90° F to 150° F. Meat bags entering the cooking vat would be at room temperature. Since water and meat will move in opposite directions, as the temperature of the water rises, so would that of the meat. This process permitted the meat to be gradually and uniformly cooked. The cooking process was expected to take about two hours. During the cooking process, approximately 12 percent of the weight was estimated to be lost from the meat.

From the cooking vats, the meat would be taken to a cooling system by a conveyor belt. The cooling system was similar to the cooking system except that the temperature of the water decreased from 150° F to 90° F. Two hours were required to cool the product to room temperature. Each cooking and cooling vat would have a conveyor that moved the meat at a rate of one foot per minute while holding forty pounds per square foot. This would result in a cooking capacity of 160 pounds per minute or 9,600 pounds per hour. Therefore, two sets of cooking and cooling vats would be required to process the expected output of 258,400 pounds per day (340 pounds per carcass times 760 usable carcasses).

From the cooling system, the meat would move through a blower tunnel where the bags would be air dried to minimize moisture build-up on the freezer condensers. After drying, the meat would enter a tunnel-type blast freezer. It was estimated to take five hours at one foot per minute belt movement to pass through the 300-foot long freezer tunnel. The frozen meat would then be placed in paperboard boxes for stacking and storage in the refrigerated warehouse.

Water and Power Requirements

Cold water would be required primarily for domestic purposes. Hot water would be used extensively for beef precooking, cooling and cleaning.

For a plant that has a capacity to kill 120 head per hour, but does not bone or fabricate the carcass, the water requirement has been estimated to be 109,200 gallons per day by the U.S. Department of Agriculture, (March 1978). Since the proposed plant would also bone, fabricate, and precook its product, the water requirement was estimated to be at least twice that amount, or 218,400 gallons per day.

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Hot water requirements for cooking and cooling would be dictated, in part, by the volume of the cooking and cooling vats, the rate at which the water flows in the tanks, and the plant's operating level.

Volume of vats = 120 feet long x 4 feet wide x 1.5 feet deep = 720 cubic feet

1 cubic foot = 7.48 gallons

720 cubic feet = 5,400 gallons

It was estimated that two hours would be required to pass through the vat. The water would enter the vat at 150° F and exit at 90° F. The vats will exchange water four times in an eight hour period. The total geothermal water requirement for an eight hour day will be 21,600 gallons.

Since this plant would be operating at different levels of rated capacity, adjustments would be required for the estimated operating levels. Table 18 presents the hot and cold water requirements for the assumed operating levels.

A beef packing plant that operates at a capacity of 120 head per hour would require 3,742,034 kilowatt hours of electricity a year (U.S. Department of Agriculture, July 1978). For a plant that bones its meat, electricity requirements were estimated to be 6,021,336 kilowatt hours per year (Franzmann and Kuntz, 1976). Two modifications were necessary to the published data to provide better estimates for this project. The first adjustment was due to the plant's slaughter rate. The second adjustment was required to include a freezing plant rather than just a fresh meat chiller. Chilling meat requires only one-fourth the energy necessary to freeze meat. The monthly electric power requirements for the plant is expected to range from 301,067 kwh when the plant is operating at 60% capacity, to 401,422 kwh when the plant is operating at 80% capacity. The freezing unit was estimated to require 84,000 kilowatt hours per month regardless of the level of plant operation (Table 19).

Electricity estimates also included the power necessary to pump groundwater from a depth of 100 feet. The cost of pumping water with a pumping rate of 400 gallons per minute was determined for the first year of operation by calculating the required water horse-power (10.10) times the number of kilowatts (13.953) times the time required to pump the quantities of water needed. The electric energy requirements were estimated at 390,017 kwh per month for the first year to 491,662 kwh per month for the fourth year (Table 19).

Financial Arrangements

The meat precooking facility was assumed to have a corporate business structure due to the large initial capital requirement. One half of the necessary investment cost was assumed to be obtained from the sale of stock, with the balance to be borrowed from lending institutions at 10 percent interest. The corporate structure allows for more flexibility in the raising of capital, i.e., a selected group of investors may raise the needed capital or it may be raised through a public stock sale. Immediate term financing will be obtained as necessary from conventional lenders at 12 percent interest.

Marketing Precooked Beef

The study evaluated the feasibility of the plant, assuming the availability of a ready market for the processed product. The pre-cooking of meat is a relatively new industrial innovation. Existing

Table 18. Daily estimated hot and cold water requirements for a beef slaughter and precooking plant, Animas Valley, New Mexico.

Operating Level	Water Required: Hot Geothermal	Cold	Total
Percent of Rated Capacity	gallons		
60 percent	151,200	131,040	282,240
70 percent	162,000	152,880	314,880
75 percent	172,800	163,800	336,600
80 percent	183,600	174,720	358,320

Table 19. Estimated electric power requirements per month, beef slaughter and precooking plant, Animas Valley, New Mexico.

Operating Level (% of rated capacity)	Power Requirements: Plant	Freezing Unit[a]	Water Pumping	Total
Percent	kwh/month			
60	301,067	84,000	4950	390,017
70	351,245	84,000	5490	440,735
75	376,334	84,000	5880	466,214
80	401,422	84,000	6240	491,662

[a] The freezing unit was assumed to run 16 hours per day to maintain the storage area temperature.

plants that fabricate and precook meat produce a standardized product which caters to the needs of exclusive markets such as hotels, restaurants and institutions. Even though this is not an entirely new product, the volume produced at this one location would necessitate an intensive merchandising effort. At this time, household consumption of consumer sized frozen beef cuts is minimal. However, the potential for an increase in consumer acceptance exists with a greater household use of microwave ovens and quality merchandised frozen products.

There are three possible market outlets for the products of the plant. The products could be marketed under agreement or contract where the quality, volume and price are specified at the time the agreement is signed. The second alternative would be to consign the output to a bonded broker or agent. In this case, the price of the output is left to vary according to market conditions. The third alternative would be for the plant to sell its own output. In this case, retail outlets have to be established. The plant would have to reckon with the formidable food chains that account for about two-thirds of all the fresh and processed meat sold to consumers (Dietrich and Farris, March 1976). Food chains traditionally have had contracts with meat processors that cannot be broken into easily. Lordsburg is not located in a major beef consuming area. It is 163 miles away from El Paso, 157 miles from Tucson, 256 miles from Phoenix, 300 miles from Albuquerque, and 600 miles from Los Angeles. The cost of marketing the product could significantly reduce the plant's profitability, and can only be estimated with accuracy after a complete marketing survey.

Investment Requirements

The plant's investments have been divided into the following components: land and sitework, slaughter, boning, fabrication, cooking and cooling, freezing and storage, and plant support. These components have been appropriately divided between the categories of buildings and equipment. Earlier studies on beef packing plants have been the main source of information on investment costs: Franzmann and Kuntz (1966), Logan and King (1962), Sporleder and Vastine (1973), and U.S. Department of Agriculture (1972 and July 1978).

The proposed plant would be located on a 40 acre site on or near the Lightning Dock KGRA. The land and sitework necessary for the plant and plant support facilities was estimated to cost approximately $305,000 (Table 20).

The plant was assumed to utilize two types of building construction, cinder block on concrete slab and pre-fabricated metal structures. The cinder block on concrete slab construction is expected to be utilized in the slaughter, boning fabrication, cooking and cooling, and freezing sections. The basic cost for a cinder block on concrete slab structure was estimated to be $33 per square foot. The slaughter facility required special construction to assure the most efficient use of labor and equipment and to ensure compliance with sanitation standards, which raised the construction cost to $60 per square foot. In the cold storage, welfare and cafeteria, office, and dry storage areas, pre-fabricated metal structures were utilized. The sections of the plant utilizing pre-fabricated metal structure, with the exception of the office and cold storage building, were conventionally finished on the interior and were estimated to cost $27.00 per square foot

Table 20. Total land, building and equipment requirements and costs for the beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979.

