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ENVIRONMENTAL ASSESSMENT  
FOR  
KELLEY HOT SPRING GEOTHERMAL PROJECT:  
KELLEY HOT SPRING AGRICULTURAL CENTER

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GEOTHERMAL POWER CORPORATION  
NOVATO, CALIFORNIA  
UNDER CONTRACT DE-AC03-79ET27041  
U. S. DEPARTMENT OF ENERGY

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i. PREFACE

This environmental assessment (EA) for Kelley Hot Spring Agricultural Complex was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 as amended (42 U.S.C. Section 4321 et sec.). This EA follows applicable policies and procedures for compliance with NEPA set forth in the Department of Energy Regulations. It analyzes the environmental impacts of an integrated swine production unit together with necessary ancillary operations deriving its primary energy from a known geothermal reservoir in accordance with policies established by Title III of the National Energy Conservation Act (NECPA) (Pl. 95-619).

ii. SUMMARY

This environmental assessment covers 6 areas designated as potentially feasible project sites, using as the basic criteria for selection ground, surface and geothermal water supplies. The six areas, comprising <sup>+</sup>150 acres each, are within a 2 mile radius of Kelley Hot Springs, a known geothermal resource of many centuries standing, located 16 miles west of Alturas, the county seat of Modoc County, California.

The project consists of the construction and operation of a 1360 sow confined pork production complex expandable to 5440 sows. The "farrow to finish" system for 1360 sows consists of 2 breeding barns, 2 gestation barns, 1 farrowing and 1 nursery barn, 3 growing and 3 finishing barns, a feed mill, a methane generator for waste disposal and water storage ponds. Supporting this are one geothermal well and 1 or 2 cold water wells, all occupying approximately 12 acres.

Environmental reconnaissance involving geology, hydrology, soils, vegetation, fauna, air and water quality, socio-

economic, archaeological and historical, and land use aspects were carefully carried out, impacts assessed and mitigations evaluated. From the environmental point of view Site #6 is the best location and most feasible from the geothermal resource. It is clear of archaeological and historical sites, soils and vegetation are marginal dry farm fields. Terrain is gently-sloping, geothermal resource evaluations point to the hottest water, and there is ample room for expansion. Access can be made relatively easily although it is the most remote (1 mile) from the state highway. Site #3 is a good, acceptable alternate location, but must be connected to the geothermal resource at Site #6 with a pipeline 1 1/4 miles long. Archaeological sites are avoided. Access to Highway 299 is direct, although a road to the geothermal well along the pipeline must be constructed and maintained.

Site #5 is also an acceptable alternative, but does not have as good a geothermal resource as the first two. It does have a geothermal well of known quality and temperature. It is proximal to Highway 299, clear of archaeological and historical sites, and has non-critical vegetation and soils.

Sites #1, #2 and #4 were removed from further consideration because of archaeological and historical complications, limited room for expansion, unacceptable and/or unfeasible access routes and land use conflicts. Site #1 must have the existing geothermal well, developed in 1969, plugged and abandoned according to California Division of Oil and Gas regulations, and if done according to the constraints outlined in this report will cause no further environmental impact.

The project's internal environmental design features were studied through team efforts and found to be well within acceptable environmental limits. Fifty-three internal environmental engineering design and operational options were examined. These are discussed in other project documents and summarized in appendices to this document. Only those

features [cf. Final Technical Report KHSAC 1980], that reduce or mitigate project impacts or provide for humane, efficient and healthful environments for the animals involved have been incorporated into the project. These same features proved to be the most economical for long range production as well. The project will not generate odors because of the methane generation system. No noise will be created that will be noticed off site; while extensive, the visual aspect will not conflict with existing agricultural installations related mostly to cattle or lumbering. Water quality of natural drainages (surface and subsurface), will not be impaired. Positive socio-economic impacts are expected with little impact on the burden of local government with perhaps the necessity of expanding the local schools (grades 1-8).

The impact of the project on the geothermal resource will utilize, at full production,  $\frac{+}{-}1\%$  of the local heat flow estimated for the area. No impact is expected on the flow, water quality or temperature of Kelley Hot Spring if any of Sites #6, #3, or #5 are to be developed.

## 1. DESCRIPTION OF THE PROPOSED ACTION

The proposed project designated as the Kelley Hot Spring Agricultural Complex (KHSAC) is a joint federal and privately funded geothermal development demonstrating the economics and operational application of low temperature geothermal heat to swine production complex.

Federal participation is through a Department of Energy (DOE) Contract DE-AC03-79ET27041 made under a Program Opportunity Notice ED-77-N-03-1553. Further federal participation may occur through established government financing for economic development projects.

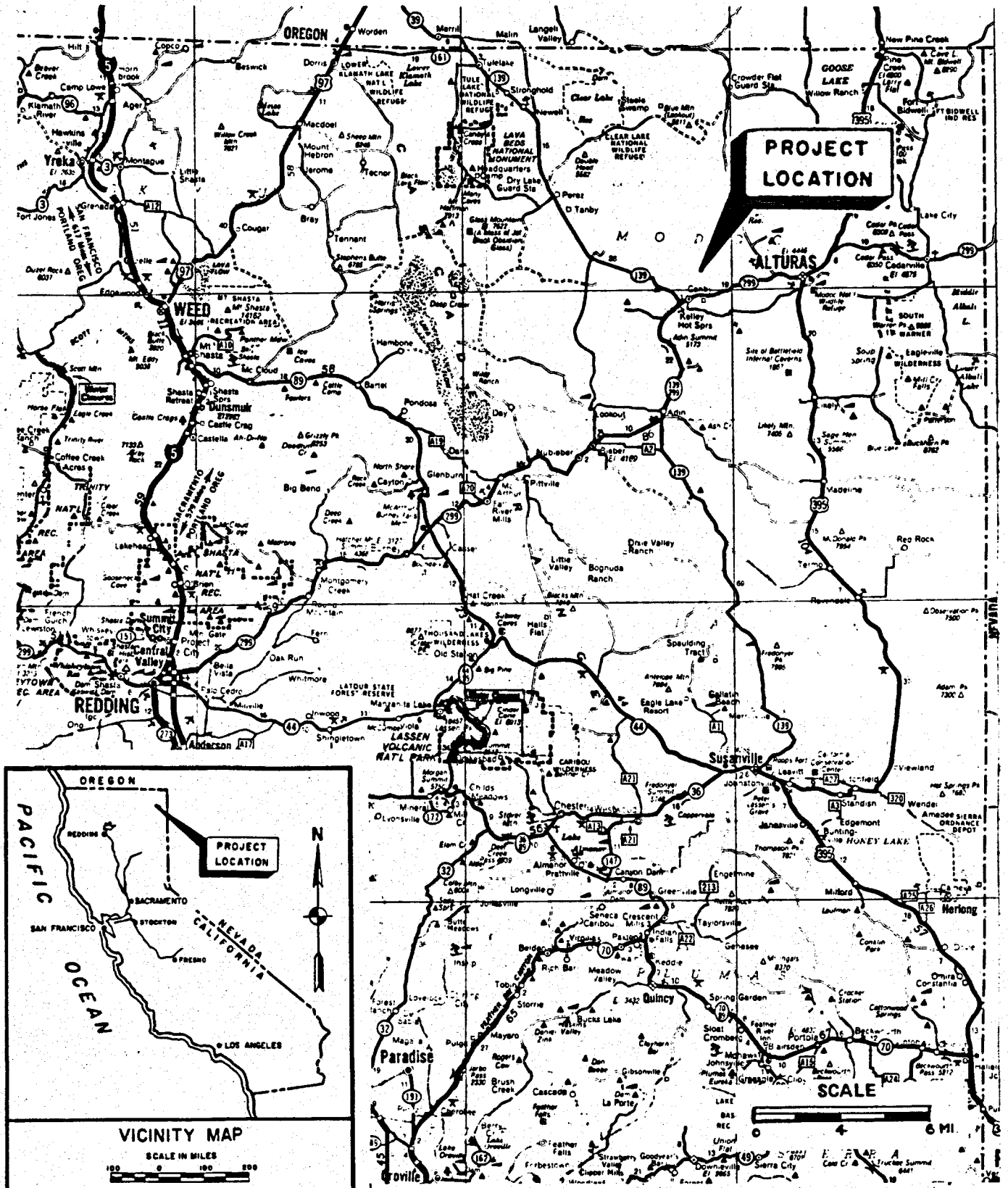
This environmental assessment is prepared under the DOE "Guidelines for Environmental Review" and describes the current status, impacts, and mitigations arising from a cascade of geothermal heat applications centering around a confined swine-raising unit and various support operations.

The project is located in northeastern California at Kelley Hot Spring in central Modoc County 16 miles west of Alturas (Figure 1). It is 84 miles south of Klamath Falls, Oregon. The project is immediately adjacent to the extensive federal lands described in the Upper Pit River Area Geothermal Leasing EAR (BLM & NFS, 1976).

### 1.1 LOCATION

The proposed project is located on private property in the vicinity of a large natural hot spring known as Kelley Hot Spring. The spring and potential sites are located in portions of Sections 20, 27, 28 and 29 T42N, R10E (MDM), approximately 2.5 miles east of Canby and 16 miles west of Alturas (the county seat of Modoc County).

# KELLEY HOT SPRING PROJECT AREA LOCATION



The natural hot spring, a geothermal well and two (Nos. 1 and 4) of six project site possibilities are located in the SE/2 of Section 29 (see Figure 2). Site #3 lies between Highway 299 and the Southern Pacific Railway in the S/2 NW/4 and the N/2 SW/4 Section 29. Site #5 and another geothermal well (KHS1) lie in the E/2 NW/4 and the W/2 NE/4 Section 27. Site #6 lies in the E/2 SW/4 Section 20. All sites lie on bench land about 20 to 30 feet above the flood plain of the Pit River.

State Highway 299 between Canby and Alturas passes along the northern edge of the alternate sites #2 and #3, and Kelley Hot Spring. The aspect of both foothill bench land and flood plain is pastoral--mainly pasture land and open space.

## 1.2 PROJECT DESCRIPTION

The project proposed and discussed in this document is an agricultural production complex based upon geothermal energy as its primary energy source. The complex is made up of the following modules which contribute to the efficient integration of production, waste disposal, and energy utilization.

- o geothermal well or wells, including an injection well to dispose of spent geothermal waters if necessary
- o heat exchange and transfer system to distribute usable heat within the project
- o feed production and processing unit which combines environmentally controlled growth of barley, the utilization of local agricultural waste products and locally-produced grains or feed stuffs
- o swine breeding facility as the major livestock product which includes environmentally controlled breeding and gestation units, sow farrowing units, pig nursery units and hog growing and finishing units. These units consist of total environmental control, automatic feeding, and waste control systems

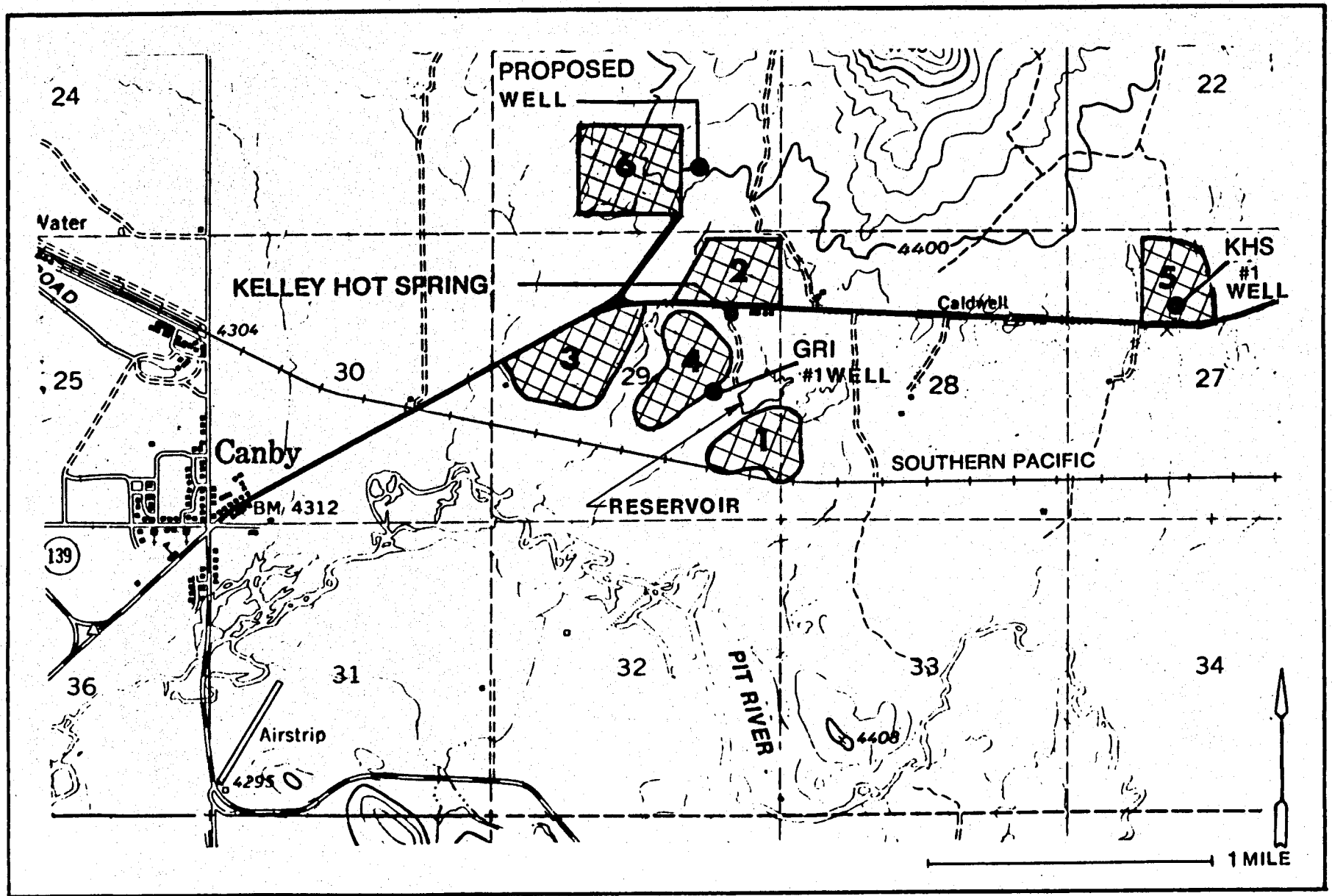


Figure 2 - Candidate Project Sites

- o solid waste management system based upon controlled conversion of manure and other biological wastes to biogas. Its principal constituent, methane, will be delivered to the property line, then piped to a generator operated by a local utility on a cogeneration basis
- o liquid waste management system based on aerated holding ponds and spray fields for small amount of excess water that might arise periodically

#### 1.2.1 General

The physical configuration of the site is in the preliminary design stage at this writing. Buildings relation, size, and disposition at this time is shown in Figure 3. Their configuration is adapted to the final site chosen--Site #6 or its alternate Site #3--and cleared for use by the various permitting agencies.

#### 1.2.2 The Geothermal Module

The geothermal module will include reservoir test wells, at least one production well, complete with proper casing, blowout prevention equipment if regulations require it, appropriate control valves, geothermal water and steam piping, heat exchanger, heat distribution piping and heat exchange units to the environments to which they are applied. Figure 4. illustrates diagrammatically the components of these units. The well is expected to produce 325 gallons per minute at a temperature of 208°F. According to the preliminary design report the geothermal waters have a purity sufficiently high to permit them to be used within the project operations, hence no reinjection well is incorporated into the project design. Geothermal reservoir characteristics are discussed in a subsequent section.

#### 1.2.3 The Feed Production Module

The feed production module will consist of a feed mill, storage sheds, grain bins, environmentally controlled grain-sprouting

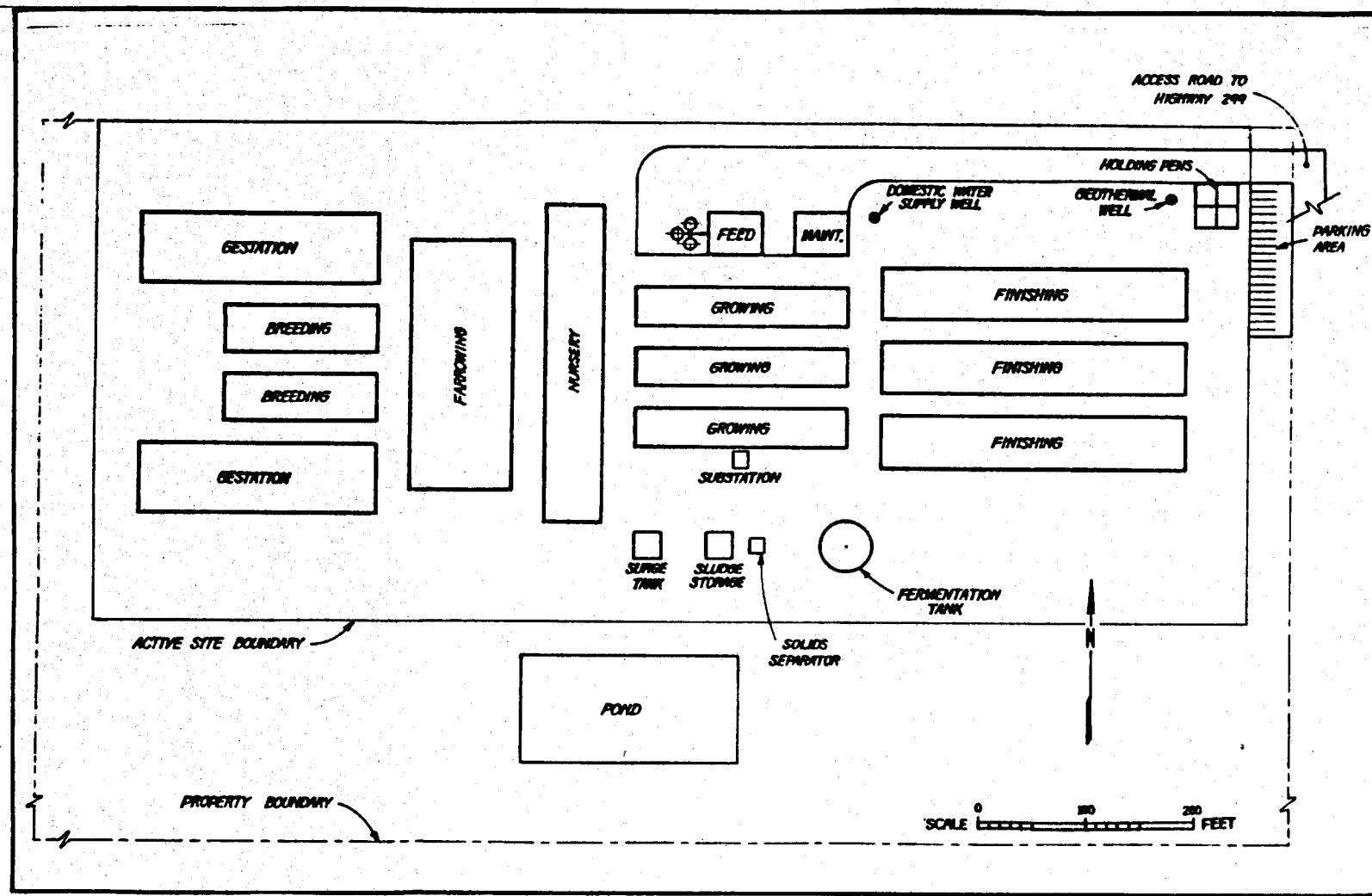


Figure 3  
 General layout of the structures housing the various project subsystems.



equipment, feed mixing, intraproject storage and other feed processing and distribution systems. The integration of these units is shown in Figure 5. Total land usage of this facility for this project and possible future expansion is on the order of 1 acre, including adequate circulation roads with appropriate turning radii for feed delivery trucks and trailers.