Item	Land and Buildings: Area Required	Land and Buildings: Construction[d]	Land and Buildings: Cost[a]	Equipment: No. Required	Equipment: Cost	Total Cost (Land, Buildings and Equipment)
	(sq. ft.)	($/sq. ft.)	(dollars)		dollars	dollars
Land						
Land	40 acres		$ 250,000			
Sitework			55,000			
Subtotal			$ 305,000			$ 305,000
Slaughter Facility*						
Kill floor	8,970	60	$ 538,200		$ 282,000	
Rendering	5,000	40	200,000		480,000	
Hide curing	5,500	34	187,000		77,800	
Subtotal			$ 925,200		$ 839,800	$1,765,000
Boning Facility[b]**	8,400	33	$ 277,200			
Overhead rail (ft.)				120	$ 1,224	
Overhead rail trolley stop				4	280	
Overhead rail switches				16	1,088	
Overhead rail trolley (heavy duty)				1,200	18,900	
Javis scribe saw				4	1,900	
Conveyor for bones and fat (1-½ by 32 ft)				4	23,856	
Conveyor for boning table (7 x 32 ft)				4	82,868	
Conveyor for bone and fat to the rendering truck (2 x 16 ft)				4	19,524	
Boned meat catch pan (2 x 7 ft)				4	4,371	
Scales				40	4,800	
Subtotal			$ 277,200		$ 158,811	$ 436,011
Fabrication Facility*	500	33	$ 16,500			
Fabrication system includes grinder, kidney plate, stuffer, and conveyor belt system					$ 234,600	
Packaging machine					370,000	
Subtotal			$ 16,500		$ 604,600	$ 621,100
Cooking and Cooling Facility	4,800	33	$ 158,400			
Cooking system				2	$ 150,000	
Cooling system				2	150,000	
Infeed and discharge conveyors***				4	16,000	
Subtotal			$ 158,400		$ 316,000	$ 474,400
Freezing and Storage Facility						
Freezing building	6,000	33	$ 198,000			
Blow dryers				2	$ 2,000	
Blast freezers				2	300,000	
Cold storage building	6,000	27	162,000			
Central refrigeration unit				1	700,000	
Forklift				1	30,000	
Subtotal			$ 360,000		$1,032,000	$1,392,000
Plant Support Facilities						
Corrals[c]*	52,300	9	$ 470,700			
Welfare and cafeteria	5,390	27	145,530		$ 100,000	
Office*	4,800	34	163,200		50,000	
Dry storage*	687	27	18,549			
Equipment cleanup*	448	27	12,096			
Parking lots*	104,200	1	104,200			
Dock aprons*	1,740	2	3,480			
Water system						
Geothermal hot water					280,000	
Cold water					60,800	
Sewage treatment plant					523,500	
Vehicles					100,000	
Subtotal			$ 917,755		$1,114,300	$2,032,055
Total Buildings and Equipment			$2,960,055		$4,065,511	$7,025,566
Contingency						$ 702,557
TOTAL						$7,728,123

[a] Includes a six percent architecture fee.

[b] The equipment cost has been adjusted by the Metal Works Price Index to account for inflation.

[c] Corral estimates are based on the amount of penning areas, alleys, and fencing necessary. Have a holding capacity of two and one-half day's kill.

* Source: United States Department of Agriculture, July, 1978.

** Source: United States Department of Agriculture, August, 1972.

*** Source: KOCH Corporation General Catalog Number 197, August, 1978.

(Table 20). The cold storage building was assumed to be a urethane foam insulated metal shell, unfinished on the interior with a cost of $27.00 per square foot (Table 20). The interior of the office building was painted and decorated, costing $34 per square foot.

The slaughter facility was the most costly single section of the plant, except for plant support facilities. The cost of the facility was nearly equally divided between building and equipment.

Space requirements for the slaughter facilities were estimated to be 8,970 square feet for the slaughter section, 5,500 square feet for the hide curing section and 5,000 square feet for the rendering section (Table 20). The cost of the kill floor accounted for about 58 percent ($925,200) of the cost of slaughter facility buildings with the rendering accounting for nearly 22 percent and the hide curing section 20 percent. The square foot cost of the buildings ranged from $34.00 to $60.00, with an average cost per square foot of about $47.

The equipment necessary for the slaughter facility was expected to cost $839,800. The rendering section equipment amounted to approximately 57 percent of the total slaughter facility equipment. About 34 percent of the total equipment cost was assigned to the kill floor with hide curing accounting for the remaining 9 percent of the total.

It was estimated that the space requirement for the boning facility would be 8,400 square feet (Meat Industry, 1978). The building cost was estimated to be $277,200 (Table 20). The necessary equipment for the boning section was estimated to cost $158,811. The conveyor system accounted for approximately 80 percent; the overhead rail carcass suspension system acounted for nearly 14 percent of the equipment cost; and the remaining six percent included saws, catch pans and scales.

The space requirement for the fabrication facility was estimated to be 500 square feet, for a cost of $16,500 (Table 20). The total equipment cost for the fabrication facility was estimated to be $604,600. The packaging machine was the largest component of the equipment cost in the fabrication facility, representing about 61 percent of the total. The grinder, press, stuffer, and conveyor belts, accounted for the remaining 39 percent of the equipment cost.

The cooking and cooling facility was expected to require 4,800 square feet of space, for a total cost of $158,400. The equipment for the cooking and cooling facility was estimated to cost $316,000. Equipment utilized in the cooking and cooling section consisted of a cooking vat, a cooling vat and a conveyor belt system. The cooking and cooling equipment each accounted for about 47 percent of the total equipment cost, with the conveyor system accounting for about 6 percent of the cost.

The total cost of the freezing and storage facility was $1.4 million (Table 20). The freezing section was estimated to require 6,000 square feet of space, for a total cost of $198,000. The equipment utilized in the freezing section was expected to cost $302,000, of which the blast freezers accounted for over 99 percent. The cold-storage structure was assumed to be a pre-fabricated metal building insulated with urethane foam. Approximately 6,000 square feet of space was assumed to be required, resulting in a total cost for the facility of $162,000 (Table 20). The central refrigeration unit was the major equipment item in the cold-storage facility, accounting for nearly 96 percent of the total cost of $730,000.

The category of plant support facilities constituted the largest component of total plant cost. Buildings accounted for $917,755 and support facilities equipment $1.1 million (Table 20). Support facilities included an aggregation of many items. Corrals were the largest investment item, accounting for about 51 percent of the building investments. The office constituted approximately 18 percent of the total, while nearly 16 percent was accounted for by the cafeteria and welfare facilities. Approximately 11 percent of the total building costs were attributed to parking lots and the remaining 4 percent was accounted for by various small items.

Nearly 47 percent of the cost of equipment included in the plant support facility was accounted for by the sewage treatment plant. The geothermal hot water system accounted for approximately 25 percent, vehicles about nine percent, and welfare and cafeteria equipment about nine percent of the total. The remaining 10 percent was divided nearly equally between office equipment and the cold water supply system.

The total investment for land, buildings and equipment was $7.0 million. Of this total, the plant support facilities accounted for about 29 percent, the slaughter facility accounted for nearly 25 percent, and the freezing and storage facility cost amounted to 20 percent. Eight percent of the total was attributed to the fabrication facility, with the cooking and cooling and boning facility accounting for seven and six percent of the total investment, respectively. The remainder of about four percent was associated with the land and sitework costs. To this a 10 percent contingency fee was added to the investment cost, bringing the total investment in land, buildings, and equipment to $7.7 million (Table 20).

Operating Expenses

Given a per unit requirement, the total operating expense depended to a large extent on the level of output given the plant's fixed capacity. The average total operating expense would initially decrease as output increased reaching a minimum at the plant's optimum point, and increasing as output was expanded beyond the optimum output point. Operating expenses were grouped into investment expenses, labor expenses, utilities, cattle purchases, and materials and supplies expenses. They were summarized for four years of plant operation in Table 21.

Fixed Investment Expenses

Annual fixed operating expenses associated with the fixed investment included depreciation, insurance expense, property taxes, and maintenance expenses (Table 21). Annual depreciation for the enterprise was estimated to be $440,545 (Appendix Table B-2). Depreciation was calculated on a straight line basis with a 10 percent salvage value. A 25 year life on buildings and 12 year life on equipment was assumed. Estimated annual maintenance costs were estimated at 2.5 percent for buildings and 10 percent for equipment, for a total of $520,220 (Appendix Table B-2). Maintenance costs were assumed to occur on a weekly basis. Insurance on capital items was assumed at a rate of $1.00 per $100 of the remaining value of a capital asset. The annual insurance cost for the first year was estimated to be $73,927 paid monthly, with the insurance cost decreasing steadily to $60,709 in the fourth year

Table 21. Total estimated expenses, first four years of operation, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979

Item	Year 1 (60% of Plant Capacity)	Year 2 (70% of Plant Capacity)	Year 3 (75% of Plant Capacity)	Year 4 (80% of Plant Capacity)
	dollars			
Non-Cash Expenses				
Investment Expenses				
Depreciation	440,545	440,545	440,545	440,545
Cash Expenses				
Investment Expenses				
Insurance	73,927	69,521	65,116	60,709
Property Tax	68,333	64,260	60,188	56,116
Maintenance	520,220	520,220	520,220	520,220
Subtotal	662,480	654,001	645,524	637,045
Wages, Salaries and Office Expense				
Administrative Salaries	556,000	556,000	556,000	556,000
Union Plant Workers	2,717,000	2,904,000	2,904,000	2,904,000
Office Materials and Supplies	240,500	240,500	240,500	240,500
Subtotal	3,513,500	3,700,500	3,700,500	3,700,500
Utilities Expense	154,992	175,080	185,172	195,240
Cattle Purchases	77,760,000	90,720,000	97,200,000	103,680,000
Packaging Materials Expense	1,308,500	1,526,700	1,636,750	1,744,750
Other Plant Expenses	113,797	119,407	119,407	119,407
Subtotal	83,953,814	97,336,233	103,927,898	110,517,487
Interest Expense				
Long Term Loan	383,535	376,837	369,442	361,271
Medium Term Loan	410,986	270,199	100,053	0
TOTAL EXPENSES	84,748,335	97,983,269	104,397,393	110,878,758

(Appendix Table B-3). Taxes on property are assessed and levied at the county level with a tax rate of $27.73 per $1,000 assessed property value (N. M. Department of Development, 1975). In the first year, the property tax was estimated to be $68,333, declining to $56,116 by the fourth year (Appendix Table B-3). Taxes were assumed to be paid in two equal annual installments.