#### 1.2.4 The Swine Production Module

The swine production module is made up of replicated units designed especially to accommodate the environmental and operational requirements for each step of production; i.e., breeding, farrowing, nursery, growing and finishing. The interrelationships of swine production and the facilities necessary for optimal production are shown in Figure 6. Buildings are pre-engineered, constructed of standard prefabricated metal, insulated and enclosed. Interior fittings and equipment are commercial metal prefabricated gates, farrowing pens, feeders and other handling equipment. Floors are cement, some equipped with geothermal heating pipes, and some are equipped with specially fabricated grating over manure gutters; these gutters are equipped with water flush waste removal equipment. All such equipment is readily available, production tested and adaptable to these purposes.

All units are environmentally controlled for temperature, humidity, noise and odor. Environmental control concepts are integrals of each design feature creating optimal comfort for animals, efficiency in handling, disease control and elimination of objectionable implications usually associated with swine production such as aesthetic, water and air quality parameters.

Visual environmental control is exercised by landscaping and the fact that buildings are well-designed, low profile, color banded to merge with the rural agricultural aspect of the area.

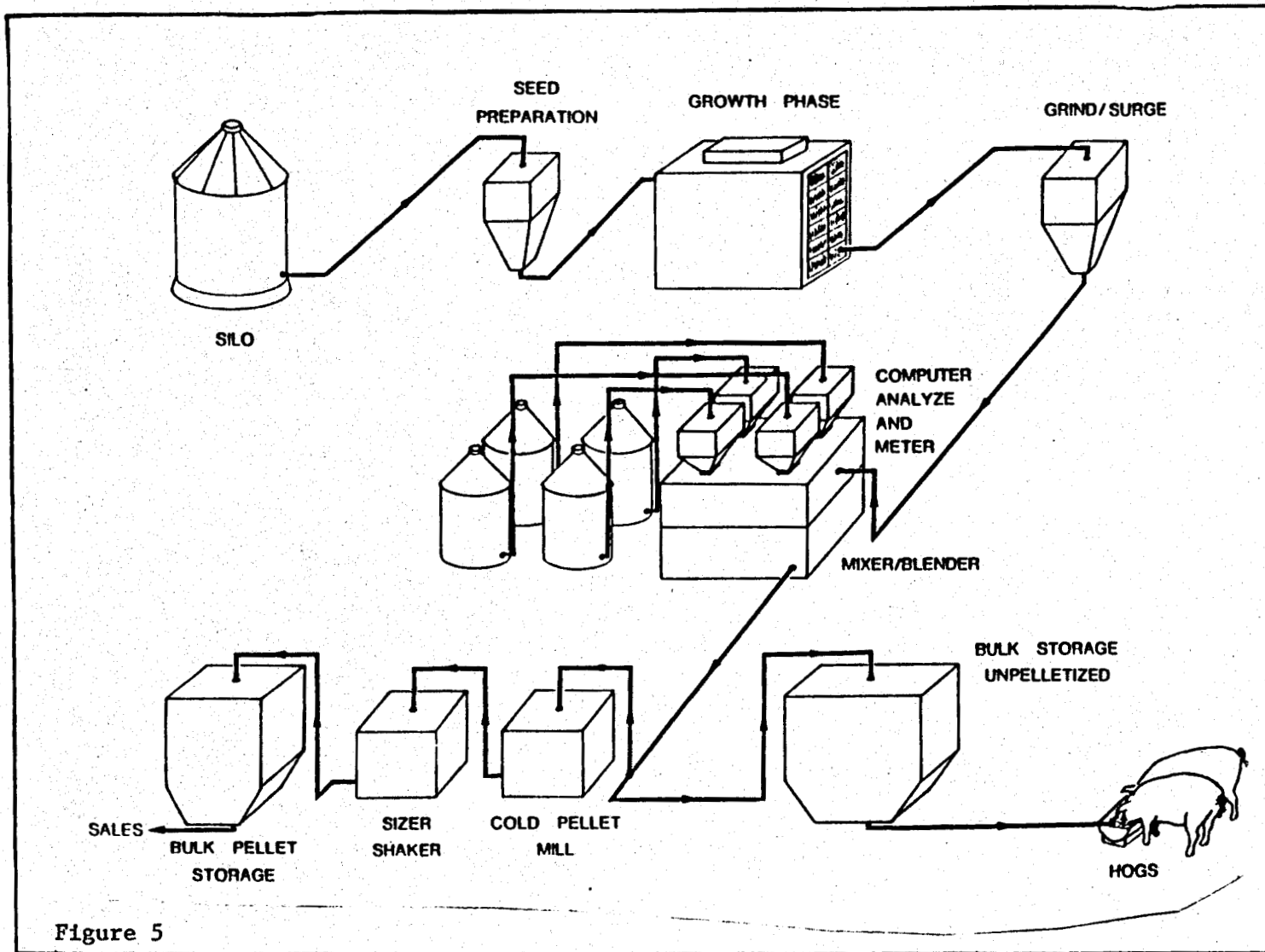
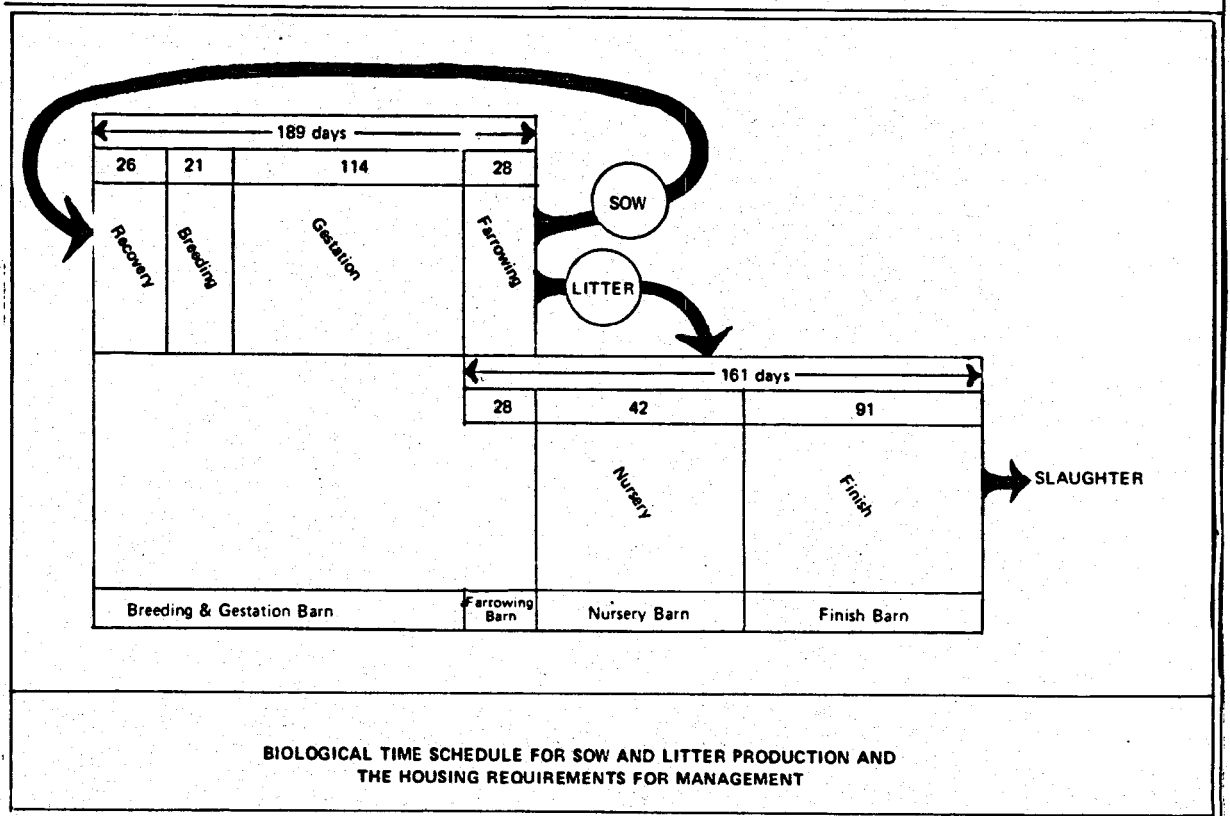


Figure 5

Feed production subsystem showing commercial feed production option with project feed supply. Mixer-blender unit combines grains, by-products and/or agricultural waste materials supplied to the project with or without sprouted grain grown at the project tailoring feed stuffs to the ration desired.

FIGURE 6



### 1.2.5 Solid Waste Management System

The principal requirement of this system is the control and use of animal wastes to eliminate odors, convert biological solids to useful products and eliminate the possibility of water and air pollution in the area. The system involves three major components:

Waste collection system  
Methane generation  
Residual sludge disposal

#### 1.2.5.1 Waste Collection and Transport System

Waste from each production building is collected separately in order to limit disease exposure. Excretia is collected in gutters below slatted floors of the hog living area. Flooring is specially developed to facilitate passage of manure yet be of low maintenance and sanitary.

At full capacity a 1360 sow complex produces 71 tons of manure and flush water per day. This flowable, pumpable slurry of about 75% flush water is delivered to the biogas generators through an enclosed piping system.

#### 1.2.5.2 Biogas Generation

Biogas generation is a thermophilic anaerobic fermentation operated optimally at 131°F. Methane, carbon dioxide, hydrogen, and traces of other gases are generated and diverted without compression to holding tanks. Methane, stripped of the other gases (where necessary), will be converted to electricity. Methane generated will be piped to the property boundary and delivered to a local utility to produce electricity. The utility will furnish power to the project. A continuous flow generator tank 20 feet high and 50 feet in diameter is expected to provide optimal operating and standby capacity (see Figure 7). According to the preliminary design, minimum production of methane is  $105 \times 10^3$  cubic feet per day.

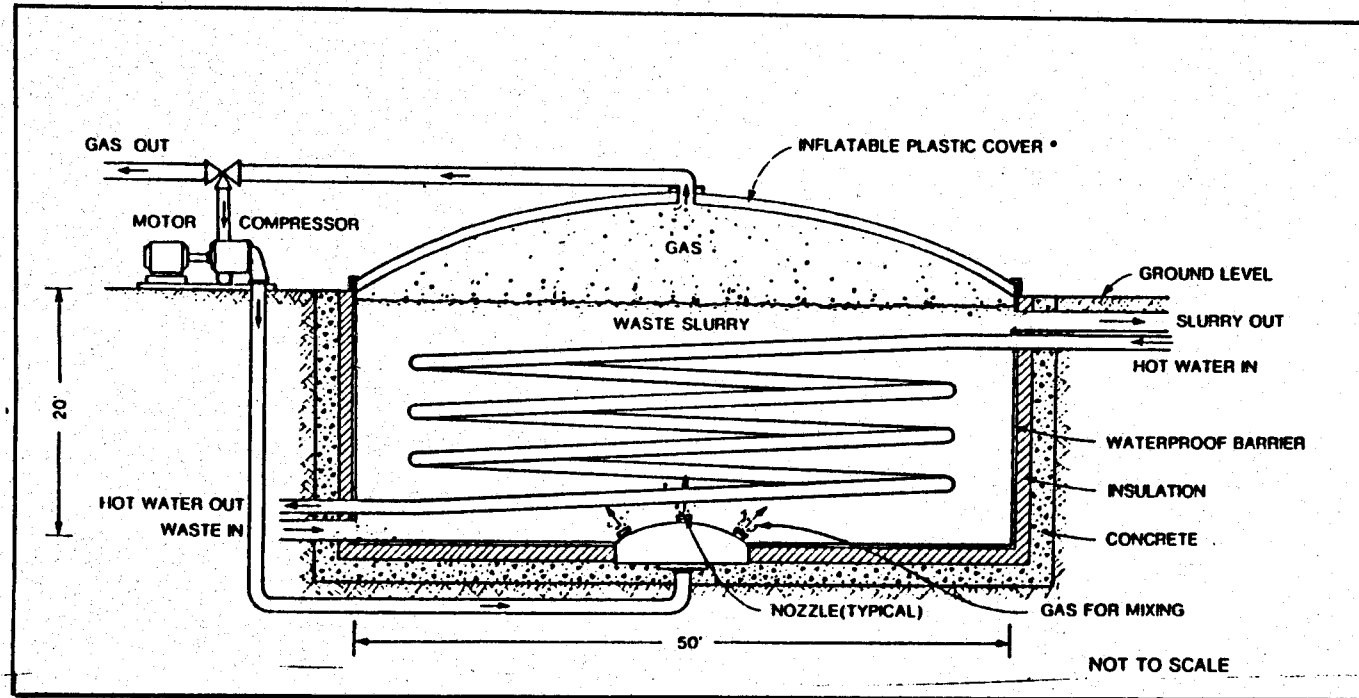


Figure 7  
 Conceptual design of biogas generation system.

#### 1.2.5.3 Residual Sludge Disposal

It is estimated that there will be a residual of 10,000 pounds of undigestible or inert materials monthly. This residual is rich in nutrients including nitrogen and, because of the anaerobic digestion, the process is free of disease and coliform bacteria. Hence, the sludge provides a usable fertilizer/growth medium in quantities sufficient for agricultural or greenhouse planting medium applications. This residue will be collected from settling ponds described in the liquid waste management system. The residue will be sold as fertilizer or transported to the county disposal site.

#### 1.2.5.4 Human Waste

Human waste will be controlled in a system separate from the swine waste facility. In order to conform to health and building standards, the human waste system will feature standard septic systems sufficient to meet applicable codes.

#### 1.2.6 Liquid Waste Management System

Liquid wastes are generated from excretia and from liquid removed from methane digestion tanks. Water, partially from discharges of the liquid waste system itself, is a transport medium from the solid waste management system. Upon discharge from the biogas generators, the slurry contains about 50% solids. Because so much of its objectionable material has been removed, a series of aerated ponds will effectively remove the balance of pollutants and provide purity standards well within the Water Quality Control Board regulations. As noted above, much of this water will be recycled through the plant.

### 1.3 KNOWN ENVIRONMENTAL ISSUES

The known environmental issues that confront the siting, construction and operation of this configuration of an agricultural complex are:

- a) The area has archaeological and historical sites of record.
- b) The proximity of the upper Pitt River and its small tributaries requires maintenance of high water quality standards and containment of project waters within recognized controlled disposal facilities on the project site.
- c) Hog odors that might impair the high aesthetic quality of the area must be eliminated.
- d) Adequate potable water sources must be available on site.
- e) The natural ecosystem particularly as it might impinge on wildlife and waterfowl must not be impacted.
- f) The extraction of geothermal fluid should not influence the water quality, flow rate or temperature of the natural hot springs of the area.
- g) Abandonment of GRI #1 Well.

### 1.4 PURPOSE AND NEED FOR PROPOSED ACTION

#### 1.4.1 Purpose

The purpose of the proposed action is to demonstrate the engineering practicality and economic soundness of using geothermal energy as a base energy source to operate an integrated swine production complex. The conceptual design indicates that by using manure and wastes as a substrate for methane generation and geothermal energy for space heating and special applications large complexes can actually be largely energy selfsufficient and in some periods actually export electrical energy into conventional distribution systems.

The need for the proposed action is to demonstrate the economical feasibility of substituting geothermal energy in the form of hot water at a relatively low enthalpy for the more

expensive and rapidly depleting oil and natural gas normally used for space heating. The preliminary design report states that "the use of geothermal direct heat energy in the complex displaces nearly 350,000 gallons of fuel oil per year. Generation of biogas (methane) displaces an additional 300,000 gallons of fuel oil per year."

The proposed action will demonstrate that the complex will produce  $6.69 \times 10^6$  pounds of pork per year, utilizing 12,957.5 tons of feed per year and maintain 1,360 sows and associated breeding stock and production animals in total confinement.

## 2. CURRENT ENVIRONMENTAL STATUS

### 2.1 GEOLOGY

#### 2.1.1 Stratigraphy

The general aspects of the geology for the Modoc Plateau are generally described in the BLM-EA for upper Pit River (pp. II-1-2). The applicable portion is limited to the Warm Springs Basin portion of the Pit River drainage between Alturas and Canby. No details are given by BLM for this area. The area of special interest lies between 4320 and 4350 feet elevation. The Modoc plateau rises to the north to elevations of 5,000 to 6,000 feet. Figure 8 illustrates the cross-section stratigraphy just north of Canby and Kelley Hot Spring (see also Figure 15 p.85a). The project sites are located along the north side of the Pit River in the Warm Springs Basin on shallow Quaternary alluvial sediments that lie proximal to the foothill escarpment marking the base of the Modoc Plateau. Underlying rocks are sedimentary and tuffaceous beds of the Alturas Formation. The sedimentary deposits are in the form of large alluvial fans and valley bottom land. Erosion subsequent to massive deposition has left benches and terraces at various heights above the present valley floor. (See Figure 9, p. 20a.)