Wages and Salaries

Evaluated at each of the plant's four operating levels, the annual wage bill depends on the number of employees, monthly wage rate, and other employee benefits. The number of employees was determined largely by technical input-output requirements and estimated employee efficiencies. The following assumptions were made concerning plant employee efficiency:

1) When the plant operates at 60 percent of rated capacity, 75 percent of the labor input at maximum capacity would be required. This situation occurs in the first year of operation.
2) When the plant operates at 70 percent of rated capacity, 80 percent of the labor input at maximum capacity would be required. This situation occurs in the second year of operation.
3) When the plant operates at 75 percent of the rated capacity (third year), 80 percent of the capacity labor input would be required.
4) By the fourth year, the percentage of the rated capacity of the plant and percent of maximum labor input would be equal,

i.e.; 80 percent of rated capacity of the plant would require 80 percent of the maximum labor input.

The labor force was expected to consist of 247 full-time employees when 60 percent of the capacity was utilized. The labor force would then increase to 264 employees at the 70 percent capacity level. The number of full-time employees is expected to remain constant at 264 employees for the 75 percent and 80 percent levels (Table 22). The plant's administrative staff was not expected to change with the processing rate. Table 22 presents the plant labor and management requirements.

Given the current average wage rate of a union employee at $4.31 per hour, the average annual salary including overtime payments and benefits was assumed to be $11,000. The union plant workers' annual salaries were estimated to be about $2.7 million in the first year of operation, and about $2.9 million in the next three years of operation (Table 23). Worker's salaries were assumed to have been paid weekly. The annual administrative salaries were estimated to be $556,000 paid on a bi-monthly basis (Table 23). Included in administrative expense was the board of directors, general manager, plant superintendent, sales manager, purchasing manager, office manager, controller, and 31 office employees. General office materials and supply expenses were estimated to be $240,500 annually, paid monthly (Table 23). The total is expected to be 3.5 million in the first year of operation and increase to $3.7 million thereafter. Plant labor expenses are expected to account for 78 percent of the total costs during a typical year, administrative expenses about 15 percent, and general office expense, the remaining seven percent.

Table 22. Estimated management and labor requirements, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979.

	Plant's Operating Level (percent of rated capacity)[a]			
Management	60%	70%	75%	80%
	---Number of Employees---			
General Manager	1	1	1	1
Senior Cattle Buyer	1	1	1	1
Beef Sales Manager	1	1	1	1
Plant Superintendent	1	1	1	1
Assistant Superintendents	3	3	3	3
Cattle Buyers	7	7	7	7
Beef Salesman	9	9	9	9
Office Manager	2	2	2	2
Credit Manager	2	2	2	2
Bookkeeper	3	3	3	3
Payroll & Billing Clerk	3	3	3	3
Secretaries	3	3	3	3
Switchboard	1	1	1	1
SUBTOTAL	37	37	37	37
Plant Labor				
Kill Floor	62	66	66	66
Dock	3	4	4	4
Rendering	3	4	4	4
Hide Curing	3	4	4	4
Maintenance	15	16	16	16
Clean-up	7	8	8	8
Yard	6	7	7	7
Boning & Vacuum Packaging	95	100	100	100
Fabrication	5	6	6	6
Freezer, Boxing & Warehouse	11	12	12	12
SUBTOTAL	210	227	227	227
TOTAL	247	264	264	264

[a] The percent of rated capacity in this study corresponds to years of operation of 1 to 4.

Sources: U.S. Department of Agriculture, July, 1978.
Meat Industry, October, 1978.

Table 23. Annual administrative, plant labor and general office expense by year of operation, beef slaughter and precooking plant, Animas Valley, New Mexico

Item	Cost			
	Year of Operation			
	1	2	3	4
	dollars			
Administrative Expense:[a]				
Board of Directors Fees and Expenses	25,000	25,000	25,000	25,000
General Manager Salary	40,000	40,000	40,000	40,000
Plant Superintendent	30,000	30,000	30,000	30,000
Sales and Purchasing Managers, 2 @ $30,000	60,000	60,000	60,000	60,000
Office Manager and Credit Controller 2 @ $30,000	60,000	60,000	60,000	60,000
31 Other Office Employees @ $11,000	341,000	341,000	341,000	341,000
SUBTOTAL	556,000	556,000	556,000	556,000
Plant Labor Expense:				
Union Workers	2,717,000	2,904,000	2,904,000	2,904,000
Office Expense:				
Advertisement	100,000	100,000	100,000	100,000
Administrative Travel	12,000	12,000	12,000	12,000
Telephone	60,000	60,000	60,000	60,000
Office Supplies	30,000	30,000	30,000	30,000
Computer Services	24,000	24,000	24,000	24,000
Dues & Subscriptions & Public Relations	4,000	4,000	4,000	4,000
Teletype Services	1,500	1,500	1,500	1,500
Other Utilities	2,000	2,000	2,000	2,000
Depreciation of Office Equipment	7,000	7,000	7,000	7,000
SUBTOTAL	240,500	240,500	240,500	240,500
TOTAL	3,513,500	3,700,500	3,700,500	3,700,500

[a] includes fringe benefits.

Utilities

The utilities required by the plant were electricity for pumping hot and cold water, and electricity for general plant operations. Based on the commercial rates from the Columbus Electric Cooperative cited previously in this report and electricity requirements from Table 18, electricity costs were estimated at $154,992 for the first year, $175,080 for the second year, $185,172 for the third year, and $195,240 for the fourth year, or $195,240 annually (Table 21).

Cattle Purchases

The number of cattle required depended on the operating level of the plant. At an assumed price of $0.54 per pound for a 1,000 pound animal transported to the plant the annual cost in year one would be $77.8 million, year two -- $90.7 million, year three -- $97.2 million, and year four -- $103.7 million (Table 21 and Appendix Table B-4). Cattle were assumed to be purchased on weekly cash terms.

Packaging Materials

Packaging materials were required at two stages in the production process. The meat was placed in cryovac bags and sealed before cooking. After freezing, the meat was placed in paperboard containers for storage and shipment. The total packaging costs range from $1.31 million for year one to $1.74 million for year four (Table 21 and Appendix Table B-5). Packaging materials were assumed to be purchased on weekly cash terms.

Other Plant Operating Expenses

This category includes such items as cleaning materials and supplies, replacement of small equipment items, fuel for the plant's vehicles, and other items used in day to day plant operation. This cost was computed as three percent of plant workers' wages, administrative salaries, and maintenance expense incurred on a weekly basis. It was $113,797 in the first year and $119,407 per year in the next three years (Table 21).

Total Operating Expenses

Cattle purchases represent 93 percent of the total annual operating expenses of $83.95 million for the first year of operation, wages and salaries represent only four percent, packaging materials and other plant operating expenses account for about two percent, and fixed investment expenses, and utilities account for the remaining one percent (Table 21). In the fourth year of plant operation, cattle purchases represent 94 percent of the total annual operating expenses of $110,517,487, wages and salaries represent only three percent, and all other expenses three percent of the total operating expenses (Table 21).

Interest Expense

To meet the required investment capital of $7.73 million, a loan of $3.86 million for 20 years at 10 percent interest would be required. The plant is expected to secure a medium term loan for $3.99 million to cover operating costs of the first three weeks. This loan of $3.95 million would be payable within three years at a 12 percent interest.

Table 24 presents the interest expense for the first four years of the plant's operation. The total interest paid on a monthly basis in the first year was estimated to be $794,521 of which $383,535 would be on the long term loan and $410,986 on the medium term loan. The

Table 24. Principle payments and interest expense for the first four years of plant operation, beef slaughter and precooking plant, Animas Valley, New Mexico

Year of Operation	Long Term Loan: Principle Paid [a]	Long Term Loan: Interest Paid	Long Term Loan: Total	Medium Term Loan: Principle Paid [b]	Medium Term Loan: Interest Paid	Medium Term Loan: Total
	dollars					
1	63,941	383,535	447,476	1,096,705	410,986	1,507,661
2	70,639	376,837	447,476	1,341,576	270,199	1,611,775
3	78,034	369,442	447,476	1,511,722	100,053	1,611,775
4	86,205	361,271	447,476	0	0	0

[a] Based on an ordinary annuity of 240 equal monthly payments.

[b] Based on an ordinary annuity for 35 equal monthly payments.

total interest paid in the fourth year would only be $361,271, or the interest on the long term loan, since the intermediate loan would have been repaid after the third year. The interest expense for each subsequent year after the fourth year would be reduced by $19,260 due to principle repayment, reaching zero after 20 years with the loan fully repaid.

Sales and Revenue

Returns to the plant would be composed of sales revenue from the precooked meat, precooked fabricated roast product, fresh product and by-products. Annual sales for the first year would consist of 16.3 million pounds of precooked roasts sold at an estimated price of $2.00 per pound for a total of $32.6 million and 26.3 million pounds of fabricated roast sold for $1.75 per pound or $46.1 million. In addition, 7.7 million pounds of fresh boxed beef at $0.90 per pound or $6.9 million, and $5.1 million of by-products would be sold. The total estimated sales for the first year of operation were about $90.7 million (Table 25). Annual sales were expected to increase to $120.9 million by the fourth year of operation (Table 25). The sales of precooked meat were expected to increase to 21.7 million pounds for a value of $43.5 million. Fabricated roast products increased to 35.1 million pounds, and were sold for $61.4 million. The amount of boxed beef increased to 10.3 million pounds, which sold for $9.2 million, and the income from the sale of by-products was expected to increase to $6.8 million. In the fourth year of operation, the fabricated roast product was expected to account for about 51 percent of the total sales, precooked meat 36 percent, fresh boxed beef about eight percent and by-products the remaining five percent.

Table 25. Estimated annual production and revenue by year of operation, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979

Product	Year One 60% of Capacity		Year Two 70% of Capacity		Year Three 75% of Capacity		Year Four 80% of Capacity	
	Production[a]	Revenue[a]	Production[a]	Revenue[a]	Production[a]	Revenue[a]	Production[a]	Revenue[a]
	1,000 pounds	1,000 dollars	1,000 pounds	1,000 dollars	1,000 pounds	1,000 dollars	1,000 pounds	1,000 dollars
Precooked Meat[bc]	16,302	32,604.00	19,019	30,038.00	20,392	40,783.60	21,736	43,472.00
Fabricated Roast Product[de]	26,334	46,084.50	30,723	53,765.25	32,941	57,646.00	35,112	61,446.00
Fresh Product[fg]	7,695	6,925.50	8,978	8,079.75	9,626	8,662.95	10,260	9,234.00
Subtotal		85,614.00		99,883.00		107,092.55		114,152.00
By Products								
Fat	5,130	359.10	5,985	418.95	6,417	449.19	6,840	478.80
Bones	5,700	85.50	6,650	99.75	7,130	106.95	7,600	114.00
Rumen Contents	14,250	213.75	16,625	249.38	17,825	267.38	19,000	285.00
Other Offal Products	N/A[h]	855.00	N/A	997.50	N/A	1,069.50	N/A	1,140.00
Hides	N/A	3,562.50	N/A	4,156.25	N/A	4,456.25	N/A	4,750.00
Subtotal		5,075.85		5,921.83		6,349.27		6,767.80
TOTAL		90,689.85		105,804.83		113,441.82		120,919.80

[a] Assumed 250 slaughter days per year.

[b] Calculations as follows: 130 lbs. entering cooking process less 12 percent shrink x slaughter less condemnation.

[c] Price of $2.00 per pound based on telephone conversation with a Wes-Pac Meat Processing Plant Vice-President, May 8, 1979.

[d] Calculations as follows: 210 lbs. entering cooking process less 12 percent shrink x slaughter less condemnation.

[e] The price of precooked meat was discounted $0.25 per pound to $1.75 per pound for the fabricated roast product.

[f] Calculations as follows: 54 lbs. per animal x slaughter less condemnation.

[g] Assumed price of $0.90 per pound.

[h] Revenue based on a per head basis.

From the estimated total revenue, a bad debt allowance of two percent was deducted. This resulted in adjusted gross sales of $88.9 million in the first year, $103.7 million in the second year, $111.2 million in the third year, and $118.5 million in the fourth year (Exhibit 11). All receipts were assumed to be collected or considered bad debts by the end of the year. The output was assumed to be sold on seven day credit terms, which was in accordance with current meat industry practice. The seven day credit terms, in addition to an average five day cold storage of the products, results in a total lag of twelve days from animal slaughter to payment.

Profitability

From the adjusted gross sales, the cost of goods sold must be determined and subtracted to obtain gross profits. From the gross profit, interest payments and taxes were subtracted. The first year's net profit after taxes of $2,476,631 (Exhibit 11) was 2.7 percent of gross sales, while the second year's net profit after taxes of $3,423,278 was 3.2 percent of gross sales. The third year's net profit of $4,065,355 was 3.6 percent of gross sales, and the fourth year's profit of $4,573,588 (Exhibit 11) was 3.8 percent of gross sales. The meat industry has an average after-tax profit level of one percent of gross sales. Forward integration into carcass breaking and boxing operations adds another percent, for a total of two percent on gross sales; further fabrication processes are believed to increase the after-tax profit level by another two percent (U.S. Department of Agriculture, July 1978). Thus, the net profit expressed as a percentage of gross sales is in a "reasonable" range.

EXHIBIT 11. Proforma income statements for the first four years of operation, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979.

	Year 1		Year 2	
Sales	$ 90,689,850		$105,804,830	
Less two percent allowance for bad debts	1,813,797		2,116,097	
Adjusted Gross Sales		$ 88,876,053		$103,688,733
Cost of Goods Sold:				
Cattle Purchases	$ 77,760,000		$ 90,720,000	
Plant Worker's Wages	2,717,000		2,904,000	
Packaging Materials	1,308,500		1,526,700	
Administrative Salaries	556,000		556,000	
Maintenance	520,220		520,220	
Office Materials and Supplies	240,500		240,500	
Utilities	154,992		175,080	
Other Plant Expenses	113,797		119,407	
Insurance	73,927		69,521	
Property Taxes	68,333		64,260	
Total Cash Expenses	$ 83,513,269		$ 96,895,688	
Depreciation	440,545		440,545	
Total Cost of Goods Sold		$ 83,953,814		$ 97,336,233
Gross Profit		$ 4,922,239		$ 6,352,500
Less Interest:				
Long Term Loan	$ 383,535		$ 376,837	
Medium Term Loan	410,986		270,199	
		$ 794,521		$ 647,036
Net Profit Before Tax		$ 4,127,718		$ 5,705,464
Less 40% Profit Tax		$ 1,651,087		$ 2,282,186
NET PROFIT		$ 2,476,631		$ 3,423,278

	Year 3		Year 4	
Sales	$113,441,820		$120,919,800	
Less two percent allowance for bad debts	2,268,836		2,418,296	
Adjusted Gross Sales		$111,172,984		$118,501,404
Cost of Goods Sold:				
Cattle Purchases	$ 97,200,000		$103,680,000	
Plant Worker's Wages	2,904,000		2,904,000	
Packaging Materials	1,636,750		1,744,750	
Administrative Salaries	556,000		556,000	
Maintenance	520,220		520,220	
Office Materials and Supplies	240,500		240,500	
Utilities	185,172		195,240	
Other Plant Expenses	119,407		119,407	
Insurance	65,116		60,709	
Property Taxes	60,188		56,116	
Total Cash Expenses	$103,487,353		$110,076,942	
Depreciation	440,545		440,545	
Total Cost of Goods Sold		$103,927,898		$110,517,487
Gross Profit		$ 7,245,086		$ 7,983,917
Less Interest:				
Long Term Loan	$ 369,442		$ 361,271	
Medium Term Loan	100,053		0	
		$ 469,495		$ 361,271
Net Profit Before Tax		$ 6,775,591		$ 7,622,646
Less 40% Profit Tax		$ 2,710,236		$ 3,049,058
NET PROFIT		$ 4,065,355		$ 4,573,588

The funds used in the start-up period to pay for the plant and equipment were owner equity and loans. The plant accumulated large amounts of cash, beginning the first year with $100,000 and ending with $4.73 million (Exhibit 12). It was necessaary to borrow an additional $3.86 million over the first three weeks of operation (Exhibit 13). The plant added about $400,000 to the cash accumulation in the second year, beginning the year with $4.7 million and ending the year with $5.18 million (Exhibit 14). The plant accumulated no additional cash in the third year of operation, with the cash balance declining by $85,524 to $5.1 million. The plant accumulated almost a million dollars of cash in the fourth year. The cash balance at the end of the fourth year was $6.0 million (Exhibit 14).