The river bottom itself has assumed old stage characteristics having a broad flat aspect, numerous meander channels, ox bow lakes, sloughs and marsh lands.

Faults are very numerous in the area with significant fault strands mapped at intervals of one to two miles. The Likely Fault is the principal northwest trending fault which passes about one mile west of Kelley Hot Spring and appears to be a significant regional boundary.

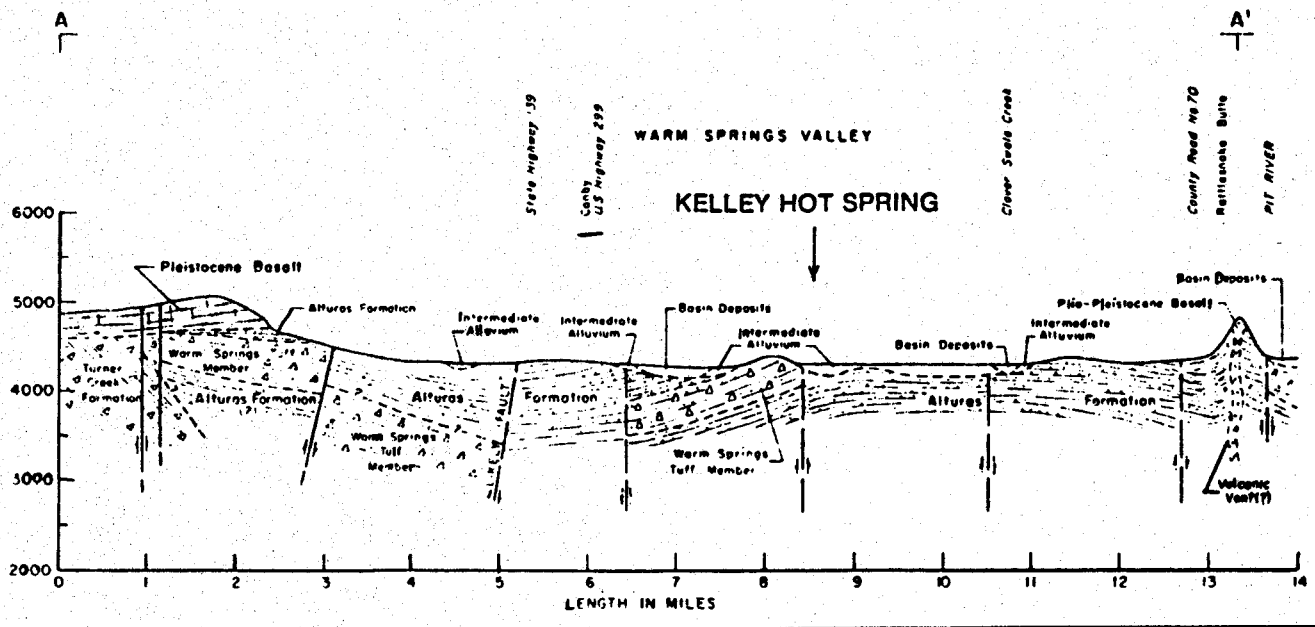


Figure 8

Cross section of geologic formations in the Warm Spring Valley. See also Figure 15, page 85a for orientation of section.

# GEOLOGY

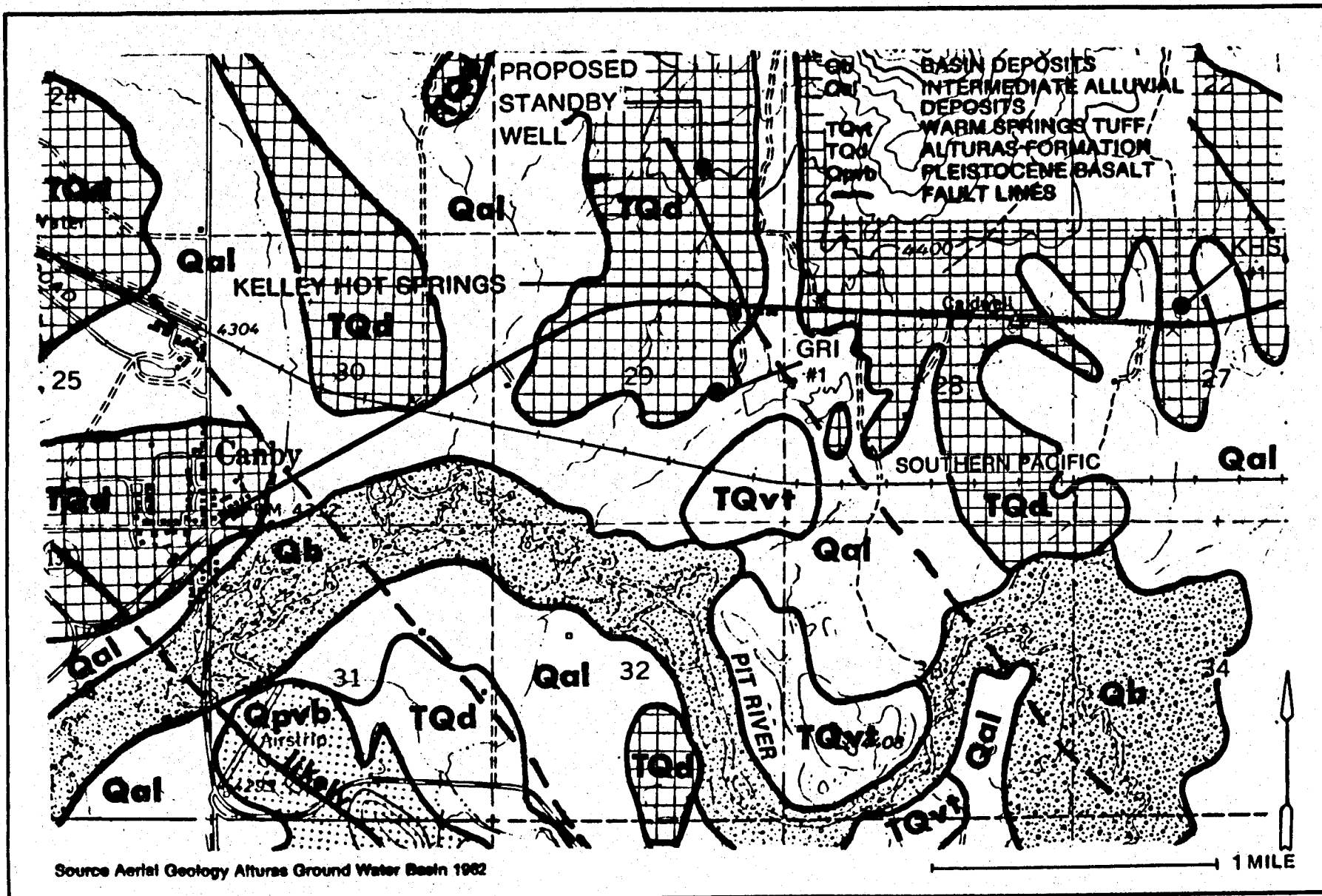


Figure 9

### 2.1.2 The Geothermal Resource

The most significant geological resources of the area are the geothermal manifestations at several hot springs in Warm Springs Valley. The largest of these is Kelley Hot Spring, the second largest artesian hot spring in the United States. Subsurface temperatures are estimated between 252°F to 304°F and reservoir depth is assumed to be between 1500 and 2000 feet.

Several temperature gradient holes indicate very high gradients (5.5°F/100 feet) and a wide distribution of heat. Apparently several faults permit upwelling of thermal waters from depth. The Likely Fault serves as a western boundary to high temperature gradients and to natural thermal springs.

Figure 2 shows the location of two geothermal wells in the area. GRI Kelley #1 was drilled in May 1969 by Geothermal Resources International to 3200 feet. A heat zone occurred at 1600 feet. Bottom hole temperature was reported to be 230°F. KHS #1 was drilled in 1974 by Geothermal Power Corporation to 3396 feet adjacent to Kelley Hot Spring. Bottom hole temperatures reported were 239°C. Geotechnical interpretation suggests the geothermal water load is in Warm Springs tuff.

Kelley Hot Spring appears to be a model for deeper fluids: total dissolved solids of about 1000 ppm; sodium, the principal cation; sulfate, chlorine and bicarbonate the most abundant anion. Fluorine concentration is 2 ppm, boron 4 ppm.

Silicate concentration is about 100 ppm., pH is mildly alkaline. These data indicate little scaling or corrosion will be encountered and no toxicity problems are expected.

Reservoir size is conservatively estimated to cover at least 4 square miles, about 2000 feet thick and at a temperature about 239°F. Gross heat reserve is calculated at about  $3.37 \times 10^{17}$  calories. A utilization rate of 325 gpm will utilize less than 1% of the heat in the fluid alone over a 30 year period. Thus the reservoir within the drilled depth

has sufficient reserve to supply a plant many times the size of the proposed demonstration plant.

### 2.1.3 Seismicity

Fault traces are numerous in the Kelley Hot Spring area. The nearest active fault is the Likely Fault which passes NW-SE just southwest of Canby. No epicenters have been reported from this area. The closest significant quake (see footnote), occurred along the Port Sage Fault near Herlong, California, about 125 miles south of Alturas December 14, 1950. Its intensity was VII and its magnitude 5.6 on the Richter scale. Other epicenters are known from the vicinity of Lassen Peak ranging in magnitude from 4.5 to 5.9 on the Richter scale.

## 2.2 SOILS

### 2.2.1 General Aspects

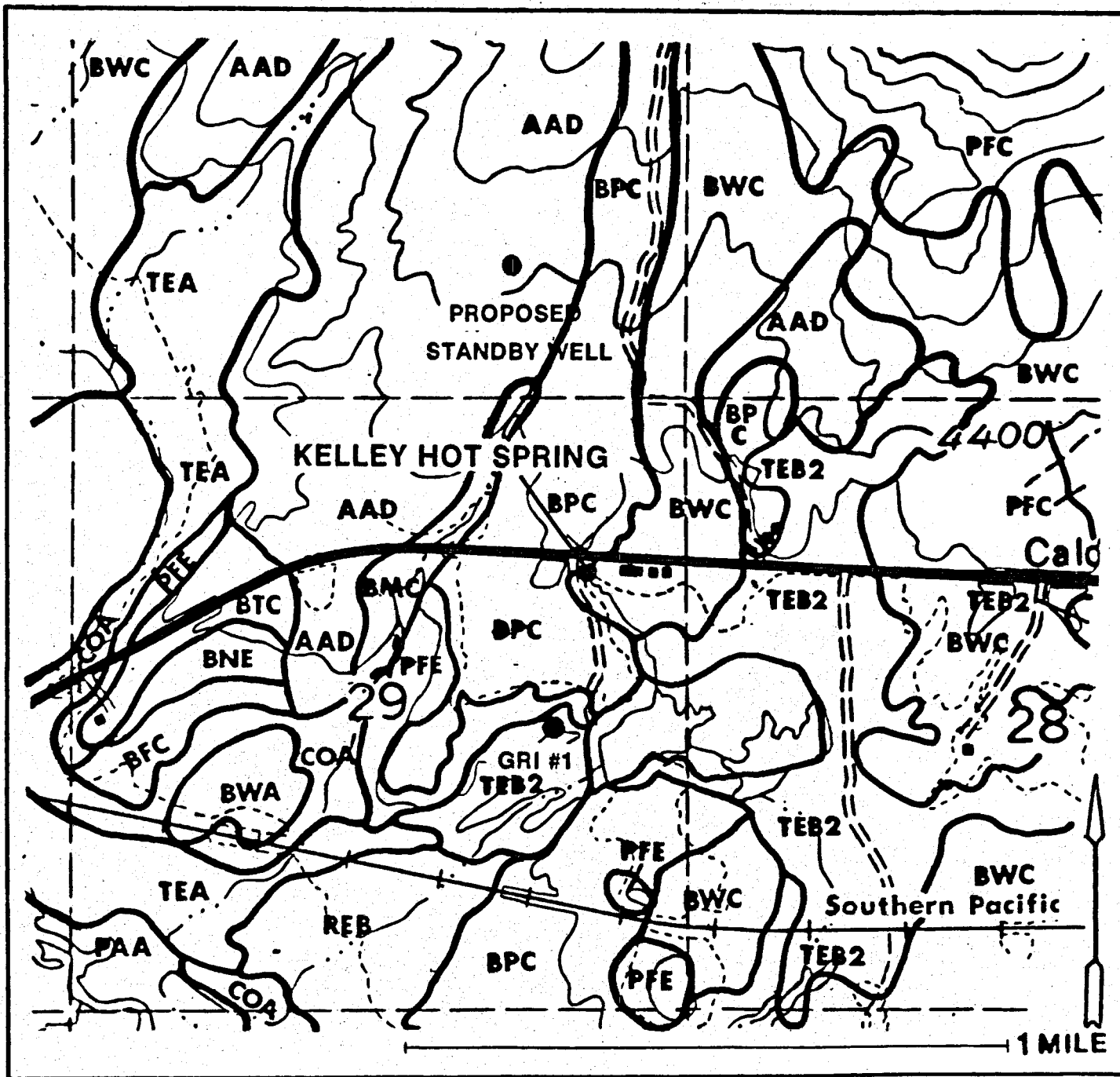
Soils in the study area are of widespread types within the Warm Springs Valley and the Pit River area in general. Figure 10 shows the distribution of the principal soil types within a two-mile radius of Kelley Hot Spring. Topographically, they are divided between lowland river deposits and the terraces and escarpments which foot the Modoc Plateau. Table I correlates the map symbol with the number found in the soil survey of Modoc County.

Soils of the area are mostly clays or loams (with a substantial clay fraction). Nearly all contain montmorillonite clay which characteristically has a strong tendency to shrink or swell with loss or gain of water. All are formed under moderately dry climate and some have calcium deposits in lower subsoils.

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Data from: Crustal Strain and Fault Movement Investigation, Faults and Earthquake Epicenters in California. California Department of Water Resources Bulletin #116.2 Jan. 1964. No other epicenters have been reported since that publication for the area in question.

### KELLEY HOT SPRING GEOTHERMAL PROJECT AREA



- AAD — Ager Clay
- BFC — Barnard Gravelly Loam
- BMC — Daphnedale Loam
- BNE — Daphnedale Cobble Loam
- BPC — Daphnedale Delta Loams
- BTC — Bieber Gravelly Loam
- BWA — Ladd Sandy Loam
- BWC — Ladd Sandy Loam

Figure 10  
**SOILS**

- CAD2 — Tuff Outcrop-Cause, eroded complex
- COA — Alturas Loam
- PAA — Pit Silty Clay Loam
- PFE — Delta Cobble Loam
- REB — Reba Loam
- TEA — Rumbo Loam
- TEB2 — Rumbo Loam Eroded

Table I. Soils of the Kelley Hot Spring Study Area

Soil Survey Designation	Map Symbol	Soil Name		Family or Higher Taxonomic Class
100	AAD	Aper clay, 2 to 5% slopes		Very fine montmorillonetic, mesic, Entic Chromoxererts
103	COA	Alturas loam		Fine montmorillonetic, mesic, typic, Natrixerolls
106	BFC	Barnard gravelly loam	0-9%	Fine montmorillonetic, mesic, Aridic, Durixerolls
109	BTC	Bieber gravelly loam	0-9%	Clayey montmorillonitic, mesic, shallow Aridic, Durixerolls
119	BMC	Daphnedale loam	2-9%	Fine montmorillonitic, mesic, typic, Argixerolls
120	BNE	Daphnedale cobbly loam	9-30%	Fine montmorillonitic, mesic, typic, Argixerolls
122	BFC	Daphnedale-Delma loams	2-9%	Fine montmorillonitic, mesic, typic, Argixerolls
128	PFC	Delma cobbly loam	0-9%	Clayey montmorillonitic, mesic, shallow Aridic Argixerolls
129	PFE	Delma cobbly loam	9-30%	Clayey montmorillonitic, mesic, shallow Aridic Argixerolls
150	BWA	Ladd sandy loam	0-2%	Fine loamy, mixed mesic, typic Argixerolls
151	BWA	Ladd sandy loam	2-9%	Fine loamy, mixed mesic, typic Argixerolls
176	PAA	Pit silty clay loam	0-2%	Fine montmorillonitic, mesic, chromic, Pelloxererts
182	REB	Reba loam	0-5%	Fine montmorillonitic, mesic, serollic, Paleargids
185	TEA	Rumbo loam	0-2%	Fine montmorillonitic, mesic, haploxergollic Natrargids
186	TEBa	Rumbo loam	2-5%	Eroded montmorillonitic, mesic, haploxergollic Natrargids

Soils on the sites selected for study are for the most part either Ager clays or the Daphnedale variant, which is a mixture of Daphedale and Delma loams or cobbly loams. The Daphnedale variant (122 or BPC on the map) is slightly acid while Ager clay is mildly to moderately alkaline. Both have unfavorable shrink-swell potential because of the quantity of montmorillonitic clay fractions. Table II shows the approximate percentage of each major type for each study site, its current vegetation and land use.

## 2.2.2 Soils of the Studied Project Sites

### 2.2.2.1 Sites 1, 2 and 4.

The majority of these sites are on Daphnedale variant loam on 2 to 9% slopes. The loam consists of well-drained soils formed on old lake terraces underlain by old lake sediments. It is a grayish-brown, cobbly loam, and a clay loam slightly acid about 11 inches thick. Its heavy clay subsoils are 5' or more deep. Permeability is slow and available water capacity is 9 to 11 inches. Shrink-swell potential is moderate and risk of corrosion of concrete is low. It is unsuited for road fill, the top soil is rated poor and is not well suited for dikes and levees. Its shrink-swell potential may present difficulties for foundations.

The Daphnedale variant has a Storie index\* of 24, which means it is poorly suited to general intensive agriculture. Where it is irrigated its capability rating is IVE-1. It is mainly used for irrigated pasture (not involved in the site chosen), mostly contour flooded, but sprinkler irrigation is often used. Frequent applications are required because of its low water-holding capacity. Rooting depth is restricted by soft lake sediments at depth of 11 to 35 inches. They are subject to moderate erosion hazard. The dryland farming

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\* Prime agricultural land has a Storie index rating of 80-100.

Table II. Soil types, percent distribution of soils, land use and vegetation on study sites.