Owner equity was assumed to be $3.86 million in the beginning balance sheet (Exhibit 15). A gain of $1.5 million to $5.3 million was recorded in the first year's ending balance sheet. This was due to the inclusion of $2.5 million of retained earnings, less the cash dividend of $1.0 million paid in the first year of operation (Exhibit 16). Owner equity increased to $6.8 million by the end of the second year due to the inclusion of a total of $5.9 million of retained earnings, less the total cash dividends of $3.0 million over two years (Exhibit 16). Owner equity increased by $1.07 million in the third year of operation, bringing the total owner equity to $7.8 million after cash dividends of $6.0 million have been paid. Owner equity increased to $8.4 million at the end of the fourth year (Exhibit 16).

The percentage of returns to total assets range from 33.1 for year one to 42.0 percent in year four (Exhibit 17). A good, profitable business typically returns greater than 20 percent to total

EXHIBIT 12. Pro forma monthly cash flow for the first year of operation, beef slaughter and meat precooking plant, Animas Valley, New Mexico 1978-1979

	Starting	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	dollars												
Cash Inflow													
Beginning Cash	3,864,000	100,000	67,802	353,749	639,696	925,643	1,211,590	1,497,537	1,783,484	2,069,431	2,355,378	2,641,325	2,893,106
Cash Sales		3,436,523	3,436,542	3,436,542	3,436,542	3,436,542	3,436,542	3,436,542	3,436,542	3,436,542	3,436,542	3,436,542	4,147,551
Payments on Accounts Receivable			4,266,051	4,266,051	4,266,051	4,266,051	4,266,051	4,266,051	4,266,051	4,266,051	4,266,051	4,266,051	4,266,051
Loans	3,964,123	3,850,000											
Total	7,828,123	7,386,523	7,770,395	8,056,342	8,342,289	8,628,236	8,914,183	9,200,130	9,486,077	9,772,024	10,057,971	10,343,918	11,306,708
Cash Outflow													
Facility & Equipment	7,728,123												
Cattle Purchases		6,761,739	6,761,739	6,761,739	6,761,739	6,761,739	6,761,739	6,761,739	6,761,739	6,761,739	6,761,739	6,761,739	3,380,870
Packaging Material		113,783	113,783	113,783	113,783	113,783	113,783	113,783	113,783	113,783	113,783	113,783	56,891
Wages		231,234	231,234	231,234	231,234	231,234	231,234	231,234	231,234	231,234	231,234	231,234	173,426
Salaries		46,333	46,333	46,333	46,333	46,333	46,333	46,333	46,333	46,333	46,333	46,333	46,333
Insurance		12,320	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	5,793
Property Tax												34,166	
Repairs & Maintenance		43,352	43,352	43,352	43,352	43,352	43,352	43,352	43,352	43,352	43,352	43,352	43,352
Office Materials & Supplies		11,708	11,708	11,708	11,708	11,708	11,708	11,708	11,708	11,708	11,708	11,708	11,708
Advertisement		8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333
Utilities		12,916	12,916	12,916	12,916	12,916	12,916	12,916	12,916	12,916	12,916	12,916	12,916
Other Plant Expenses		9,483	9,483	9,483	9,483	9,483	9,483	9,483	9,483	9,483	9,483	9,483	9,483
Profit Tax													1,651,087
Subtotal	7,728,123	7,251,201	7,245,041	7,245,041	7,245,041	7,245,041	7,245,041	7,245,041	7,245,041	7,245,041	7,245,041	7,279,207	5,400,192
Loans													
Principle Payments		5,089	99,946	100,937	101,937	102,949	103,968	104,999	106,041	107,092	108,155	109,226	110,310
Interest Payments		62,431	71,659	70,668	69,668	68,656	67,635	66,606	65,564	64,513	63,450	62,379	61,295
Dividends													1,000,000
Total	7,728,123	7,318,721	7,416,646	7,416,646	7,416,646	7,416,646	7,416,646	7,416,646	7,416,646	7,416,646	7,416,646	7,450,812	6,571,797
Ending Cash Balance	100,000	67,802	353,749	639,696	925,643	1,211,590	1,497,537	1,783,484	2,069,431	2,355,378	2,641,325	2,893,106	4,734,911

EXHIBIT 13. Pro forma weekly cash flow for the first eight weeks of operation, beef slaughter and meat precooking plant, Animas Valley, New Mexico 1978-1979

	Week							
	1	2	3	4	5	6	7	8
	dollars							
Cash Inflow								
Beginning Cash	100,000	45,938	74,869	48,480	48,295	177,914	284,366	413,985
Payments on Accounts Receivable			1,066,513	1,777,521	1,777,521	1,777,521	1,777,521	1,777,521
Loans	1,600,000	1,700,000	555,000					
Total	1,700,000	1,745,938	1,696,382	1,826,001	1,825,816	1,955,435	2,061,887	2,191,506
Cash Outflow								
Cattle Purchases	1,555,200	1,555,200	1,555,200	1,555,200	1,555,200	1,555,200	1,555,200	1,555,200
Packaging Material	26,170	26,170	26,170	26,170	26,170	26,170	26,170	26,170
Wages	54,340	54,340	54,340	54,340	54,340	54,340	54,340	54,340
Salaries		23,167		23,167		23,167		23,167
Insurance	6,160			6,160				6,160
Repairs & Maintenance	10,004	10,004	10,004	10,004	10,004	10,004	10,004	10,004
Office Materials & Supplies				11,708				11,708
Advertisement				8,333				8,333
Utilities				12,916				12,916
Other Plant Expenses	2,188	2,188	2,188	2,188	2,188	2,188	2,188	2,188
Subtotal	1,654,062	1,671,069	1,647,902	1,710,186	1,647,902	1,671,069	1,647,902	1,710,186
Loans								
Principle Payments				5,089				99,946
Interest Payments				62,431				71,659
Total	1,654,062	1,671,069	1,647,902	1,777,706	1,647,902	1,671,069	1,647,902	1,881,791
Ending Cash Balance	45,938	74,869	48,480	48,295	177,914	284,366	413,985	309,715

EXHIBIT 14. Pro forma quarterly cash flow for years two through four of operation, beef slaughter and meat precooking plant, Animas Valley, New Mexico 1978-1979

	Year Two				Year Three				Year Four			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
	dollars											
Cash Inflow												
Beginning Cash	4,734,911	1,055,283	2,318,546	3,615,979	5,184,850	1,277,052	2,773,427	4,301,932	5,099,326	1,533,800	3,626,247	5,766,788
Cash Sales	21,982,011	21,982,011	21,982,011	22,811,521	23,468,673	23,568,673	23,568,673	24,458,056	25,122,298	25,122,298	25,122,298	26,070,309
Payments on Accounts Receivable	--	4,977,059	4,977,059	4,977,059	--	5,336,303	5,336,303	5,336,303	--	5,688,067	5,688,067	5,688,067
TOTAL	26,716,922	28,014,353	29,277,616	31,404,559	28,653,523	30,182,028	31,678,403	34,096,291	30,221,624	32,344,165	34,436,612	37,525,164
Cash Outflow												
Cattle Purchases	23,587,200	23,587,200	23,587,200	19,958,400	25,272,000	25,272,000	25,272,000	21,384,000	26,956,800	26,956,800	26,956,800	22,809,600
Packaging Material	396,945	396,945	396,945	335,865	425,555	425,555	425,555	360,085	453,635	453,635	435,635	383,845
Wages	742,500	742,500	742,500	676,500	742,500	742,500	742,500	676,500	742,500	742,500	742,500	676,500
Salaries	139,000	139,000	139,000	139,000	139,000	139,000	139,000	139,000	139,000	139,000	139,000	139,000
Insurance	17,380	17,380	17,380	17,013	16,279	16,279	16,279	15,912	15,177	15,177	15,177	14,810
Property Tax	—	34,167	—	32,130	--	32,130	—	30,094	--	30,094	—	28,058
Repairs and Maintenance	130,055	130,055	130,055	130,055	130,055	130,055	130,055	130,055	130,055	130,055	130,055	130,055
Office Materials and Supplies	35,125	35,125	35,125	35,125	35,125	35,125	35,125	35,125	35,125	35,125	35,125	35,125
Advertisement	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Utilities	43,770	43,770	43,770	43,770	46,293	46,293	46,293	46,293	48,810	48,810	48,810	48,810
Other Plant Expenses	29,852	29,852	29,852	29,852	29,852	29,852	29,852	29,852	29,852	29,852	29,852	29,852
Profit Tax	—	—	--	2,282,186	—	--	—	2,710,236	--	--	--	3,049,058
SUBTOTAL	25,146,827	25,180,994	25,146,827	23,704,896	26,861,659	26,893,789	26,861,659	25,482,152	28,575,954	28,606,048	28,557,954	27,387,713
Loans												
Principle Payments	337,534	347,676	358,120	368,882	379,965	391,384	403,145	415,260	20,754	21,276	21,814	22,362
Interest Payments	177,278	167,137	156,690	145,931	134,847	123,428	111,667	99,553	91,116	90,594	90,056	89,508
Dividends	—	—	—	2,000,000	--	—	--	3,000,000	—	--	—	4,000,000
TOTAL	25,661,639	25,695,807	25,661,637	26,219,709	27,376,471	27,408,601	27,376,471	28,996,965	28,687,824	28,717,918	28,669,824	31,499,583
ENDING CASH BALANCE	1,055,283	2,318,546	3,615,979	5,184,850	1,277,052	2,773,427	4,301,932	5,099,326	1,533,800	3,626,247	5,766,788	6,025,518