Site	Soil	Percent	Current Land Use	Extant Vegetation
1	122	90	Cultivated field and pasture	Annual grass and old field
	151	5	"	"
	129	5	"	"
2	122	100	Cultivated field	Annual grass
3	100	35	Cultivated field	Annual grass
	109	5	" "	" "
	120	60	" "	" "
4	122	95	Cultivated field	Annual grass
	129	5		Old field and sage juniper
5	120	100	Pasture	Big sage
6	100	100	Cultivated field	Annual grass, sage-juniper

areas are rated IVe-1 and used for range, pasture, wheat and barley culture. Only grass is recommended for planting. It is not considered prime agricultural land.

#### 2.2.2.2 Soils on Sites #3 in part and #5

These sites lie on Ager clay typical of high lake terraces and escarpments formed from old lake sediments underlain by silt stone and mud stone. It is grayish-brown, mildly to moderately alkaline clay about 33 inches thick. The next layer is brown calcerous clay 6 inches thick. Permeability is slow. Runoff is medium, the hazard of erosion is moderate and the available water capacity is 8 to 10 inches. It has a high to moderate shrink-swell potential and the risk of erosion on concrete is low. It is unsuited for road fill, top soil is poor, and is only fair material for dikes and levees. Because of its high shrink-swell potential and low strength, it is rated "severe," i.e., major soil reclamation, special design or intensive maintenance may be required for construction. Its high clay content may present unusual problems for excavation for foundations, pipelines or sewer lines.

The Ager clay soil has a Storie index of 20, i.e., poorly suited to agriculture. It is used mostly for range. Small areas are used for small grains and irrigated grass. Its capability rating is IIIe-r irrigated because of its tillage characteristics and slow permeability. Its dryland capability rating is IVe-5 because good seedbeds are difficult to maintain and the soil is subject to erosion. It is not considered prime agricultural land.

### 2.3 HYDROLOGY AND WATER QUALITY

#### 2.3.1 The Drainage Basin

Figure 11 shows the local surface drainage pattern for the study area which is part of the Warm Springs Valley sub-basin of the Alturas ground water basin. In the following

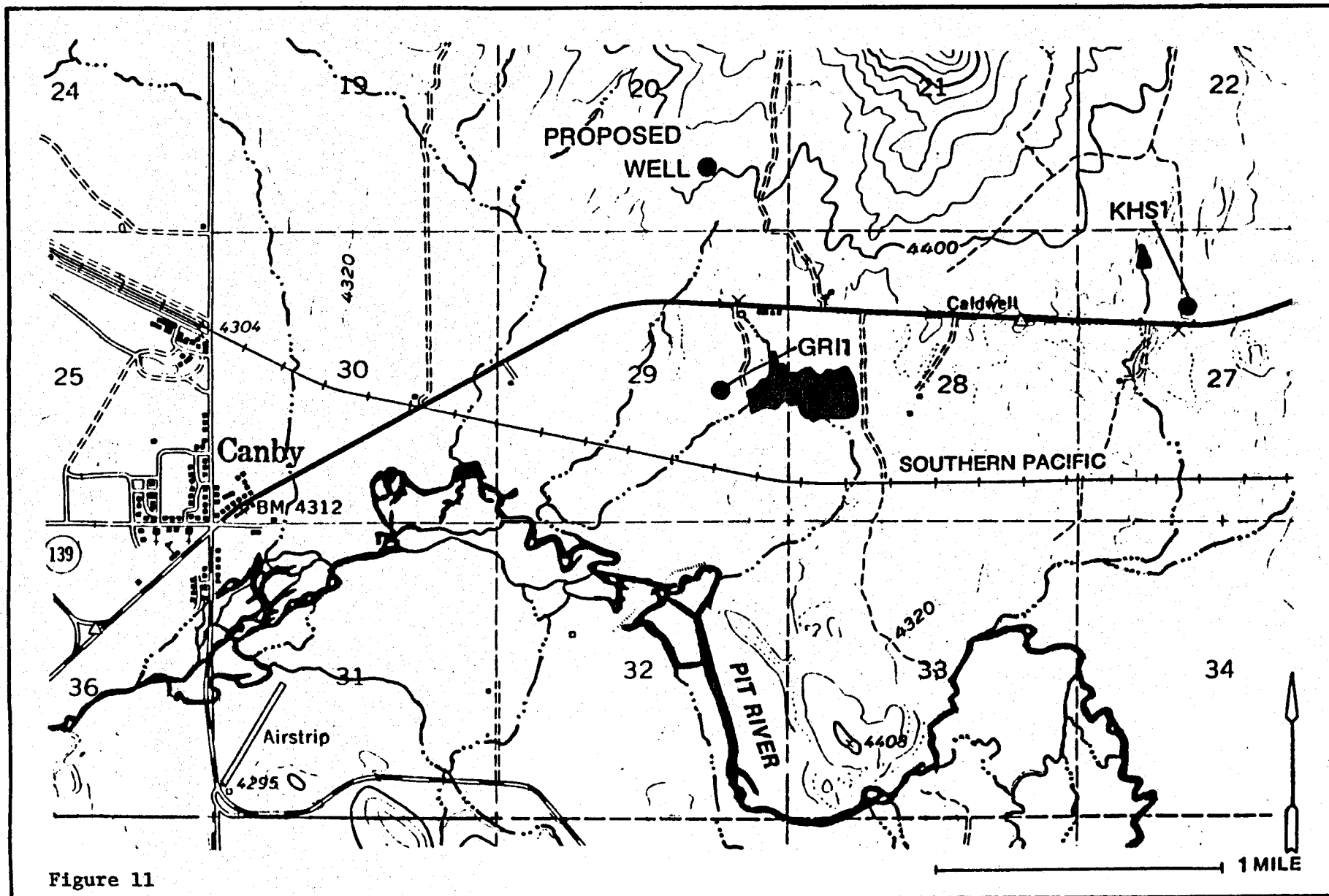


Figure 11

Stream drainage in the vicinity of Kelley Hot Spring and Canby. Note the extensive meandering of the Pit River.

discussion pertinent details of the sub-basin have been extracted or summarized from the Department of Water Resources, Bulletin 98 (1956) entitled, "North Counties Ground Water Investigation," chapter on the Alturas Ground Water Basin, pp. 95-111.

### 2.3.2 Underground Water

Subsurface movement of water is generally south or southeasterly toward the Pit River from recharge areas in the mountains to the north (Devil's Garden area). Warm Springs tuff form both surface barriers and subsurface floors for water movement in the sediments above them (cf. Figure 8 , page 20).

Most of the studied areas lie on ground indicated as fair to poor ground water availability (Site #5 is the exception). However, a good domestic well was developed about 150 yards east of the hot spring by the Bureau of Indian Affairs in 1978.

### 2.3.3 Water Quality

Water quality in the Warm Springs sub-basin in the vicinity of the project has excessive sodium absorption ratios and is not recommended for irrigation, although it is acceptable for domestic use. It appears to be acceptable for all project uses, however.

At this writing no information is available concerning the water quality of the reservoir into which the hot spring drains (see Figure 2). Apparently, there is substantial inflow of surface drainage from surrounding hills. This dilution of hot spring constituents maintains a relatively stable trophic level in the lake which supports several species of warm water game fish, and where shallows occur a marsh habitat is in evidence.

Details of water quality in the Pit River at the gauging station 4 miles south of Canby are given in the BLM-EAR, pp. 11 - 30-33. Peak flows in the river occur in January, but heavy flows occur in April and May. Mineral constituents and dissolved ions are heaviest in winter months when suspended sediments and turbidity is highest. They are lowest during the snow run-off period of April and May; e.g., boron ranges erratically from 160 to 50 ug/l during the year but drops in April and May from zero to 40 ug/l.

Geothermal fluids have a moderate level of dissolved solids,  $\pm 1000$  ppm. Flourine and boron concentrations are 2 and 4 ppm respectively. The pH is mildly alkaline. Heavy metals appear to be at low concentrations in both surface, underground, and geothermal water.

## 2.4 VEGETATION

### 2.4.1 General Aspects

Technically plant communities of the study are typical of the desert biome and the Great Basin cool desert subregion. Current classifications indicate the major communities as Great Basin sagebrush and northern juniper woodland<sup>1</sup> or the Artemisia-Chrysonthamnus-Purshia cover type in the Shrub System, and the Juniperus-Artemisia-grass cover in the nonaborescent heliophyte system.<sup>2</sup>

These classifications indicate both the affinity to the widespread Great Basin flora and cool, dry habitat east of the Sierra Nevada Mountains. While other communities with similar affinities occur in the area, the two indicated above are

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<sup>1</sup>N. H. Cheatham and J. R. Haller. 1975. "An annotated list of California habitat types," in Major, J. and H. G. Barbour, 1976, Terrestrial Vegetation of California, Wiley Interscience Press.

<sup>2</sup>G. Holstein. 1980. California Vegetation Cover Types California Natural Diversity Data Base (Draft Manuscript).

the climax types on the study sites and the foothills of the escarpment to Modoc Plateau. In the floodplain below the terraces and alluvial fans are extensive, perennial grass and riparian habitats, common to much of the northern Great Basin, are also found. (cf. Figure 12).

In the study area the influence of man, both ancient and modern, is evident. The annual grass-weed community is clearly anthropogenic and several of its dominant and codominant species are of Mediterranean origin. Aerial photos show that all six study sites would be juniper-sage if allowed to succeed naturally.

Annual grasses occupy areas previously disturbed by cultivation. Many components of this community are present in each of the other communities in varying degrees at the site involved. In past decades junipers intruded more extensively into the annual grassland areas, but have been removed by cultivation and possibly by early inhabitants.

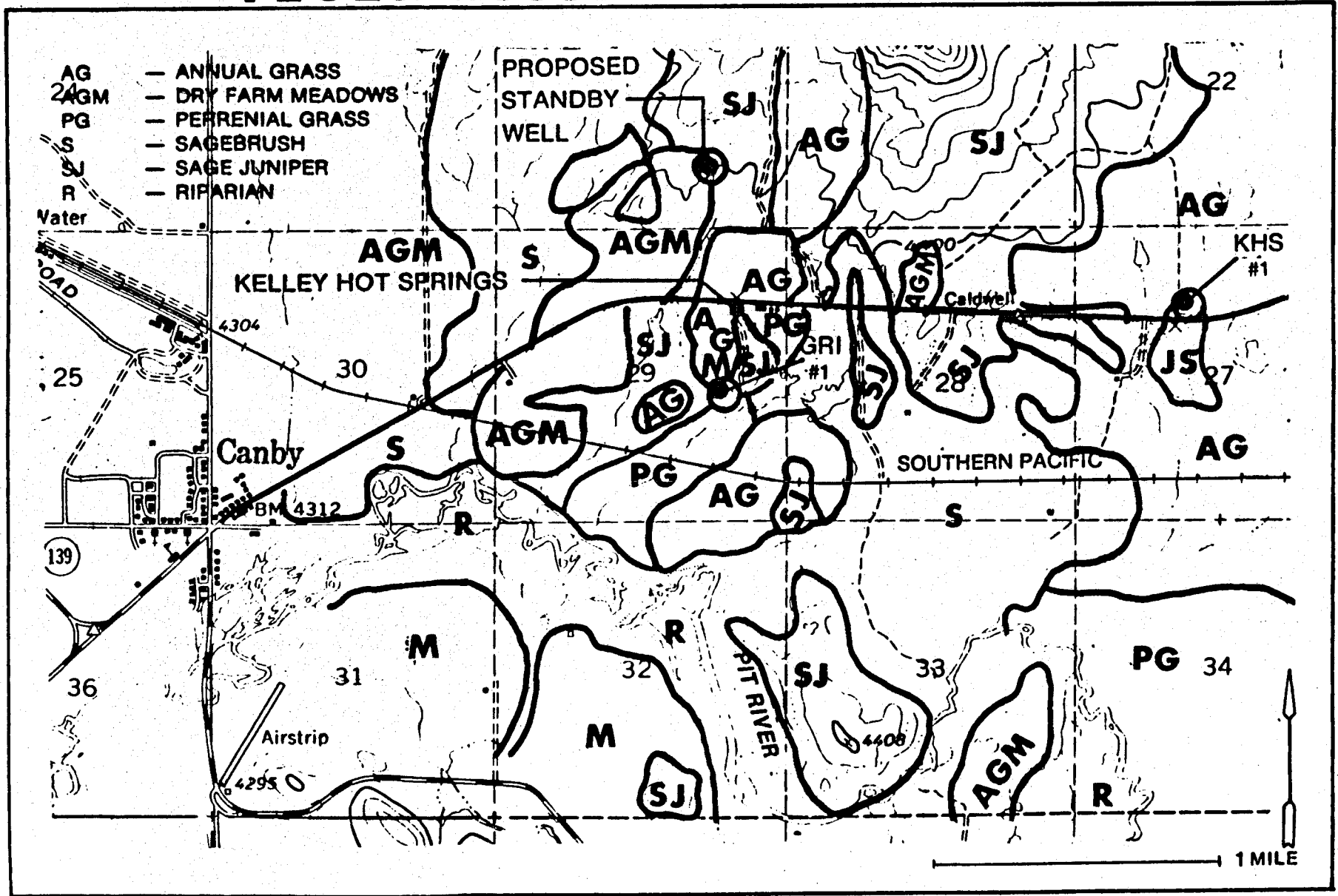
Juniper and Big Sagebrush communities are not well-separated as they are in other areas observed in the BLM EIR. On project sites it is best developed on the advance faces of the alluvial fans and old terraces where slopes are steeper but adequate drainage still obtains. Juniper communities per se occupy uplands or rocky soils above the terraces, alluvial fans and benches.

#### 2.4.2 Plant Communities of the Study Area

All six sites are primarily the juniper-sage plant community. Several sites have been modified by cultivation or intensive grazing. Table III compares the plant communities encountered at each site.

Several characteristics of each of the involved communities are described in the BLM-EA of the upper Pit River (pp II 46-55). Annual grass communities tend to have heterogeneous compositions depending on the intensity and frequency

# VEGETATION



31a

Figure 12

Table III. Percent composition of vegetation communities at study sites.

Site	Vegetation Community				
	Annual Grass	Big Sage	Sage Juniper	Perennial Grassland	Riparian
1	70		15	10	5
2	100				
3	100				
4	70		20	10	
5	30	70			
6	80		10	10	

of tillage and grazing pressure. Many of its dominants are subordinants of shrub associations and in the study area most of the annual grass dominants are found in other communities. The characteristic dominant is western cheat grass (Bromus tectorum) and weedy herbs such as yellow star thistle (Centauria melitensis, filaree, Erodium sp., mostly cicutarium, Russian thistle (Salsola kali), several species of the family Boraginaceae, mostly of the genera Plagiobothrys Allocarya and Amsinkia. Lomatium species (carrot family), are common. Clovers also occur, most commonly Trifolium macrocepholum. In "old field" stands several perennial plants appear such as lupines, mostly Lupinus leucophyllus var. canescens, mule ears (Wyethia mollis) rabbit brush (Chrysothamnus sp., often nauseosus and loco weed (Astragalus sp.).

#### 2.4.2.1 The Big Sage Community

Big sage communities are common on the upper reaches of alluvial fans and higher benches on deep, well-drained soils. In the general area this community dominates much of the landscape but is only involved directly on Site #5 at the location of KHS #1 geothermal well. Big sagebrush (Artemisia tridentata) is structurally but not numerically dominant. A co-dominant is rabbit brush (Chrysothamnus especially). Arrow-leaved balsa root (Balsamorhiza sagittata), lupines (Lupinus leucophyllus var. canescens) are among several broad-leaved

perennials. Western cheat grass was present as was the Borages mentioned above on this site. Squirrel tail grass (Sitanion hystrix), and Thurber's needle and thread grass (Stipa thurberiana) were present in low numbers. Since the area was disturbed by overgrazing, Russian thistle was common, especially in washes.

#### 2.4.2.2 The Sage-Juniper Community

The sage-juniper community is mostly noted for the physical dominance of western juniper (Juniperus occidentalis). Because most of these soils are deep, the juniper is an invader from its more normal habitat on steeper, rocky soils on the foothill escarpment rising about 1/2 mile beyond most of these potential project sites. Any of the foregoing herbs may be encountered. On Site #4 major codominants were big sage and bitter brush (Purshia tridentata).

#### 2.4.2.3 The Perennial Grass Community

Perennial grass communities are a complex of plant associations near or beside the Pit River just south of the study area (see Figure 2). These associations are very variable in composition depending upon disturbance, irrigation, drainage, soil composition, and level of alkali. Characteristically, associations on low rises with some drainage have a dominance of annual grasses and herbs with several perennial herbs such as horseweed (Conyza canadensis), and fleabane (Erigeron sp.). As perennial water increases sedges (Carex sp.) and rushes (Juncus sp.) begin to become important and are dominant (especially rushes) where water stands. Meadow barley (Hordeum brachyantherium) and rabbit-foot grass (Polypogon monospleinensus) are common also. The areas between these two extremes support a variety of perennial grasses and

and herbs including blue grasses (Poa nevadensis, P. sandbergii), wheatgrass (Agropogon spicatum), and silver hairgrass (Deschampsia caespitosa).

#### 2.4.3 Rare Plant Species

No rare species were encountered on the initial site reconnaissance. A check of California Native Plant Society Rare Plant Records at U.C. Davis indicates no rare species occur anywhere in the whole Canby Quadrangle. No rare species identified for Modoc County occurs in the plant communities found on the project sites. Also, no endangered species have been found on the sites.

### 2.5 FAUNA

#### 2.5.1 General Aspects

The project area includes several wildlife habitat types. The largest portion of the area consists of level or gently rolling terrace lands that have been cultivated in the past or present and are now dominated by stands of annual grasses. Western juniper and Big Sagebrush are found on the terrace faces that slope down to the valley of the Pit River. Open western juniper brushland also occurs on rocky outcrops to the north of Highway 299. Much of the valley floor is made up of heavy, highly alkaline soils that support a saltgrass association. Near the hot spring and old resort are groves of cottonwood trees. Aquatic habitats in the area are the Pit River itself and small reservoirs that are fed in part by Kelley Hot Spring.

Fish and wildlife resources of the upper Pit River area were described in an Environmental Analysis Report on proposed geothermal leasing prepared by the USDI Bureau of Land Management and USDA Forest Service in 1976. This document does not provide site-specific data that could be directly applied to the project site, but it does indicate in a general way the kinds of resources that may be expected.