EXHIBIT 15. Beginning balance sheet, beef slaughter and meat precooking plant, Animas Valley, New Mexico, 1978-1979

Assets		
Cash		$ 100,000
Fixed Assets		
Land*	$ 335,500	
Buildings*	2,920,561	
Equipment*	4,472,062	
Total		$7,728,123
TOTAL ASSETS		$7,828,123
Liabilities and Owner Equity		
Liabilities		
Medium Term Loan	$ 100,000	
Long Term Loan	3,864,123	
Total Loans		$3,964,123
Owner Equity		3,864,000
Total Liabilities and Owner Equity		$7,828,123

* Includes contingency.

EXHIBIT 16. Pro forma balance sheet: December 31, for the first four years of operation, beef slaughter and meat precooking plant, Animas Valley, New Mexico, 1978-1979

	Year 1 of Operation			Year 2 of Operation		
Assets						
Current Assets						
Cash			$ 4,734,911			$ 5,184,850
Prepaid Insurance			5,793			5,426
Total Current Assets			$ 4,740,704			$ 5,190,276
Fixed Assets						
Land*		$ 335,500			$ 335,500	
Buildings*	$ 2,920,561			$2,920,561		
Less Accumulated Depreciation	- 105,140	2,815,421		- 210,280	2,710,281	
Equipment*	$ 4,472,062			$4,472,062		
Less Accumulated Depreciation	- 335,405	4,136,657		- 670,810	3,801,252	
Total Fixed Assets			$ 7,287,578			$ 6,847,033
TOTAL ASSETS			$12,028,282**			$12,037,309**
Liabilities & Owner Equity						
Liabilities						
Medium Term Loan		$2,853,295			$1,511,719	
Long Term Loan		3,800,182			3,729,546	
Property Taxes		34,167			32,130	
TOTAL LIABILITIES			$ 6,687,644			$ 5,273,395
Owner's Equity						
Owner Equity		$3,864,000			$3,864,000	
Retained Earnings	$ 2,476,631			$5,899,909		
Less Cash Dividends	- 1,000,000	1,476,631		-3,000,000	2,899,909	
Total Owner's Equity			$ 5,340,631			$ 6,763,909
TOTAL LIABILITIES & OWNER EQUITY			$12,028,275**			$12,037,304**

	Year 3 of Operation			Year 4 of Operation		
Assets						
Current Assets						
Cash			$ 5,099,326			$ 6,025,518
Prepaid Insurance			5,059			4,692
Total Current Assets			$ 5,104,385			$ 6,030,273
Fixed Assets						
Land*		$ 335,500			$ 335,500	
Buildings*	$2,920,561			$ 2,920,561		
Less Accumulated Depreciation	- 315,420	2,605,141		- 420,560	2,500,001	
Equipment*	$4,472,062			$ 4,472,062		
Less Accumulated Depreciation	-1,006,215	3,465,847		- 1,341,620	3,130,442	
Total Fixed Assets			$ 6,406,488			$ 5,965,943
TOTAL ASSETS			$11,510,873**			$11,996,216**
Liabilities & Owner Equity						
Liabilities						
Long Term Loan		$3,651,512			$3,565,308	
Property Taxes		30,094			28,058	
TOTAL LIABILITIES			$ 3,681,606			$ 3,593,366
Owner's Equity						
Owner Equity		$3,864,000			$3,864,000	
Retained Earnings	$9,965,264			$14,538,852		
Less Cash Dividends	-6,000,000	3,965,264		-10,000,000	4,538,852	
Total Owner's Equity			$ 7,829,264			$ 8,402,852
TOTAL LIABILITIES & OWNER EQUITY			$11,510,870**			$11,996,218**

* Includes contingency.

** Difference due to rounding error.

EXHIBIT 17. Return to assets and equity for the first four years of operation, beef slaughter and meat precooking plant, Animas Valley, 1978-1979

	Year 1	Year 2	Year 3	Year 4
		Return to Assets		
Net Income	$ 2,476,631	$ 3,423,278	$ 4,065,355	$ 4,573,588
Interest Expense	794,521	647,036	469,495	361,271
Net Profit Before Interest Expense	$ 3,271,152	$ 4,070,314	$ 4,534,850	$ 4,934,859
Assets				
Beginning of Year	$ 7,728,123	$12,028,282	$12,036,899	$11,510,873
End of Year	12,028,282	12,036,899	11,510,873	11,996,216
Average Investment in Assets	$ 9,878,203	$12,032,591	$11,773,886	$11,753,545
Return on Total Assets	= $ 3,271,152 / 9,878,203	= $ 4,070,314 / 12,032,591	= $ 4,534,850 / 11,773,886	= $ 4,934,859 / 11,753,545
	= 33.1 Percent Return on Assets	= 33.8 Percent Return on Assets	= 38.5 Percent Return on Assets	= 42.0 Percent Return on Assets
		Return to Equity		
Net Income	$ 2,476,631	$ 3,423,278	$ 4,065,355	$ 4,573,588
Owner Equity				
Beginning of Year	$ 3,864,000	$ 5,340,631	$ 6,763,909	$ 7,829,264
End of Year	5,340,631	6,763,909	7,829,264	8,402,852
Average Owner's Equity	$ 4,602,316	$ 6,052,270	$ 7,296,587	$ 8,116,058
Return on Owner's Equity	= $ 2,476,631 / 4,602,316	= $ 3,423,278 / 6,052,270	= $ 4,065,355 / 7,296,587	= $ 4,573,588 / 8,116,058
	= 53.8 Percent Return to Owner Equity	= 56.6 Percent Return to Owner Equity	= 55.7 Percent Return to Owner Equity	= 56.4 Percent Return to Owner Equity

assets. The returns for beef precooking are high but not unreasonable considering the new technology and risk involved. The returns to the owner's equity ranged from 53.8 to 56.6 percent. The leverage positions, reflected by the extremely high returns to owner's equity, may not be obtainable. If it was necessary for the owners of the plant to put up more cash "up-front", the return to owner equity would be lower than the percentage in this study.

Price Sensitivity

If it became necessary to reduce the price of the precooked meat and fabricated roast product by 10 cents per pound, with all other costs held constant, the before-tax net profits for each of the four years would be reduced to the levels presented in Table 26. A price reduction of 10 cents per pound would reduce before-tax profits in the first year of operation from $4.3 million to $100,110, a reduction of 97.6 percent. Such sensitivity in product prices could cause major cash flow problems. The same price reduction in the fourth year would reduce profits by about 71 percent from about $7.6 million to $2.2 million. By-products are normally purchased by other processors that purchase several beef packing plants' by-products. The proposed plant's location would be away from other major processing plants. If the plant had to pay transportation costs for its by-products, the profitability of the plant could be reduced.

It was assumed that the plant would buy its live cattle at $0.54 per pound at the plant site. An increase in the price of cattle of $0.02 per pound, holding other costs constant, would reduce the after-tax profit levels to those shown in Table 27. In the first year of

Table 26. Before tax net income received under two product prices, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979

Year	Before Tax Net Income: Discounted[a] Product Prices	Before Tax Net Income: Non Discounted[b] Product Prices	Decline in Profit
	dollars	dollars	percent
1	100,110	4,127,718	97.6
2	980,498	5,705,464	82.8
3	1,697,842	6,775,591	74.9
4	2,199,350	7,622,646	71.1

[a] The precooked meat and fabricated roast products have been discounted 10 cents per pound.