### 2.5.2 Animals of the Study Area

The project area provides year-around mule deer habitat and is included in the critical winter range for the Interstate Deer Herd (D. Thayer, California Dept. of Fish & Game, Alturas, personal communication). In the EAR, a deer winter concentration area is indicated in the eastern portion of Site #4 (Map 17, Vol. 2, Upper Pit River EAR). The juniper habitat is particularly important for deer since it serves as excellent cover during the day.

The eastern part of the project area is also of potential value as antelope winter range, according to the EAR (Map 18, Vol. 2). In addition, nearby areas to the north of Highway 299 are used as antelope kidding grounds in the late spring (Thayer, pers. comm.).

Local mammals observed on ground reconnaissance were ground squirrels (probably beechy), black-tailed jack rabbits and cottontail. Striped skunks, raccoons, and coyotes are regular inhabitants on all sites. Chipmunks can be observed in summer months in juniper sage associations. No evidence of marmots or porcupines was found on any site but could be present on occasion.

Evidence of California quail, and ringnecked pheasant was observed around the general area of the hot spring. Mourning dove and sage grouse were not observed but should be expected. Although sage grouse summer range and a strutting ground are located in the general region (Map 21, Vol. 2 EAR), there is probably no key sage grouse habitat in the project area (Thayer, pers. comm.). Crows and ravens were observed in winter. Black-billed magpies, robins, song sparrows, white crown sparrows, golden crown sparrows, fox sparrows, Cassins finch, common house finch, lesser gold finch, house "sparrows," bluebirds, yellow warbler (and other unidentified species), probably Audobon's warbler, mountain bluebirds, Brewer's tricolored and yellow blackbirds are all noted within the area.

Most have been actually observed by team members. Other species undoubtedly occur during migration periods but were not observed. The periodicity of site visits mostly in fall, winter and early spring precluded a complete listing of birds and many mammals that could be observed by a resident bird watcher.

Waterfowl utilize the Pit River valley for feeding and resting in migration and during the winter. The reservoirs within the project area are important to waterfowl because they are often open when other bodies of water are frozen over (Thayer, pers. comm.). This would also apply to water-holding ponds associated with the project. In all likelihood they would not be subject to freezing.

Many sightings of birds of prey have been recorded in the vicinity of Kelley Hot Spring (Map 20, Vol. 2, EAR). Golden eagles have been observed a number of times and there are some records of the prairie falcon and the endangered southern bald eagle in the area as well. The American peregrine falcon, another endangered species, has also been observed in the general region but not near the project site. The project area is probably most heavily used by birds of prey in the winter; no nesting sites have been identified.

#### 2.5.4 Fish of the Study Area

The Pit River in the vicinity of Kelley Hot Spring supports five game fish species and six species of non-game fish (Table IV). Fish are believed to occur in the reservoirs on the project site, but the species involved and the status of their populations are not known.

The species listed are warm water denizens of slow-moving eutrophic aquatic habitats and are not the salmonoids and other game fish for which the upper reaches of the Pit River are noted.

Table IV. The fish fauna of the Pit River between Alturas and Highway 299 bridge southwest of Canby

<u>Game Species</u>	
Brown Bullhead	<u>Ictalurus nebulosus</u>
Channel Catfish	<u>Ictalurus punctatus</u>
Largemouth Bass	<u>Micropterus salmoides</u>
Green Sunfish	<u>Lepomis cyanellus</u>
Bluegill	<u>Lepomis macrochirus</u>
<u>Non-Game Species</u>	
Speckled Dace	<u>Rhinichthys osculus</u>
Sacramento Sucker	<u>Catostomus occidentalis</u>
Sacramento Squawfish	<u>Ptychocheilus grandis</u>
Tui Chub	<u>Fila bicolor</u>
Pit Sculpin	<u>Cottus pitensis</u>
Hardhead	<u>Mylopharodon conocephalus</u>

Source: Fig. 6, Vol. 1, EAR.

## 2.6 AIR QUALITY

Data for the Alturas region is very limited and none exists for the project area. According to a California Air Resources Board mobile unit 20-day survey in September 1973 at Alturas, the legal standard for hydrocarbons was exceeded twice and for particulate matter once. Existing air pollution sources in the area are few. A lumber mill is located 2 miles west of Alturas and a small bark mill is at Canby. Auto traffic is the other contributing source, but because of the low population and low activity level, these are not serious factors. Air particulate matter may be substantial on occasion from wind-blown dust, but some rain falls most months (July and August average less than half an inch), so natural dust of local origin arises through disturbance or after extended drought. Vegetation ground cover reduces this problem in the area.

## 2.7 ARCHAEOLOGY AND HISTORY

### 2.7.1 Native American Utilization

A detailed study of Native American utilization of the Kelley Hot Spring area was carried out for this environmental document by Dr. Shirley Silver, Professor of Anthropology, Sonoma State University and David Hunt, Staff Ethnologist, Sonoma State University. The report (28 pages), is summarized here for salient information. The full report is available through DOE-SAN on request.

The study site lies entirely within the tribal boundaries of the Astariwawi group of the Pit River Indians. Kniffen (1925) estimates their numbers to have been about 200 divided into 4 widely-separated village subgroups. The hot spring, now known as Kelley Hot Spring, was at or near what is believed to be the village site of the largest of the four subgroups--the Astariwa, but they no longer live in the vicinity. A member of another branch of the Pit River Indians lives nearby (northeast of the spring), on lands administered by the Bureau of Indian Affairs. Other descendants live in the general vicinity or have removed to the Alturas rancheria. Other descendants are scattered in towns throughout Modoc County.

The area in general, i.e., all vegetative components, was used for foraging for plants (the roots of juncus and epos--Perideridia species in the carrot family, commonly known as yampa in the Pacific northwest, the bulbs of onion and camas, a variety of seeds, including acorns and bearberry--manzanita species), fish (suckers and trout), birds (quail, sage grouse, blue grouse, ducks), small mammals (marmots, squirrels, rabbits), and large mammals (deer and antelope). Willows, tules, and rushes were used for basketry. The spring was used for retting and conditioning fibers for basketry.

Various sites within a mile radius of the Spring were used extensively and over many centuries as village and home sites, burial grounds, religious and recreational activities. Circular communal winter houses were dug into the ground and had one center post which supported an earth-covered roof. Entrances were on the roof, and on one side. Each house sheltered several related families, ranging in size from five to fifteen. Houses served also as sweat houses and assembly halls.

The Spring was used variously--water source, bathing and therapeutic activity, minor ritual uses. Apparently the Spring was not a "power place" where tribal members went for power quests, although the "power of the spring should be avoided."

#### 2.7.2 Archaeology

As indicated above several major sites of great antiquity (7-9000 years) have been located and their boundaries determined by Dr. Richard Hunt, Department of Anthropology, Sonoma State College. While his investigations during 1980 were limited to areas of interest to the project, other information indicates locations of other sites and activity areas. Precise locations can be obtained by professional investigators through the field reports. Only general information is included here and the upshot of the 6-month investigation precluded the use of Sites #1, #2 and #4. Sites #5 and #6 are outside of any archeological sites in the area. A small corner of the property containing Site #3 is involved in an extensive site but the project area, even if expanded, can be precluded from encroaching on archaeological sites.

A burial site has been recorded in 1970. It is in the NW/4 of Section 29, apparently north of Highway 299. A grave is marked on the USGS Topographic Map about 100 yards south of the Spring, apparently the grave of John N. Kelley, who died in 1878 at age 13. A large Indian burial ground is marked on

recent maps about 3/4 mile to the southeast.

### 2.7.3 Historical Sites

The first non-Indian owner of record was Melan Stewart in 1876. John Kelley purchased about 100 acres, including the spring in 1879. The hot spring area has been used for ranching and limited farming (1876 to present), and as a popular resort (1925 to 1940).

The former Kelley Hot Spring resort lies immediately east of the spring. It comprises an old lodging or inn, a small store and several out-buildings. Remnants of a large outside swimming pool and a dance pavilion can still be seen although in an advanced state of disrepair.

## 2.8 LAND USE

### 2.8.1 General Aspects

The environs of Kelley Hot Spring is utilized principally for livestock production either directly or indirectly. Ever since the settlement (1876) by white men, cattle grazing has been the predominant activity. Land use has been divided into range, pasture (dry and irrigated) and small grain or hay production. (See Figure 13, p. 41 )

A major secondary or passive use has been that of wildlife habitat. Kidding grounds for antelope occur in the vicinity; it is winter and some summer deer range and wildfowl occur both as migrants and summer residents in the lowlands and reservoirs.

A localized recreation spa was built near the hot spring and was used between the years 1920 and 1940. Another localized use is for watershed and impoundment.

# LAND USE

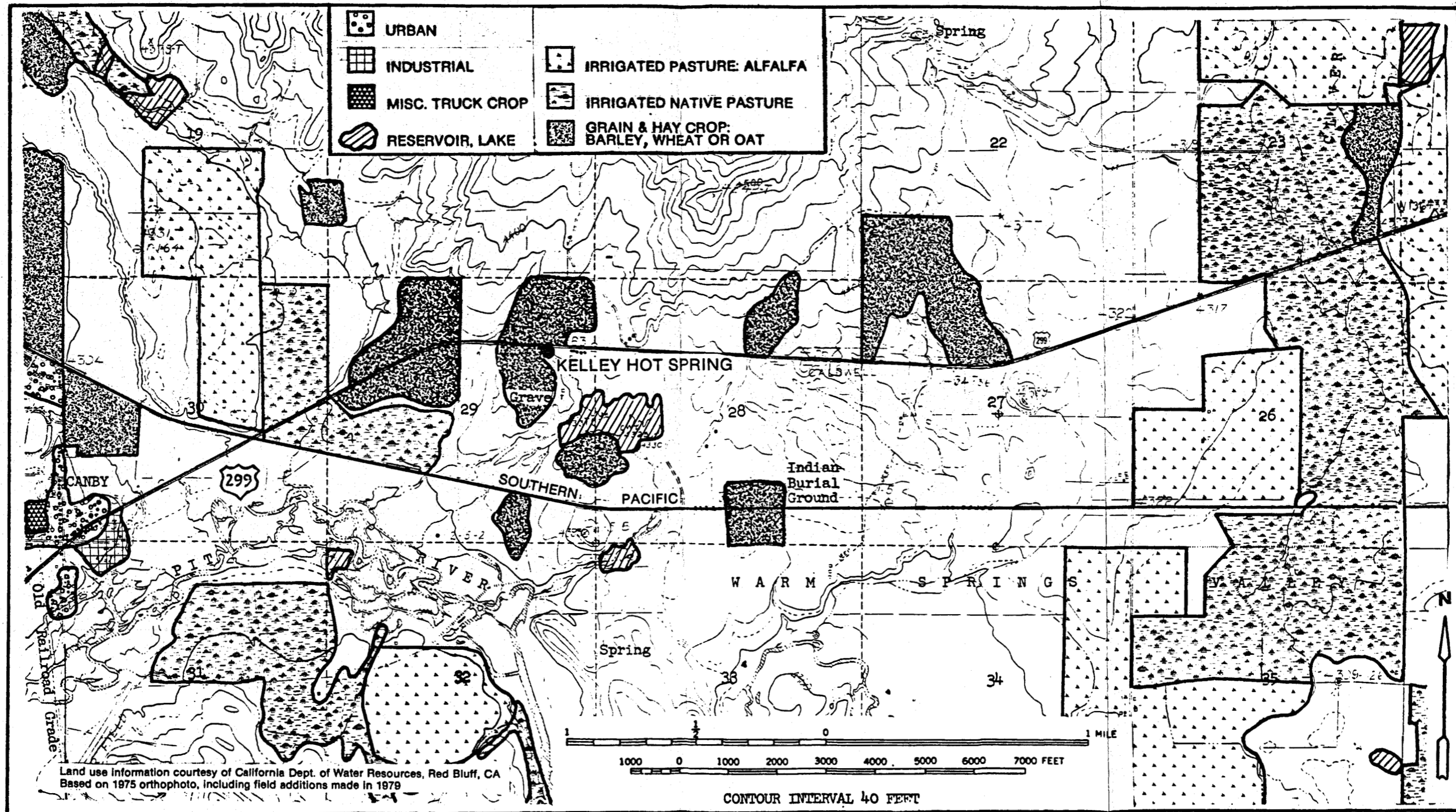


Figure 13

A railroad passes through Warm Springs valley about 1 mile south of the hot spring. A major improved highway (state route #299) passes about 100 yards north of the spring.

### 2.8.2 Land Use of the Project Sites

#### 2.8.2.1 Land Use of Sites 1, 2, 3, 4

These study sites are closest to Kelley Hot Springs (see Figure 2). Study Site #1 is currently used for dry land farming, either small grains or grass hay, but is tillage restricted to the top of the old terrace. It is bounded on the north by Kelley Hot Spring Reservoir which covers approximately 30 acres. It is used for recreation, hunting and fishing by local residents. The railroad passes east and west along the south boundary. Cattle grazing occurs over the whole portion. The nearest occupied residence is  $\frac{1}{2}$  mile.

Study Site #4 is used for the same purpose and in the same manner as Site #1. It lies immediately west of the hot spring. It contains, however, a geothermal well (GRI #1), which was an exploratory well used to assess the reservoir at depth (3206'). Highway 299 passes along its northern border; the southern edge drops off  $\frac{1}{2}$  15-30' to the river bottom flatland. The western edge borders a wash. The nearest occupied residence is about  $\frac{1}{4}$  mile to the northeast.

Study Site #2 is entirely devoted to dry land farming and pasture. It is bounded on the south by Highway 299 and otherwise surrounded by sage-juniper grazing land. The nearest residence lies  $\frac{1}{8}$  mile to the east.

Study Site #3 is also used for dry land farming and grazing. It is bounded on the north by Highway 299 and on the south by the edge of a 30' terrace which drops to irrigated meadowland below. The nearest residence is about  $\frac{1}{8}$  mile to the west and another about  $\frac{1}{2}$  mile to the west.

In general, yields from farming on these sites are poor; i.e., 37 bu. of barley/acre and 2.3 animal units/month/acre as grazing. The town of Canby lies 2.5 miles further west from the spring and 1.5 miles from the western edge of Site #3.

#### 2.8.2.2 Land Use at Site #5

This site is used entirely for cattle grazing. Inspection suggests that the fertility and production is substantially less than that rated for the soil in general. It is also the site of a geothermal well (KHS #1), drilled to a depth of 3396 feet. The nearest residence is about 1/2 mile to the southwest. Highway 299 passes along the southern border of the site.

#### 2.8.2.3 Land Use at Site #6

This site is used entirely for dry farming; it is surrounded by juniper-sage woodland except on the south which is also dry farmed. Highway 299 passes about 1 mile to the south. The closest residence is about 2 miles to the southeast.

#### 2.8.3 Transportation

As indicated above, State Highway 299 passes alongside or within 1 mile of every project site. This is a principal through highway connecting Alturas with Redding in the east-west direction. At Alturas it joins State Highway 395 running north and south.

Table V shows the average daily traffic on Highway 299 in the general vicinity of the project.

Table V. Traffic counts on Highway 299.

Miles from Lassen-Modoc County Line	Average Daily Traffic		
	Peak Hour	Peak Monthly	Monthly Average
22.3 Canby, Centerville Road	200	1,675	1,450
37.1 Airport Rd. North	200	1,675	1,450
40.28 Alturas, Juniper Street	260	2,100	1,950
	320	2,400	2,150

Ref.: Cal Trans, 1978. "Traffic Volumes on California State Highways; Route 299."

Traffic generated by the project is estimated as follows:

Private cars . . . . .	28 to 31 trips per day
Service vehicles other than trucks	4 trips per day
Trucks . . . . .	3 to 4 trips per day
Total . . . . .	37 to 41 trips per day

2.8.4 Public Services

The following are key public services in the area that have a bearing on the project:

Security	Modoc County Sheriff Department
Fire	U.S. Forest Service
Utility	Surprise Valley Electrical Cooperative
School	Primary through 8 - Canby
	High School 9 - 12 - Alturas
Medical	Alturas
Sewer	All contained on site
Solid Waste	Canby - county land fill

## 2.9 AESTHETICS

### 2.9.1 Visual

All prospective sites have the aspect of open space and a rural character. The preferred site (Site #6), is about 1 mile from the highway, and the rest are immediately proximal to the highway. In their present condition, no site, except perhaps as it is involved with the hot spring, presents a visual node to persons travelling Highway 299.

### 2.9.2 Audial

Sources of noise are only from common natural phenomena except those sites proximal to the highway. Truck traffic yields probably the highest current source (cf. section on safety for traffic volumes). The railroad generates periodic noises but impacts only Site #1 and then only slightly. The location of Site #3 sustains noise from Highway 299 and the railroad but no background data are available at this time.

### 2.9.3 Odoral

No objectionable odors are generated in the area. Recently some concern has been aired about the mill ponds at Canby in conjunction with proximal housing developments. Apparently the problems have been resolved satisfactorily and they no longer are considered a background source of odors. In any event none of the project sites were affected at any time.

## 2.10 SOCIO-ECONOMIC IMPACTS

### 2.10.1 Labor Trends and Outlook

The total projected population of Modoc County for 1980 is 8770 of which 4300 are male and 4470 female. Median age group of both sexes is 25-34. Estimated work force is 4525 of which 2610 are males and 1915 are females. About half the labor force by sex are between the ages 25 to 44.

Eleven percent of the population and the workforce is Spanish-American. Sixteen percent of the population is below poverty level, but 32% of the Spanish-American population is below poverty level. Table VI shows the trend of employment and unemployment in the county for years 1978 to 1980.

Table VI. Labor force trends.

	1978	1979	1980
Total force*	4,325	4,425	4,525
Employed	4,075	4,150	4,250
Unemployed	250	275	275
Unemployment Rate**	5.5	6.2	6.1

\*Labor force by place of residence. Employment includes persons involved in labor-management disputes.

\*\*The unemployment rate is computed from unrounded data; therefore, it may differ from rates using rounded figures such as in this table.

Source: "Labor Market Newsletter, Modoc County," State of California, Employment Development Department, Employment Data and Research, March 1979.

The unemployment level for Modoc County is expected to level off at about 6% for the next several years. Table VII shows the unemployment categories of salaried wage earners. Note that about 20% is employed in agriculture, but this includes forestry and fisheries also.

Table VII. Categories of wage earners.