[b] From income statement exhibits for the respective years.

Table 27. Before tax net income under two live cattle prices, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979

Year	Live Cattle Prices: 56¢/pound[a]	Live Cattle Prices: 54¢/pound[b]	Reduction In Income
	dollars	dollars	percent
1	1,398,438	4,127,718	66.1
2	2,495,214	5,705,464	56.3
3	3,324,369	6,775,591	50.9
4	3,930,454	7,622,646	48.4

[a] Increased price of two cents per pound.

[b] Before tax net income from respective income statement exhibits.

operation, the price increase would reduce the before-tax profit from $4.1 million to $1.4 million, a reduction of 66.1 percent. In the fourth year, the two cent per pound increase in the purchase price for live cattle would only reduce profits by about 48 percent.

Savings Due to Geothermal Resource

The savings can be established by determining how much it would cost the plant to use natural gas. There are two sources of savings from the geothermal resource: (1)savings in equipment cost, and (2) savings due to the substitution of hot water for natural gas in pre-cooking.

A different set of cooking and cooling equipment would be needed if the plant were to use natural gas instead of geothermal hot water. It was estimated that such equipment would cost approximately 1.3 times a much as a hot water system.

Hot water cooking system cost	$300,000
Natural gas cost cooking system	
(100,000 x 1.3)	$390,000

The plant would save $90,000 in cooking equipment cost. The investment required for a hot water supply system of would be an additional $280,000. Therefore, the equipment cost is actually $190,000 more when using geothermal hot water as opposed to natural gas. On a yearly basis, the additional cost becomes $14,250 using the previously depreciated methods.

With the processing capacity of 80 pounds per minute, a specific heat of the meat of 0.8 BTU and the total change in temperature of 60° F required (150 - 90° F). The amount of heat required would be 3,840

BTU per minute (80 lbs per/minute x 0.8 BTU x 60° F). Assuming a 40 percent efficiency in the use of natural gas, only 0.01 MCF/minute would be required (3840/(940,000 x .40) = 0.01). With the price of natural gas being $2.57 per MCF, the cost per minute for the two production lines would be $0.0257; thus, the fuel cost for the two production lines operating 16 hours per day would save $6,168 annually in fuel costs.

When the annual fixed cost of $14,250 is considered with the annual fuel cost savings of $6,168, a cost or net decline in profit of $8,082 per year is the net result. The savings in fuel cost does not justify the large additional expenses of the geothermal supply and reinjection system.

Although the contribution made by substituting geothermal hot water for natural gas is negative, at today's energy prices, further consideration should be given to two factors. Currently, natural gas prices are held down by regulations. With the deregulation of oil and natural gas prices, natural gas prices will rise and the potential for plant savings increases. Also, availability of natural gas and other fuels has been a problem (Ries, 1977). It cannot be quantified how much the plant would lose in the event of a fuel shortage. It is safe to say that the plant could possibly be better off in the long run with a more reliable source of energy. Geothermal hot water provides such an alternative, though not a cheaper alternative at current market prices of natural gas.

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APPENDIX A

Appendix Table A-1. Sources of funds, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Owner's Equity		$1,244,644
Loans		
Short Term	$ 70,000	
Long Term	$1,244,645	
TOTAL		$1,314,645
TOTAL		$2,559,289

Appendix Table A-2. Annual depreciation expense by investment classification, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Item	Investment[a]	Salvage Value	Balance of Depreciation[b]	Annual Depreciation
	- - - - - - -	- - - - - - -	dollars - - - - - - -	- - - - - - -
Buildings	1,970,279	394,056	1,576,223	78,811
Fixtures	98,307	19,661	78,646	7,865
Equipment	47,265	2,442	44,824	8,066
Vehicles	38,438	10,460	27,978	4,165
Wells	185,000	29,500	155,500	4,588
Total	2,339,289	456,119	1,883,171	103,495

[a] Calculations utilize information from Table 7.

[b] Balance for depreciation = investment - salvage value.

Appendix Table A-3. Average annual insurance expense for geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Item	Investment Cost	Salvage Value	Depreciable Balance	Insurance on Salvage[a]	Insurance on Balance[b]
	dollars				
Buildings	1,970,279	394,056	1,576,223	3,941	7,881
Fixtures	98,307	19,661	78,646	197	393
Equipment	47,265	2,442	44,824	24	224
Vehicles	38,438	10,460	27,978	105	140
Wells	185,000	29,500	155,500	295	778
Subtotal	2,339,289	456,119	1,883,171	4,562	9,416
Total				13,978	

[a] Insurance on salvage = $1.00 per $100.

[b] Insurance on balance = $0.50 per $100.

Appendix Table A-4. Average annual property tax, geothermal greenhouse tomato production Animas Valley, New Mexico 1979

Item	Assessed Value	Tax	Assessed Salvage Value[a]	Tax on Salvage[b]	Assessed Balance for Depreciation[c]	Tax on Balance
	dollars					
Land and Site	49,995	1,386	--	--	--	--
Buildings	--	--	131,339	3,642	525,355	7,284
Fixtures	--	--	6,553	182	26,213	363
Equipment	--	--	814	23	14,940	207
Vehicles	--	--	3,486	97	9,325	129
Wells	--	--	9,832	273	51,828	719
Subtotal		1,386	152,024	4,217	627,661	8,702
Total Tax						12,919

[a] Assessed salvage value = 33.33 percent of salvage value given in Appendix Table A-2.

[b] Tax on salvage = $\frac{\text{Assessed Salvage Value} \times 27.73}{1{,}000}$

[c] Assessed balance for depreciation = 33.33 percent of the balance for depreciation given in Appendix Table A-2.

[d] Tax on balance = $\frac{\text{Assessed Balance for Depreciation} \times 13.865}{1{,}000}$

Appendix Table A-5. Estimated annual maintenance expense, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979.

Item	Investment Cost[a]	Maintenance Cost[b]
	------------- dollars	-------------
Buildings	1,970,279	49,257
Fixtures	98,307	9,831
Equipment	47,265	4,727
Vehicles	38,438	3,844
Wells	185,000	18,500
Total	2,339,289	86,159

[a] Investment costs from Table 7.

[b] Maintenance = 2.5% for buildings and 10% for fixtures equipment, vehicles and wells.

Appendix Table A-6. Short term borrowing and repayment schedule, geothermal greenhouse tomato production, Animas Valley, New Mexico, 1979

Month	New Loans	Carryover From Previous Period	Total Borrowings	Payments	Interest	Principle	Balance
January	$70,000	--	$ 70,000	$ 3,359	$ 700	$ 2,659	$ 67,341
February	40,000	$ 67,341	107,341	1,734	1,073	661	106,680
March	40,000	106,680	146,680	1,734	1,467	267	146,413
April	15,000	146,413	161,413	2,212	1,614	598	160,815
May	--	160,815	160,815	81,117	1,608	79,509	81,306
June	--	81,306	81,306	58,418	813	57,605	23,701
July	36,000	23,701	59,701	1,344	597	747	58,945
August	43,000	58,945	101,954	2,231	1,020	1,211	100,743
September	40,000	100,743	140,743	1,734	1,407	327	140,416
October	41,000	140,416	181,416	2,734	1,814	920	180,496
November	--	180,496	180,496	39,977	1,805	38,172	142,324
December	--	142,324	142,324	80,186	1,423	78,763	63,561
TOTALS				$276,780	$15,341	$261,439	$ 63,561

Appendix Table A-7. Sources of funds, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Owner's Equity		$1,335,294
Loans		
Short Term	$ 70,000	
Long Term	$1,335,395	
TOTAL		$1,405,395
TOTAL		$2,740,789

Appendix Table A-8. Annual depreciation expense by investment classification, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Item	Investment[a]	Salvage Value	Balance of Depreciation[b]	Annual Depreciation
Buildings	$1,967,864	$393,573	$1,574,291	$ 78,715
Fixtures	98,186	19,637	78,549	7,855
Equipment	231,348	2,439	228,909	44,885
Vehicles	38,391	11,071	27,320	4,036
Wells	185,000	29,500	155,500	4,588
Total	$2,520,789	$456,220	$2,064,569	$140,079

[a] Calculations utilize information from Table 12.

[b] Balance for depreciation = investment - salvage value.