Category	Number Employed	Percentage
Total Employment	2,650	100
Agriculture	525	20
Construction/Mining	75	3
Manufacturing	250	9
Transportation/Public Utilities	125	5
Trade	375	14
Finance/Insurance/Real Estate	75	3
Services	225	8
Government	1,000	38

Source: "Labor Market Newsletter, Modoc County," State of Calif., Empl. Devel. Dept., Empl. Data & Research, March, 1979.

Monthly unemployment rates for the county for the years 1978 and 1979 are shown in Table VIII.

Table VIII. Monthly unemployment rates.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1978	7.5	8.6	7.7	5.2	4.4	4.4	4.8	4.5	4.1	4.0	4.5	6.1
1979	12.2	11.7	10.8	7.2	6.1	5.1	4.6	6.3	3.9	4.3	5.9	--

Source: "Labor Market Newsletter, Modoc County," State of Calif., Empl. Devel. Dept., Empl. Data & Research, March, 1979.

#### 2.10.2 Project Labor Requirement

A 1360 sow complex will employ personnel as shown in Table IX. The estimated personnel requirements for intraproject personnel are 22 full time equivalents. Support activities involve existing services purchased in the area. At least 8 persons are technicians requiring special training. It is estimated at least half of all personnel will not be indigenous to the Alturas area. A conservative estimate of new families brought into the area is 11 and possibly as high as 15.

Project management expects to hire as many local individuals as are available consistent with qualifications and willingness to work. Positive work attitude may result in higher number of local hirings and on-the-job training for specialized functions

could then be substituted for hiring outside the area. There is a definite interest in the employment of qualified American Indians and persons of Spanish descent.

Table IX. Estimated project personnel.

	Full Time Equivalents	
	1360 Sow Complex	5440 Sow Complex
<b>Operation</b>		
Geothermal Module	.0	
Feed Production Module	4.0	14
Seine Production Module	8.0	32
Waste Collection & Transport System	.5	1
Biogas Generation Module	1.5	3
<b>Maintenance</b>		
Equipment & Facilities	2.0	4
Grounds & Buildings	0.5	2
<b>Management</b>		
Business, Sales	0.5	1
Procurement & Shipping	0.5	1
Accounting	0.5	1
Records	0.5	1
Operations	1.5	2.5
<b>Support Activities (non-project)</b>		
Feedstuffs Transport	2.0	6
Animal Transport	2.0	6
Waste Removal	.05	0.1
<b>TOTAL</b>	<u>24.05</u>	<u>75.6</u>

Projecting these numbers to a 5440 sow complex and assuming no change in project concept, the total employment is on the order of 80, of which at least 50 would be new residents to the area.

## 2.11 ZONING AND THE GENERAL PLAN

According to the General Plan of 1974 "the land use element," the area is zoned as "unclassified." This designation allows agricultural uses. The project is considered agriculturally related by the Planning director, but a use permit would be required for waste water recycling.

### 3. PROJECT IMPACTS AND ENVIRONMENTAL CONCERNS

#### 3.1 INTRODUCTION

The following discussions list the more probable impacts of the project on the environment. They are divided into extra-project and intraproject impacts. Table X is a matrix of such impacts modified in a way that estimates magnitude, probability of occurrence, periodicity and amplitude. Hence the appearance of any numbers indicates a negative impact but the impact must not be taken out of this context of its modifiers. The vector, direction or environmental parameter impacted is indicated in the text under the appropriate heading that corresponds to the index of status. The index values placed on the modifiers is highly subjective since very little data are available from mensuration or from existing facilities since no comparable projects exist. They are professional judgments based on experiences and best estimates of "worst case" events.

#### 3.2 IMPACTS ON GEOLOGY FEATURES

##### 3.2.1 Geology

The project has no impacts on the geology per se of the area.

##### 3.2.2 Topography

Topographic modification covering up to 15 acres will occur, but the selected sites on gentle slopes involve no natural drainage ways and are composed of recent alluvium or lake deposits. The topographic impact will be slight at either Site #6 or Site #3.

##### 3.2.3 The Geothermal Resource

According to the geothermal technician (Dr. Subir Sanyal), who prepared the geotechnical portion of the project's final preliminary design report (August 1980), the impact of the

Table X. Impact Matrix of Project on Existing Environment.

	Geology		Soils	Hydrology		Water Quality			Biology			Antiquities		Aesthetics			Socio-Economics				Land Use		
	Topography	Geothermal Resource		Natural Streams	Aquifers	Geothermal Water	Potable Water	Waste Water	Vegetation	Rare Species	Fauna	Archaeological Sites	Historical Sites	Visual	Audial	Odoral	Services	Transport	Schools	Housing	Agricultural Support	Treasure	Degree of change
	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P	M A F P
<b>1360 Sow Unit</b>																							
Geothermal drilling	1 1 1 5	1 1 5 5	1 1 1 5						1 1 1 5	0	1 1 1 5			1 1 1 5	1 1 3 5								1 1 1 5
Roads and/or pipe-line construction			1 1 1 5						1 1 1 5	0	1 1 1 5			1 1 1 5	1 1 1 5								1 1 1 5
Building const.			5 1 1 5						3 2 1 5	0	3 2 1 5				1 1 1 5								1 1 1 5
Operation										0						1 1 1 5							2 1 1 5
Methane										0					1 1 5 5	1 1 1 1							1 1 1 5
Waste water																1 1 1 1							1 1 1 5
Reinjection		1 1 1 1														1 1 1 1							1 1 5 5
Subsidence	1 1 1 1															1 1 1 1							2 1 5 5
Induced seismicity	1 2 1 1																						2 1 5 5
<b>5440 Sow Unit</b>																							
Geothermal drilling	1 1 1 5	1 1 5 5	1 1 1 5						1 1 1 5	0	1 1 1 5			1 1 1 5	1 1 3 5								1 1 1 5
Roads and/or pipe-line construction			1 1 1 5						1 1 1 5	0	1 1 1 5			1 1 1 5	1 1 1 5								1 1 1 5
Building const.			5 2 1 5							0						2 2 1 5							1 1 1 5
Operation										0						3 3 5 5	1 1 5 5	1 1 1 1					3 2 1 5
Methane										0						1 1 1 1							2 2 5 5
Waste Water										0						1 1 1 1							3 3 5 5
Reinjection		1 1 1 1																					3 3 5 5
Subsidence	1 1 1 1																						3 3 5 5
Induced seismicity	1 2 1 1																						3 3 5 5

Index values used in Table X.

- |                     |  |                     |  |  |  |                           |   |
|---------------------|--|---------------------|--|--|--|---------------------------|---|
| Magnitude of impact | 1. negligible<br>2. small effect<br>3. moderate effect<br>4. substantial effect<br>5. great effect | Amplitude of effect | 1. highly localized<br>2. immediate area<br>3. neighborhood (one mile radius)<br>4. 5 mile radius<br>5. sub-regional | Frequency or periodicity of occurrence | 1. one time occurrence<br>2. rarely repetitive<br>3. occasional<br>4. regular<br>5. constant | Probability of occurrence | 1. very rare if at all<br>2. improbable<br>3. probable<br>4. highly probable<br>5. unavoidable surity |
|---------------------|--|---------------------|--|--|--|---------------------------|---|

\* If major portion of feedstuff produced in Modoc County.

heat withdrawal over a 30 year project life represents less than 1% of the heat contained in the fluids alone. A 1360 sow complex will draw  $2.1 \times 10^{10}$  BTUs per year or  $6.12 \times 10^{14}$  calories over the life of the project from a fluid heat reservoir of  $3.37 \times 10^{17}$  calories gross heat or  $6.73 \times 10^{16}$  calories in the fluid found in a 4 square mile portion of the resource.

Table XI summarizes peak heat requirements for the complex as presented in the final design report (August 1980). Heat withdrawals for most of the year will be much lower than that indicated. Peak heat is based on outside design temperature of  $-2^{\circ}\text{F}$  for Alturas.

Table XI. Project peak heat requirements thousands of BTUs/hr.

Building Facility	Heat Required per Building	Number of Buildings	Total Heat Required
Breeding	304	2	608
Gestation	668	2	1336
Farrowing	1,386	1	1386
Nursery	1,337	1	1337
Growing	431	3	1293
Finishing	586	3	1758
Methane	1,960	1	1960
Total			9678

Since there is no need for reinjection, the reservoir temperature of  $240^{\circ}\text{F}$  is not expected to be affected.

In the event reinjection is required for some unforeseen development, spent geothermal waters will be reinjected below or at the same level as they were extracted. The level of withdrawal when heat demand is highest, i.e., 325 gallons per minute at peak flow, occurs for relatively short periods, especially during winter. This extraction rate is expected to be made up through natural recharge volume so that measurable ground subsidence will not occur even if the integrity of the rock is other than expected. Since (in the event of reinjection) spent geothermal waters are injected at hydrostatic pressure, i.e., not forced into the ground by pumping, and near the periphery of the reservoir,

no unnatural seismic effects are forecast. All of the above apply to the projected expanded facility accommodating 5440 sows.

It should be noted that the complex geothermal flow rate at peak extraction is 325 gals/min which by design is equivalent to the flow rate of Kelley Hot Spring all year long and apparently over many centuries. Hence there appears to be little concern about the project's influence on the heat resource.

### 3.3 IMPACTS ON SOILS OF STUDIED SITES

Since none of the land is considered prime agricultural land in the area, no serious impact is expected. The principal environmental concerns involving soils are:

- o soil disturbance
- o soil quality and its impact on construction
- o erosion

#### 3.3.1 Soil Erosion

These soils produce a fine dust if disturbed when dry. Construction activities will generate windblown dust into the local atmosphere. Conversely, both soil types when exposed are subject to rapid erosion during heavy rainfall on moderate to steep slopes. Since the topography is gently rolling, sheet erosion during the construction period and the first winters following suggest that only minor amounts of soil loss will be expected. On the other hand, operations off of gravel roads or compacted areas during wet weather can cause considerable damage to the friability, permeability, and structure of affected soils. On slopes, it can increase soil loss by double the expected amount. The clay fraction will become very sticky and adhere to feet and vehicles in large, unmanageable blocks which are transported about, later contributing to dust and potential sediment load.

### 3.4 HYDROLOGIC AND WATER QUALITY IMPACTS

#### 3.4.1 Introduction

Hydrologic impacts potentially arise from a) integration or diversion of natural water courses, b) impervious surfaces, c) interception or diversion of aquifers, d) drawdown of water table or aquifers.

Since no natural water courses or drainage channels are involved on any of the six sites, water courses will maintain their integrity.

Water quality of discharges from waters generated within the project, whether geothermal or cold well water will be of a quality equal to or better than that found in existing streams.

#### 3.4.2 Impervious Surfaces

Impervious surfaces from buildings, design of roadways and ancillary construction will be of the order of 4.5 to 5 acres. If service roads between buildings are developed they will add 2 additional acres, not counting the access road leading to the project.

In the vicinity of Alturas, average annual precipitation is 12 inches with a range of 6.5 to 19.5 inches. The highest average monthly precipitation occurs from November through February, and is of the order of 1.5 inches. Much of this precipitation occurs in storm periods of several days, and rarely does 24 hour precipitation exceed .5 inches. Therefore, the impact of impervious surfaces will periodically increase stream discharge locally, but will remain well within channel capacities of local natural drainage systems.

### 3.4.3 Water Use and Aquifer Drawdown

Water will be used for the following purposes within the project:

1. Potable water for human use.
2. Agricultural grade water for animal consumption.
3. Agricultural grade water for gutter washing to form pumpable slurry.
4. Feed production, maintenance washing, and possibly for some landscaping and miscellaneous uses.
5. Heat extraction of geothermal water.

Sources of water are

1. Fresh potable well water
2. Geothermal well water
3. Recycled project water

Table XII shows the estimated volumes used from each source.

If the total design requirements for animal drinking water of 35546 gals/day had to be met, this would result in a steady withdrawal of about 25 gals/min, which the aquifers of the project site appear to be able to supply on a sustained basis.

The great demand of water would be an average of 288,000 gallons per day geothermal extracted from depths of 2000 to 4000 feet.

There is expected to be a relatively constant heat withdrawal of  $\pm 100$  GPM to supply the heat requirements of the fermentation tank throughout the year. At peak project requirements, the flow is estimated to be 325 GPM. Assuming a balance for slightly lower usages in the fermentation tanks during summer, offset by lower heat requirements in the nursery and farrowing barns for the same period, and an average of one month at or near peak flow in winter, Table XII shows that approximately 1/5, or up to 61,116 gallons per day of the average geothermal water withdrawals could be used to supply operational requirements if such spent geothermal water meets agricultural grade specifications as it is expected to do.

Table XII. Estimated volumes of water required for a 1360 sow complex.

	Source (Gallons per Day)								
	Geothermal			Fresh Potable			Recycled		
	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
Human consumption	0	0	0	+500	1000	150	0	0	0
Animal consumption	35546**	43000**	22000**	35546	43000*	22000*	0	0	0
Waste management	2070**				2070		22500		
Feed production, etc.	?	?		?	2000				
Heat extraction	288000	468000	144000	0	0	0	0	0	0

\* = estimated.

\*\* = currently a potential design option only.

Hence the withdrawals of fresh water-bearing aquifers for potable water would be of the order of only 1000 gals/min at a maximum.

#### 3.4.4 Water Quality

##### 3.4.4.1 Water Quality Standards

Important aspects of this topic were discussed in the section on hydrology; however, internal water quality is important. No data are yet available on project water to compare with E.P.A. standards.

Domestic and special uses within the complex will require potable water at human standards. These systems will be kept separate from geothermal and agricultural grade water. Table XIII shows the maximum concentrations of trace substances permissible in domestic water supply.

The principal concern is the agricultural grade water. Its principal use is manure transport and methane production. As indicated above, methane generation produces agricultural grade water suitable for irrigation. Aeration, settling, and/or biological removal can improve this quality to degrees equivalent to standard tertiary water treatment. Tables XIV and XV indicate the maximum allowances for livestock and irrigation waters.

##### 3.4.4.2 Water Discharge and Recycling Qualities

According to project design, there are two principal sources of discharge water: 1) the excess spent geothermal water, and 2) surplus water from the settling ponds accepting water from the biogas generators. These waters are expected to be equivalent to or better than natural waters in streams of the area; however, it is possible that they may not meet discharge requirements, especially with reference to boron. These events may arise from higher salt concentration or high levels of constituent ions that are unforeseen. As a general rule geothermal

Table XIII. Maximum Concentrations of Trace Substances for Domestic Water.

<u>Constituent</u>	<u>Maximum Concentration*</u>
Alkalinity	None
Ammonia	0.5 mg/l
Arsenic	0.1 mg/l
Total coliform	20,000 MPN/100 ml
Cadmium	10 ug/l
Chloride	250 mg/l
Chromium	50 ug/l
Color	75 APHA
Copper	1.0 mg/l
Cyanide	0.2 mg/l
Iron	0.3 mg/l
Lead	50 ug/l
Manganese	50 ug/l
Fluoride	**
Mercury	2 ug/l
Nitrate nitrogen	10 mg/l
Nitrite nitrogen	1 mg/l
pH	5.0 to 9.0
Selenium	10 ug/l
Sulfate	250 mg/l
Zinc	5 mg/l

\* Note that many of the maximum recommended concentrations are for mg/l whereas many of the measured values are in ug/l. 1 ug is 1/1000 of a mg, i. e., a much lower concentration.

\*\* In the United States, the primary source of fluoride is the drinking water supply. Thus, the amount of fluoride ingested is determined largely by the temperature since water intake is higher in hot weather. For this reason, fluoride limits in raw drinking water are established on the basis of air temperature.

<u>°F</u>	<u>mg/l of fluoride</u>
80-91	1.4
72-79	1.6
65-71	1.8
59-64	2.0
55-58	2.2
50-54	2.4

Table XIV Recommended maximum concentrations of trace substances in water for livestock enterprises. (EPA, 1972.)

<u>Constituent</u>	<u>Maximum Concentrations</u>
Aluminum	5.0 mg/l
Arsenic	0.2 mg/l
Boron	5.0 mg/l
Cadmium	50 ug/l
Chromium	1.0 mg/l
Copper	0.5 mg/l
Lead	0.1 mg/l
Mercury	10 ug/l
Nitrate	100 ppm
Nitrite	10 ppm
Selenium	0.05 mg/l
Zinc	25 mg/l

\* Note that many of the maximum recommended concentrations are for mg/l whereas many of measured values are in ug/l. 1 ug/l is 1/1000 of a mg, i. e., a much lower concentration.

Table XV Recommended maximum concentration of trace metals in irrigation waters. (Source: EPA, 1972.) Refer to Appendix XI.

<u>Element</u>	<u>Max. Conc. for Use Up To 20 Years On Fine Textured Soils of pH 6.0 to 8.5</u>
	mg/l
Aluminum	20.0
Arsenic	2.0
Boron	2.0
Chromium	1.0
Copper	5.0
Iron	20.0
Lead	10.0
Manganese	10.0
Nickel	2.0
Zinc	10.0

waters often have higher concentrations of all ions in the first period of extraction than later when the reservoir flow has been established. Such a period may last for 1 or 2 days to a week or so. Project holding ponds are large enough to hold such water until they can be brought to discharge quality or suitable disposal established.

The water from the biogas generators will contain suspended solids and presumably moderate levels of nitrogen and some phosphorus. They may therefore be somewhat eutropic. The biogas generation process will eliminate all harmful organisms and the resulting water will be at least of agricultural grade when passed through settling ponds. Mixing with geothermal water will reduce the concentrations of dissolved salts to acceptable discharge levels. Impoundment in various ponds could, if necessary, further reduce objectional ions, either by biological removal and/or by deposition in bottom sediments.

### 3.5 IMPACTS ON VEGETATION

Impacts on any site chosen will involve a loss of about 7 acres of existing vegetation by removal and subsequent construction. This impact is, however, relatively minimal because all sites are on land already cultivated or cultivated in the recent past. This essentially is a shift from one type of agricultural production activity to another.

In the event waste water will be utilized for irrigation on project lands or sold to adjacent farms for irrigation purposes, this represents only a change from dry farm to irrigated farm uses. Since there is ample unirrigated farm land adjacent to the preferred Site #6 and the alternate Site #3, no significant impact will be sustained on native vegetation in the event it is used for irrigation.