Appendix Table A-9. Average annual insurance expense for geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Item	Investment Cost	Salvage Value	Depreciable Balance	Insurance on Salvage[a]	Insurance on Balance[b]
	dollars				
Buildings	1,967,864	393,573	1,574,291	3,936	7,871
Fixtures	98,186	19,637	78,549	196	393
Equipment	231,348	2,439	228,909	24	1,145
Vehicles	38,391	11,071	27,320	111	137
Wells	185,000	29,500	155,500	295	778
Subtotal	2,520,789	456,220	2,064,569	4,562	10,324
Total				14,886	

[a] Insurance on salvage = $1.00 per $100

[b] Insurance on balance = $0.50 per $100

Appendix Table A-10. Average annual property tax, geothermal greenhouse potted chrysanthemum production, Animas Valley, 1979

Item	Assessed Value	Tax	Assessed Salvage Value[a]	Tax on Salvage[b]	Assessed Balance for Depreciation[c]	Tax on Balance[d]
	dollars					
Land and site	49,995	1,386	--	--	--	--
Buildings	--	--	131,178	3,638	524,711	7,275
Fixtures	--	--	6,545	181	26,180	363
Equipment	--	--	813	23	76,295	1,058
Vehicles	--	--	3,690	102	9,106	126
Wells	--	--	9,832	273	51,828	719
Subtotal		1,386		4,217		9,541
Total						13,758

[a] Assessed salvage value = 33.33 percent of salvage value given in Appendix Table A-8.

[b] Tax on salvage = $\frac{\text{Assessed Salvage Value x 27.73}}{1,000}$

[c] Assessed balance for depreciation = 33.33 percent of the balance for depreciation given in Appendix Table A-8.

[d] Tax on balance = $\frac{\text{Assessed Balance for Depreciation x 13.865}}{1,000}$

Appendix Table A-11. Estimated annual maintenance expense, geothermal greenhouse potted chrysanthemum production, Animas Valley, New Mexico, 1979

Item	Investment Cost[a]	Maintenance Cost[b]
	--------dollars--------	
Buildings	1,967,864	49,197
Fixtures	98,186	9,819
Equipment	231,348	23,135
Vehicles	38,391	3,839
Wells	185,000	18,500
TOTAL	2,520,789	104,490

[a] Investment costs plus contingency from Appendix Table A-8.

[b] Maintenance = 2.5% for building and 10% for fixtures, equipment, vehicles and wells.

Appendix Table A-12. Yearly greenhouse heating requirements.

Total heat loss was calculated as follows:

1. Roof

   329,021 x 65 x 1.22 (a) = 26,091,365 BTU/hr

2. Sidewalls

   35,526 x 65 x 1.13 (b) = 2,609,381 BTU/hr

3. Endwalls

   10,052 x 65 x 1.13 (c) = 738,319 BTU/hr

The total heat loss for the greenhouse is estimated to be 29,439,066 BTU's per hour when an exterior temperature of -5°F is assumed.

Yearly heat requirement can be calculated by use of the following equation:

BTU per hour x inverse of difference in interior and exterior temperatures x 24 hours x heating degree days

Therefore, assuming an exterior temperature of -5°F and an interior temperature of 65°F the yearly heat requirement would be:

$$29{,}439{,}066 \times \frac{1}{70} \times 24 \times 3364$$

$$= 33{,}954{,}178{,}000 \text{ BTU per year.}$$

[a] From the ASHRE Handbook of Fundamentals, 1972.
[b] From the ASHRE Handbook of Fundamentals, 1972.
[c] From the ASHRE Handbook of Fundamentals, 1972.

APPENDIX B

Appendix Table B-1. Percentage and weight distribution of boned meat cuts from a beef carcass.

Meat Cut	Percentage	Weight in Pounds
Rounds	23	103.5
Ribs	7	31.5
Subtotal	30	135.0
Chucks	25	112.5
Plates	4	18
Shanks	4	18
Tips	3	13.5
Briskets	2	9
Flanks	1	4.5
Trimmings	10	45
Subtotal	49	220.5
Loins	12	54
Fat	8	36
Cutting loss	1	4.5
Total	100	450.0

Source: Ray, 1979.

Appendix Table B-2. Estimated average depreciation and maintenance expense for buildings and equipment, beef slaughter and pre-cooking plant, Animas Valley, New Mexico, 1978-1979

Item	Annual Investment[a]	Annual Depreciation[b]	Average Annual Maintenance[c]
Slaughter Facility			
Buildings	1,017,720	36,638	25,443
Equipment	923,780	69,284	92,378
Subtotal	1,941,500	105,922	117,821
Boning Facility			
Buildings	304,920	10,977	7,623
Equipment	174,692	13,102	17,469
Subtotal	479,612	24,079	25,092
Fabrication Facility			
Buildings	18,150	653	454
Equipment	665,060	49,880	66,506
Subtotal	683,210	50,533	66,960
Cooking and Cooling Facility			
Buildings	174,240	6,273	4,356
Equipment	347,600	26,070	34,760
Subtotal	521,840	32,343	39,116
Freezing and Storage Facility			
Buildings	396,000	14,256	9,900
Equipment	1,135,200	85,140	113,520
Subtotal	1,531,200	99,396	123,420
Plant Support Facilities			
Buildings	1,009,531	36,342	25,238
Equipment	1,225,730	91,930	122,573
Subtotal	2,235,261	128,272	147,811
TOTAL	7,392,623	440,545	520,220

[a] Investment from Table 17 includes 10 percent contingency.

[b] Depreciation was calculated on a straight line basis with 10 percent salvage value and a 25 year life for buildings and a 12 year life for equipment.

[c] Maintenance was calculated to be 2.5 percent of investment for buildings and 10 percent of investment for equipment.

Appendix Table B-3. Estimated annual insurance and property tax expense for the first four years of plant operation, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979.

Insurance Expenses

Item	Investment[a]	Year 1 Depreciated Value[b]	Year 1 Insurance[c]	Year 2 Depreciated Value[b]	Year 2 Insurance[c]	Year 3 Depreciated Value[b]	Year 3 Insurance[c]	Year 4 Depreciated Value[b]	Year 4 Insurance[c]
	dollars								
Buildings	2,920,561	2,920,561	29,206	2,815,421	28,154	2,710,281	27,103	2,605,141	26,051
Equipment	4,472,062	4,472,062	44,721	4,136,657	41,367	3,801,252	38,013	3,465,847	34,658
Total	7,392,623		73,927		69,521		65,116		60,709

Property Tax Expense

Item	Investment[a]	Year 1 Assessed Value[d]	Year 1 Tax[e]	Year 2 Assessed Value[d]	Year 2 Tax[e]	Year 3 Assessed Value[d]	Year 3 Tax[e]	Year 4 Assessed Value[d]	Year 4 Tax[e]
	dollars								
Land and Buildings	3,256,061	1,085,354	26,996	1,050,307	26,024	1,015,260	25,052	980,214	24,080
Equipment	4,472,062	1,490,687	41,337	1,378,886	38,236	1,267,084	35,136	1,155,282	32,036
Total	7,728,123		68,333		64,260		60,188		56,116

[a] Investment from Table 19 includes a 10 percent contingency.

[b] Investment less accumulated depreciation.

[c] Insurance was calculated at depreciated value times $1.00 premium per $100.00 value.

[d] One third of depreciated value.

[e] Based on a tax rate of $27.73 per $1,000 assessed value.

Appendix Table B-4. Estimated daily and annual cattle expense, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979.

Year	Operation Level (Percent of Rated Capacity)	Daily Cattle Requirements	Daily[a] Cattle Cost	Annual[b] Cattle Cost
	percent	head	---------dollars---------	
1	60%	576	311,040	77,760,000
2	70%	672	362,880	90,720,000
3	75%	720	388,800	97,200,000
4	80%	768	414,720	103,680,000

[a] Based on $0.54/pound cost plant site.

[b] Based on 250 day work year.

Appendix Table B-5. Estimated daily and annual packaging materials cost, beef slaughter and precooking plant, Animas Valley, New Mexico, 1978-1979.

Year	Slaughter Less Condemnation	Precooking Packaging[a]		Prestorage Packaging[b]		Total Cost	
		Daily Cost[c]	Annual Cost[d]	Daily Cost[e]	Annual Cost[d]	Daily Cost	Annual Cost
	head	$	$	$	$	$	$
1	570	2,442	610,500	2,792	698,000	5,234	1,308,500
2	665	2,849	712,250	3,258	814,500	6,107	1,526,700
3	713	3,054	763,500	3,493	873,250	6,547	1,636,750
4	760	3,256	814,000	3,723	930,750	6,979	1,744,750

[a] Modified from Sporleder and Vastine (1973).

[b] Personal interview with Southwest Forest Industries, El Paso, Texas.

[c] Calculations as follows: 340 lbs. precooked x 1.26 cents per pound x daily slaughter less condemnation.

[d] Based on 250 days per year slaughter.

[e] Calculations as follows: 355 lbs. per animal frozen (precooked) or chilled (fresh) x 1.38 cents per pound x daily slaughter less condemnation.