Assuming the average use to be 288,000 gals/day from the project, this represents a total of 32 acre feet of water to be discharged during the year. If all such water is stored, it would require a 7 to 10 acre reservoir, assuming no discharges were permitted

into natural streams during the winter. This would then represent at a worst case a loss of approximately 17 acres of extant vegetation, but this loss represents in part a change in form of agricultural use and in part a change from upland habitat to an aquatic habitat. If these discharges can be made into existing reservoirs then the impact, for instance on the Kelley Reservoir, would result in about 1 foot increase in average water level.

### 3.6 IMPACT ON FAUNA

The impact of construction on fauna at either Site #6 or Site #3 is most severe on local small animals and a few bird species. Seven acres of disturbance will normally eliminate populations of small rodents such as mice, voles, gophers, amphibians and reptiles. A few will survive migration off the site but as a rule they must move into territories already occupied and the immigrants are usually at a severe disadvantage and vulnerable. Larger animals and most birds will be displaced or make territorial adjustments.

On the other hand, ponds and irrigated farm land (presumably small grains and pasture) form a new habitat inviting an extension of use for aquatic and meadowland fauna. Carrying capacity for these species is much greater on irrigated land than on dry land farms. Hence, in total numbers there is an expected trade-off, but some species will change.

Since the ponds are expected to be open throughout the year, considerable winter use by water fowl is expected.

Site #6 may impinge on winter deer range and possibly antelope winter range to a small degree. The exact impact is hard to estimate but judging from the proximity of ranch buildings and other types of enterprises in deer and antelope country such as Wyoming, the impact is negligible as long as hunting and poaching are strictly controlled.

The impact on sage grouse is not clear; however, the past agricultural operations on this site undoubtedly preclude further disturbance of strutting grounds and probably also nesting sites, assuming they were there at the outset.

No impact on the fishery is expected at all unless it is a positive one from planted fish in the holding ponds and reservoirs.

Impacts of all types depend entirely on what landscaping, agricultural farming practices and revegetation take place following construction. In general we expect a trade-off by change from dry farm to other types of cover and habitat.

In the event the project is increased four-fold more substantial impacts may result but these occur largely from land use change; i.e., more dry land farms changed to buildings and irrigated land. Reservoirs might increase more in depth of water than in land displaced.

### 3.7 IMPACTS ON AIR QUALITY

There will be some increase in the particulate matter of local air during construction. The clay soils of both Site #6 and Site #3 will yield a fine powder when repeatedly disturbed by traffic or earth-moving equipment. This potential can be substantially reduced by the complication of water.

No other products will arise from the project during the operation that will adversely affect air quality (cf. also section on Aesthetics, Odors).

Traffic increases connected with the project will in themselves contribute no adverse levels of hydrocarbons to the existing air quality. Large truck traffic is expected to be at a level of 2 trucks per day and passenger cars of the order of 30 trips per day. Because of the remoteness of the project and the low level of existing traffic, no adverse effects are expected even if the size of the project is

increased four-fold.

Particulate matter may be generated within the feed mill from time to time. The preparation of by-product feed stuffs from agricultural products or wastes may produce more particulate matter. These, however, are largely contained in cyclonic collectors within the mill itself. For at least part of the rations made, dry material is mixed with moist sprouted barley grown as feed within the complex; hence even this is not expected to generate an adverse air quality condition.

### 3.8 IMPACTS ON ARCHAEOLOGICAL AND HISTORICAL SITES

Project design has carefully avoided any impacts on archaeological and historical sites discovered during the course of the environmental work. Hence Sites #1, #2 and #5 were excluded from further consideration although in other respects they had attributes of considerable value. Sites #3, #5, and #6, as outlined in Figure 2, were found to be completely free of any indication of ancient or modern sites of interest (cf. Archaeological Status, Section 2.7). In addition the access road into Site #6 of the pipeline and road from a well on Site #6 to Site #3 is completely free of archaeological or historic sites. Hence, no impact on these parameters will be sustained by any part of the project.

### 3.9 IMPACTS ON LAND USE

#### 3.9.1 Project sites

The internal decisions to limit the project to Site #6 or an alternate Site #3 were made on the basis of highest potential heat flow, accessibility and freedom from possible archaeological impacts. Site #5 is usable but the heat flow potential is not as high. Therefore, the land use impact discussion will be limited to Sites #6 and #3.

Land use changes on any one of the six sites selected will change from one agricultural use to another, re from dry land farming to intensive livestock production within specially designed buildings and from dry land to reservoirs and ponds. The magnitude of the 1360 sow unit is of the order of 7 to 17 acres, depending on the requirement of water-holding capacity. If existing reservoirs can be used, the impact is expected to raise; as an example, Kelley reservoir about 1 foot, assuming all discharge waters were impounded there. In that case, only the building site and access road, comprising 17 acres, would result in a land use change.

### 3.9.2 Land Use

This type of industrial agricultural complex will bring with it some on-site residential construction as well as diverting land area to ponds. While the 1360 sow complex will not result in a far-reaching impact on the local scene, construction of a unit 4 times that size may do so. Whether or not these additional complexes will be built at the same site or dispersed at several other sites having geothermal resources is not clear at this time. Either concept has its drawbacks and advantages: a concentrated complex increases all environmental impacts somewhat, but concentrates impacts on wildlife and vegetation. It may also increase internal efficiency, disease susceptibility, and make possible additional adjunct byproduct activities. A dispersed complex (over 3 or 4 sites, one to two miles apart), increases wildlife interferences but reduces aesthetic and management effectiveness. It may improve impacts on subsurface water withdrawal by spreading withdrawal points. In either case, some land use increase will occur off-site at Canby or Alturas for residences and service activities (see section on socio-economics). The larger complex will have a much greater effect in Canby than in Alturas since the latter has some capacity to absorb several new families and services with existing facilities.

It is possible that some of this land use change described for the towns could be confined to the project site, especially if the majority of residences were developed there. This is a matter of degree since some personnel must be on-site, especially the project manager.

The impact on supportive agricultural land and economics may be substantial even for a 1360 sow complex.

Project requirements for feed are of the order of 35.3 tons per day for a 1360 sow complex. Of this about 3/4 are small grains--corn, grain sorghum (milo), wheat, oats, barley, etc. Modoc County production of barley and wheat on most non-irrigated soils is .8 and 1.02 tons respectively per acre. When irrigated it is about double or 1.6 tons per acre for both barley and wheat. The county's best soils, mostly around Goose Lake, are capable of producing 1.9 and 1.8 tons respectively per acre. Translated to production acreage based on the dominant soils of the county that are irrigated, the project would require the production of about 8000 acres. If the highest production soils are used, 7200 acres are required. While only wheat and barley are considered here, the project also requires corn and milo. If Modoc County were to produce all the grains required, some lands would have to be devoted to these crops, assuming high yielding varieties are adaptable to local climates. Whether or not this type of farming is adaptable to Modoc economics is a moot question. If not, grains will be obtained from the central valley of California, or from the Mid-West where degree-growing days are more favorable.

Needless to say, if available bench and terrace land in the Warm Springs valley were irrigated and turned to the production of grains to supply the project, it would have a profound effect on many aspects of the valley. It would probably mean that nearly all of arable land currently dry-farmed might be utilized and much of it might be irrigated using sprinkler systems, assuming adequate water supplies could materialize. If geothermal water

could be used for small grain irrigation as it has been demonstrated at the Raft River geothermal site in Idaho, and assuming an annual withdrawal of the order of 288,000 gallons per day ( .8838 acre ft/day), approximately 129 acres of barley or wheat could be grown utilizing project water using the average county requirement of 2.5 acre feet of water per acre.

Current practices in the lowland areas of Warm Springs Valley appear to be wasteful of water and cultural methods marginal or outdated. Some areas currently in sagebrush may be considered for conversion to agricultural production. The soundness of this potential impact will depend largely on economics, the value of wildlife habitat, and water supply.

The impact of diversion of the current production of feed grains in the county may cause some localized hardships for other users until sources or production are balanced.

### 3.9.3 Project Impacts on Transportation and Roads

The project will have little impact on railroad traffic, although some feedstuffs not provided locally may be brought in by rail. The main transportation impact will be through the trucking industry. An average of 2 trucks\* per day will be required for feed stuffs alone. Movement of 30,000 to 33,000 live hogs per year will average about 1/2 truck per day. Movement of other supplies into, and by-products and wastes out of the facility will be of the order of 1/4 or less truck per day.

Service trips, management trips and project personnel trips could amount to about 34 trips at a maximum, all of light vehicles. While this traffic represents an increase of 37 trips per day or approximately 962 trips per month (37 trips x 26 working days), it does not result in an important impact.

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\* Truck and trailer, or large semi- and trailer, averaging  
 † -25 tons/load.

This is a 66% increase in average local traffic load, or 57% of peak monthly load; however, the level of average monthly load is only 1,450 or 48.3 cars per day (30 day month). Hence the impact of the project on traffic is negligible (but see also Health and Safety section).

#### 3.9.4 Impacts on Other Identified Uses

##### 3.9.4.1 Introduction

Land uses in the area have been identified as:

- 1) livestock related primarily, and over the longest period
- 2) agricultural production of hay, grains and pasture
- 3) recreational--hunting, fishing and the potential reconstitution of the spa at Kelley Hot Spring

The first two uses have already been discussed and their impacts identified.

##### 3.9.4.2 Impacts on Recreation in the Area

It is difficult to identify direct impacts on hunting and fishing in the immediate area. The presence of the project will certainly locally restrict hunting of deer, antelope, grouse and pheasant in the immediate area; i.e., at least in a 1/4 mile radius. Since the area is not heavily used for that purpose, nor is the area particularly critical to the presence of game in the general area, no adverse impact is to be expected.

Similarly, the only impact the project might have on the fishery is the possible limited use of the ponds for pan fish. No existing fishery is impacted.

The presence of the project in the general vicinity of the Hot Spring is not expected to have an adverse effect on the potential development of a recreational spa at Kelley Hot Spring and the use of Kelley reservoir if such is ever intended by the present owner. Very little if any of the

project would be in view from the hot spring area and it would be nearly 3/4 of a mile to the nearest structure. The road entrance is nearly 1/4 mile from the spring and nearly 1/2 mile from the old spa, hence no traffic conflicts would exist.

No odors or noise from the project would be detectable at a site near the spring so it would essentially have no adverse effect on the operation of a recreation area.

Similarly, the project would have no effect on any established residence or commercial activities in the area or at Canby about 2.5 miles distance.

### 3.10 AESTHETICS IMPACTS

#### 3.10.1 Visual

Project impact at any site will represent a substantial change from the open rural agricultural grazing aspect to a number of low profile buildings, tanks, and ponds. In the 1360 sow complex, these represent 16 to 18 structures of metal buildings and tanks. In addition, 1 to 6 residence structures are anticipated. All sites are in open meadow land, hence, any constructed buildings will be highly visible from some points off-site unless properly landscaped. The proximity of Site #3 to Highway 299 forms a visual node of considerable importance. Only Site #1 will be visible from Canby; Site #6 appears to be shielded by woods or terrain features. However, the general aspect of the structures is modern, engineered metal buildings and from the outside appear similar to many commercial structures already visible in the lumber or agricultural activities in the valley.

#### 3.10.2 Audial

No adverse noise impact is expected from the project. Minor internal noise generated from activities within the building

will not exceed tolerable working levels, although the shrill squeal of hogs may reach 90 dBA for a few seconds. Their frequency usually does not exceed 1 every 5 minutes.

Escaping steam will not be a factor since all geothermal waters will be contained. Even if geothermal water is used in some way other than heat transport, it will have the heat removed so that no flashing will occur.

No activity connected with the agricultural complex will generate noise that can be considered objectionable at close residences or off-site. The generated noise expected is from the 2 or 3 trucks arriving or departing from the project each day. All other noise will be confined to the interior of structures and all of these will be at acceptable decible levels for health and working conditions.

### 3.10.3 Odoral

All odors will be confined to buildings. Since manure and urine is immediately removed to methane digestors, offensive odors that might otherwise adversely impact off-site sensors will not exist. Discharge from the generators is essentially odorless. Interbuilding transport of manure is continuous and enclosed in pipes. In fact, animal health is so dependent on an odor-free environment, when odors of that magnitude are perceptible the project will be shut down of its own accord.

## 3.11 HEALTH AND SAFETY IMPACTS

### 3.11.1 Traffic

Since project traffic will be distributed over much of the entire area with peak periods at 7-9 a.m. and 5-6 p.m. the overall impact is not significant. However, the point of entry to the highway could cause safety problems unless properly anticipated because of the high speed of through traffic.

### 3.11.2 Internal Safety

All machinery and equipment is to be made to operate under OSHA regulations. Specific problem areas may include fire and explosion hazards from grain dust, fire free methane, and fire from combustible feedstuffs. All have very low frequencies of potential occurrence and all can be mitigated.

Handling of livestock always entails some hazard, especially from large boars or obstreperous sows. Selection of docile brands such as Poland China crosses and elimination of aggressive males, precludes substantial concern. Hazards from manipulation of sows, especially during farrowing, has been practically eliminated through the use of scientifically designed farrowing crates which permit complete access to the sow without disturbing her.

### 3.11.3 Health

Health hazards are minimal in this complex because of the basic environmental design. No toxic substances are expected to be generated anywhere in the system.

Pathogenic organisms are largely controlled through normal intra-building sanitation procedures and through methane digestion of manures.

The disposal of large dead animals may be through removal to a rendering facility.

The other area in which long-term health hazards may occur is in the feed mill. Workmen are exposed to respiratory hazards from dust and feed constituents. These are generally mitigated through management and protective equipment.

Human waste and drinking water are handled in separate systems apart from livestock water and waste and apart from each other.

### 3.12 SOCIO ECONOMIC

#### 3.12.1 Employment and Housing Impacts

The impact from the 1360 sow complex of 8 to 11 families new to the area is not significant and can be absorbed rapidly in the existing communities. However, because they will be more highly trained and educated, their influx will create some demand for new housing.

The impact of the 5440 sow complex will be considerably greater, especially on schools, housing, and services.

The local impact on employment will be substantial during the construction phase. All construction will be contracted, including site grading and road construction. While some of this labor is out-of-county, project management expects to employ as many qualified local persons as possible. Each module will have different contractors because of the technical nature and divergence of equipment.

#### 3.12.2 Project Impact on Services

##### 3.12.2.1 Schools

Project impacts for the 1360 sow complex on schools can be absorbed into existing facilities. Table XVI shows the school enrollment for 1977. Project children in grades K through 6 will attend classes at Arlington Elementary School in Canby; grades 7 through 9 at Modoc Junior High in Alturas; and 10 through 12 at Modoc High in Alturas.

Project impacts of the 4550 sow complex will more seriously affect grades 9 through 12, although they probably can be absorbed in existing facilities. If county population continues to expand, both capital facilities and personnel may have to be increased.

Table XVI. School enrollment, fall 1977.

	Total	K - 8	9 - 12
Total Number Children	2039	1371	668
Public Schools	2007	1360	647
Vocational Education*	763	0	763
Continuation	0	0	0
Other Special Education	35	19	16
Private Schools	32	11	21

\* Students may be enrolled in more than 1 vocational education program.

Source: "Labor Market Newsletter, Modoc County," State of California Empl. Devel. Dept., Empl. Data and Research, March, 1979.

#### 3.12.2.2 Police and Sheriff

Project impacts by either a 1360 or 5440 sow complex can be handled by existing personnel and facilities. Internal security will be handled by project management, and will include controlled access.

#### 3.12.2.3 Fire Services

Fire hazards arise within the project principally in feed handling and milling, electrical fires or in residences. While internal fire prevention is a project management function, back-up assistance will be required by existing public fire control agencies, presumably the Forest Service fire station.

#### 3.12.2.4 Medical

Should the need for medical emergency services arise, the nearest hospitals are in Alturas. Estimated travel time is 20 minutes.

### 3.12.2.5 Sanitary Facilities

During construction portable chemical facilities will be provided at the project site.

Residential and project restroom and lavatory wastes will be handled in septic tanks apart from animal waste facilities. Such facilities will be installed according to existing building codes and health requirements.

### 3.12.3 Solid Wastes

Refuse collection will be contracted for privately and will not affect municipal services. Disposal will be made at an authorized county disposal site. This may include some unreclaimable sludges from settling ponds, but its volume is expected to be very low, non-toxic, and relatively inert.

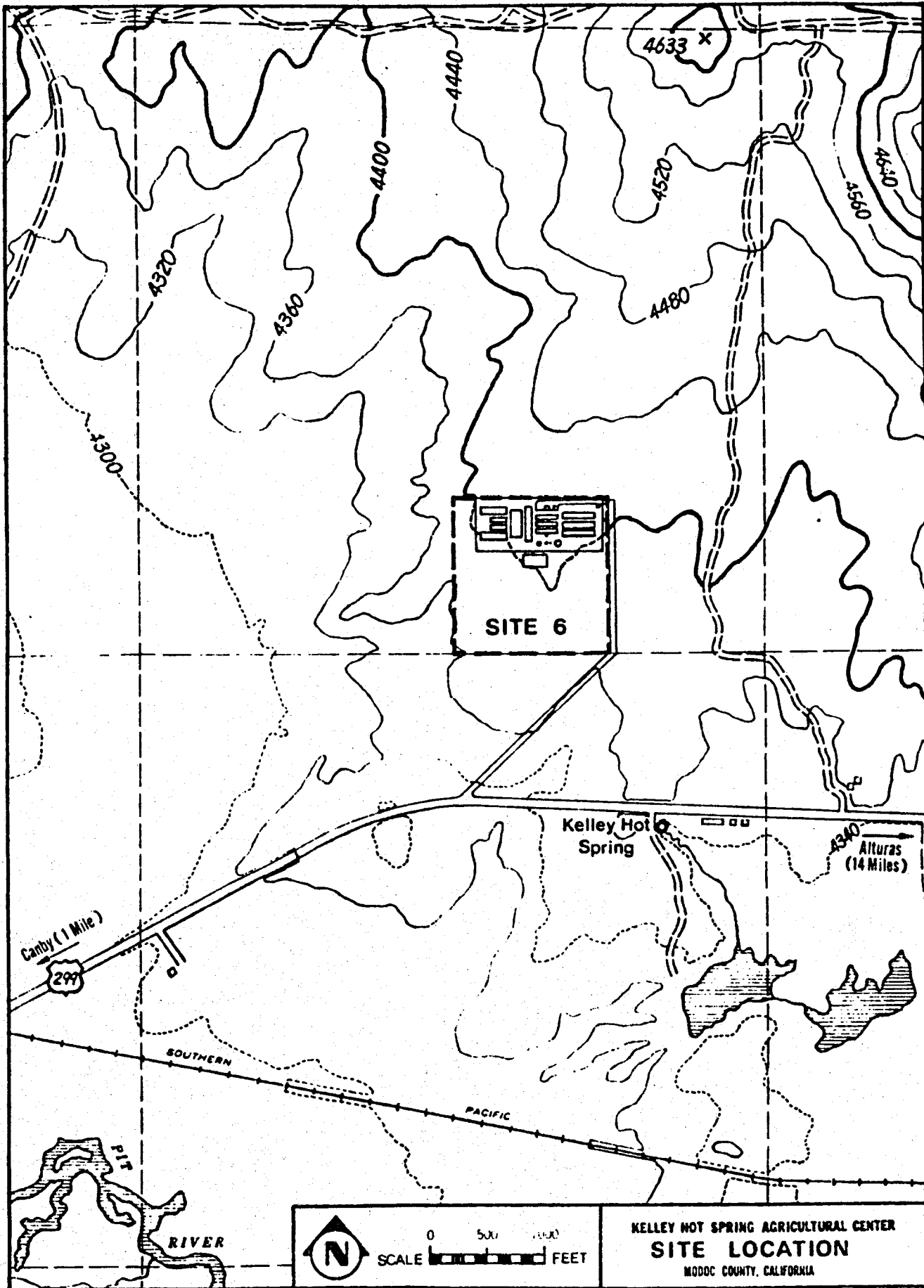
All other wastes are handled by special facilities described under the project description, including methane generation, settling ponds, and pyro-incineration. There is not expected to be any waste of geothermal origin because of the purity of the water.

In the case of geothermal well drilling, drilling wastes will be deposited in a sump. If chemical analysis indicates the presence of toxic materials, drilling "spoils" will be trucked out of the area in tanks to an appropriate disposal site approved by the Regional Water Quality Control Board.

### 3.12.4 Roads

Project traffic will be confined almost exclusively to State Highway 299 between Canby and Alturas. Private access will be constructed from Highway 299 to the project site. Site #6 access will be about one mile long (see Figure 12 ).

Roads will be built to handle heavy trucks and have a high grade all weather surface.



KELLEY HOT SPRING AGRICULTURAL CENTER  
**SITE LOCATION**  
 MODOC COUNTY, CALIFORNIA

Dwg. No. 9084-P201

Figure 14 - SITE LOCATION

### 3.12.5 General Government

Geothermal project development in California requires a number of government permits and approvals by local, regional, and state agencies (see Table XVII). Each agency must commit staff and expenditures to review, administer, and in some cases inspect the proposed project. Additional agencies will normally be involved in project review, but will not have regulatory powers.

Table XVII. Public agency responsibilities in the geothermal development process.

RESPONSIBILITY											OTHER RESPONSIBILITIES	
	Leasing and/or Multiple Land Use Planning	Stipulation of Terms and Conditions for Resource Extraction	Supervision of Operations Activities including Drilling and Maintenance	Certification of Siting, Construction and Plant Operations	Prospecting Permits Issuance	Regulation of Emissions, Effluents, and Other Wastes	Public Safety Regulation	Worker Health and Safety				
GOVERNMENT AGENCY	STATE											
State Lands Commission	X				X							Discretionary authority over project plans.
Division of Oil and Gas			X									Regulatory authority over all "downhole" operations.
Air Resources Board						X						Sets standards and reviews EIRs.
State Water Resources Control Board						X						Regulates diversions and discharges of water; reviews EIRs.
Solid Waste Management Board						X						Issues permits for solid waste disposal to protect public health.
Department of Fish and Game		X										Regulatory responsibility for stream alteration; reviews EIRs.
Department of Water Resources												Water resources development; no regulatory responsibility.
Division of Forestry		X										Regulates conversion of timberland to other uses; fire prevention; reviews EIRs.
State Energy Resources Conservation & Development Commission	X			X								Energy R&D; forecasting; energy conservation; siting.
California Public Utilities Commission				X								Jurisdiction over use and operation of power plants; EIR preparation.
Department of Industrial Relations										X		Enforces occupational health and safety standards.
Department of Health						X						Responsibility for control and disposal of radioactive substances
LOCAL												
Regional Water Quality Control Board		X				X		X				Establishes and enforces regulations for protecting surface & subsurface waters.
Planning Department	X	X		X	X							Regulates use of privately owned land.
Air Pollution Control District		X				X		X				Regulates air pollution emissions & enforces ambient air quality standards.
County Health						X				X		

Adapted from: Jet Propulsion Laboratory, California Institute of Technology, 1976. Report on the Status of Development of Geothermal Energy Resources in California. Pasadena, California.

#### 4. MITIGATIONS

##### 4.1 INTRODUCTION

The following discussions are keyed to descriptions of potential impacts under Section 3. The project has built into the final preliminary design features of operations that mitigate most of the common impacts that are usually expected from conventional swine-raising operations. The most objectionable environmental impact from swine in concentrated numbers is odors. Not only by design have odors been eliminated through the waste management program; it is axiomatic that if odors ever get to the point they are detected off of the immediate premises, the operation as a whole will have failed economically and functionally because the sows cannot produce, young pigs cannot survive and older pigs cannot make the required weight gains necessary for success. Hence it is vital to the project that odors be controlled.

Beyond this, the topics discussed below are those that have alternative approaches and are important to the area as a whole.

##### 4.2 MITIGATIONS PERTAINING TO GEOLOGY

Topographic modifications will be slight but unavoidable. Earth moving, trenching, back filling and ground leveling is necessary for construction. Because the land is gently-sloping and no large swales or depressions must be filled, the impact is not serious either to natural water drainage systems, visual or off-site scenic deterioration, or massive ecosystem disruption.

In the event the size of the project increases four-fold, these latter parameters may become more important but they cannot be avoided. Their lasting effects can be mitigated by landscaping and application of sensible engineering control for drainage and building siting, etc.

Physical isolation of 1360 sow units is one method of reducing such impacts. Isolation can be attained by separating units by 1/2 to 2 miles.

#### 4.2.1 Mitigations of Geothermal Withdrawals

Alternatives available to the project are: 1) reinjection of spent water and 2) discharging into reservoirs for subsequent application to farmland.

Project design has followed the general direction of the Lahontan Regional Water Quality Control Board to find a use for spent geothermal water if the quality of the water met minimum standards for the designed use. In this case, available water quality evidence points to the use for agricultural purposes and it is management's intention to utilize the water on nearby farms or acquire lands for dispersal uses.

In the event geothermal water quality does not meet minimum discharge standards and cannot be made acceptable economically (see Section 3.4.4.1) then a reinjection well will be drilled and the water returned to levels at or below those from which it was withdrawn. As a general rule injection wells are some distance; i.e., 1/2 to 1 mile from the point of extraction to avoid cooling water to be withdrawn and/or permitting reinjected water to regain heat prior to re-extraction.

In general the volumes to be withdrawn are well within the capabilities of the reservoir even if the project is increased four fold.

#### 4.3 INDUCED SEISMICITY AND GROUND SUBSIDENCE

In the event that the reinjection alternative is exercised, the method of reinjection is at hydrostatic pressure; i.e., it is allowed to go into the rocks under gravity flow and not forced by pumping. This procedure has eliminated the concern

for induced seismicity. However, it should be noted that seismic activity is characteristic of geothermal areas and occurs as a matter of course.

Ground subsidence is not expected to occur since the withdrawals from the project even in its four-fold form is insufficient during the life of the project to be detected. In addition it is expected that meteoric water from above will automatically replace that which is withdrawn. If it hadn't Kelley Hot Spring would have gone dry many centuries ago.

#### 4.4 SOILS

There will be no impact of the project on soils per se except that the soil profile in construction areas will be destroyed. This is an unavoidable impact and cannot be mitigated. The character of the two principal soils, Ager and Daphnedale variant, impacts the project because of the clay inherent in it. These cause concern only to engineers who must design foundations and footings to compensate for its high shrink-swell potential.

#### 4.5 HYDROLOGY AND WATER QUALITY

##### 4.5.1 Impervious Surfaces

There will be an increase of  $\pm 7$  acres of impervious surfaces (including roads, buildings and appurtenances), which is an unavoidable impact. Mitigations involve guiding runoff into existing natural water channels or into reservoirs where it can be applied to agricultural production. It may be necessary to construct non-erodable ditches or pipelines to nearby water channels. These should be equipped with appropriate energy dissipators at the point of discharge.

#### 4.5.2 Water Use and Aquifer Drawdown

Alternative procedures available to project management are the utilization of geothermal water as a replacement for some of the fresh potable water withdrawn from surface strata. As shown in Table XII, spent geothermal water could replace fresh potable water if geothermal water quality was equivalent or met minimum standards for livestock water. This might mean an additional cooling pond and circulating pump in place of a deep well pump necessary for fresh well water. Nevertheless local aquifers are easily expected to yield the 25 to 30 gallons/minute required by the project if it is as currently designed. Even though the area is not classed as a high water production area it should have sufficient water to supply a project four-fold. However, it may be necessary to disperse the wells over a wider area, i.e., up to 1 mile radius, in order to tap sufficient water-bearing strata.

#### 4.5.3 Water Quality

Because of project design, no water will be discharged or recycled within the project without meeting acceptable quality. The inherent feature of the methane generation process makes the residual water equal to or better than minimum acceptable quality for agricultural purposes. Its quality can be improved substantially, if necessary, by aerating ponds in tandem to reduce nitrogenous levels to acceptable limits. Natural settling within the ponds should reduce levels of other expected constituents to well within required limits.

#### 4.6 VEGETATION

Removal of vegetation is unavoidable and its mitigation is one of replacement or substitution. Revegetation, using native shrubs, is one alternative; however, if landscaping is one that requires irrigation, many native shrubs do not

withstand high soil moisture levels and substitute plants should be utilized. Trees, if irrigated, would serve several functions; i.e., revegetation, scenic cosmetics (if necessary) and bird habitat.

#### 4.7 FAUNA

It appears that specific mitigations for fauna will not be necessary. Bird cover will be replaced by trees and shrubs and fish may be added to reservoirs.

#### 4.8 AIR QUALITY

Particulate material in local air arising from construction and earth moving can largely be allayed by 1) use of water sprinkled on roadways and travel routes, and 2) early surfacing of roadways and interbuilding connections to consolidate fine clay particles. This impact will be greatest during construction in the dry season. Since this impact is far less than erosion of soil in the rainy period, and it is necessary to do foundation construction during dry periods, the trade-off is worthwhile.

During project operation the feed mill may be a source of particulate matter. Project design includes cyclonic dust arrestors that effectively remove vegetable dust from feed preparation operations. This factor is not considered important because much of the feed is handled as wet sprouts. Milling of grains is the only significant source of dust when cleaned, cracked, or ground, but these operations are enclosed so the cyclonic arrestors are most effective.

#### 4.9 ARCHAEOLOGY AND HISTORICAL SITES

No special mitigations are required because all archaeological and historical sites have been avoided by design and project management decisions. Only project sites 3, 5 and 6 are free of archaeological and historical sites. A special

reconnaissance of the prospective road from Highway 299 to Site #6 has been carried out and shown to be free of archaeological and historical encumbrances. All other prospective project sites were rejected because of significant relics.

#### 4.10 IMPACTS OF LAND USE

No special mitigations are required arising from land use impacts. Those impacts that are area-wide appear to be beneficial to local agricultural production, assuming it is economically viable for Modoc County farmers to produce project grains.

While far-reaching in view of potential intensification of Modoc County grain production, project grain requirements result in either displacement or diversion of existing markets to local use. The impact of traffic requires no special mitigation (however, see Section 4.11.4, Health and Safety).

#### 4.11 AESTHETICS

##### 4.11.1 Visual

While no special mitigation appears necessary, the project should opt to plant and grow trees in and about buildings to soften the overall visual impact of the installations.

##### 4.11.2 Audial

No mitigations necessary.

##### 4.11.3 Odors

This problem was discussed in the introduction to this section.

#### 4.11.4 Health & Safety

##### 4.11.4.1 Traffic

Project management should invite the opinion of Cal Trans and CHP regarding the necessity of project entrance requirements. The proposed departure from Highway 299 offers no reduced visibility but turn lanes from both directions should be considered to provide a safe speed reduction zone and turning safety. The section of highway is prone to invite traffic at high speed. In the interest of public safety turn lanes seem appropriate.

#### 4.12 SOCIO ECONOMIC MITIGATIONS

The economic prognosis of the project is better than average (cf. Economic section of Final Report Preliminary Design), hence tax revenues should far exceed any county expenses required from the project.

The only adverse impact on public services may arise from the influx of school children in the K-8 grades in the local Canby elementary school in the event the project is expanded four-fold. It may be necessary for the school district to increase the teacher-classroom ratio slightly to accommodate new pupils, assuming a majority of families live in the school district and do not commute from Alturas.

#### 4.13 SPECIAL MITIGATIONS TO REDUCE PROJECT IMPACT

There are two subjects that are cogent to the reduction of environmental impact. The first is the disposition of the geothermal well GRI #1 near Kelley Hot Spring. The second is a plan for monitoring water discharges into the environment.

#### 4.13.1 Abandonment of the Geothermal Well GRI #1

The location of this well in the center of an archaeological site of great antiquity is a cause of concern in certain quarters. A careful examination of the area indicates that the original drilling operation was characteristic of geothermal operations of the era; i.e., considerable earth disturbance to depths of 10 feet took place in the immediate site of the well. In addition a sump was dug and drill muds, etc., were dumped into it and subsequently back-filled. This original disturbance effectively destroyed any archaeological profiles or artifacts for about a 50 foot radius around the well--perhaps somewhat further toward the west--which was the location of the sump.

According to California state law specific procedures are to be followed when geothermal wells are abandoned. This operation is closely supervised by Division of Oil and Gas personnel. In general, for wells of this type the procedure is to move a small drill rig over the hole, remove debris to the bottom of the casing shoe and fill the hole with cement to a point about 10 feet of the surface of the ground. Earth is then removed around the casing and the top 10 feet of the casing is removed. The excavation is then back-filled and compacted to the level of the surrounding terrain. This procedure effectively seals the reservoir at that point.

Since the well is no longer of value to the project and cannot economically be deepened, Geothermal Power Corporation is forced by law to undergo abandonment procedures.

The field study indicates that the abandonment procedure will not further impact the archaeological site since in that area there is nothing left to impact, (the original private funded drilling activities, in 1969, disturbed the area in the immediate vicinity of the well); there is no cogent reason to delay abandonment procedures provided the following conditions obtain:

1. Operations are performed in dry weather, preferably summer or fall.
2. Excavations do not exceed a 7 foot radius around the hole.
3. Vehicular equipment traffic be strictly limited to existing roads and those areas previously disturbed by the original drilling.
4. Surface grading be restricted to the disturbed site within a 10 foot radius of the well.
5. Spoil from excavation be placed to the west of the hole and the ground under the spoil not be disturbed during the back filling operation.
6. Crew be restricted from disturbing/scavaging resources.

#### 4.13.2 Monitoring

It is essential for project waters to be monitored in order to protect the health of personnel, livestock and biota. There are several critical points at which monitoring should take place:

1. the geothermal water
2. potable water sources
3. agricultural grade intraproject water
4. discharge water at the point of disposal

##### 4.13.2.1 Geothermal Water

The quality of incoming project water needs to be known and tested frequently in the first 18 months of operation. This will allow the reservoir to adjust to flowing at a new point and any build-up of dissolved salts to be flushed out. Once the flow and quality is stabilized then a determination of its disposition can be made. If dissolved salts are of a quantity and specie precluding further use then reinjection procedures will occur. If the water is usable, as it is expected to be, then its quality should be periodically

determined to verify stabilization. Parameters that should be measured should be: total conductivity, pH, boron, flourine, lead, arsenic, and if necessary, copper.

#### 4.13.2.2 Potable Water Sources

All sources of potable water withdrawn from aquifers in the project area, including residential wells in the vicinity, should be monitored on a quarterly basis for at least a three-year period. Parameters that should be measured are: total conductivity, pH, flourine, total nitrogen phosphate, arsenic, coliform bacteria.

#### 4.13.2.3 Intraproject Agricultural Grade Water

Water recycled for animal use should be monitored quarterly until it is established that it is safe for the purposes for which it is used. Parameters to be measured are the same as those in 4.13.2.2.

#### 4.13.2.4 Disposal Water

Water discharged should be tested as needed to determine that it meets the requirements for the use or disposition directed. These requirements will be set by the Lahontan Regional Water Control Board. If discharged into the Pit River drainage, its quality will be equal to or better than the water at the point of confluence. If used for irrigation the critical level to be monitored will be boron. However, total nitrogen and phosphate may also be important ions to consider. Monitoring should be made at the point of discharge and prior to discharge. Subsequent tests may be necessary if impoundment levels become low.

## 5. ALTERNATIVES

### 5.1 INTRODUCTION

The alternatives discussed in this section are limited to those parameters not addressed in the Impact (section 3) and Mitigations (Section 4). The purpose of this section is to inspect alternatives to the proposed action and the alternatives leading to the choices of operation, equipment, sizing and configuration of the project components.

### 5.2 ALTERNATIVES TO THE PROPOSED ACTION

#### 5.2.1 The Electrical Conversion Alternative

The Kelley Hot Spring area has been considered and explored as a source of heat to power electrical generators. The early explorations by Geothermal Resources International, Inc. were proposed with this in mind. Hence considerable geotechnical data have been accumulated that tend to indicate heat flows and potential for the area, Figure 15. This culminated in the drilling of GRI #1 well near Kelley Hot Spring and subsequently of KHS #1 1 1/2 miles to the east. These wells indicated heat levels well below those required for electrical generation and proved that the resource was water dominated. Hence the electrical conversion of geothermal heat is not economical, at least considering the state of the art and current economics. (See also Section 7.1.)

#### 5.2.2 Livestock Class Alternatives

Very early in the proposal stage several alternative agricultural applications using geothermal heat were reviewed. Those included were greenhouse production facilities, dairy, beef feeding, sheep raising, hogs, poultry, and rabbits. The selection of swine was based on economic return, availability of production equipment, market acceptance of the

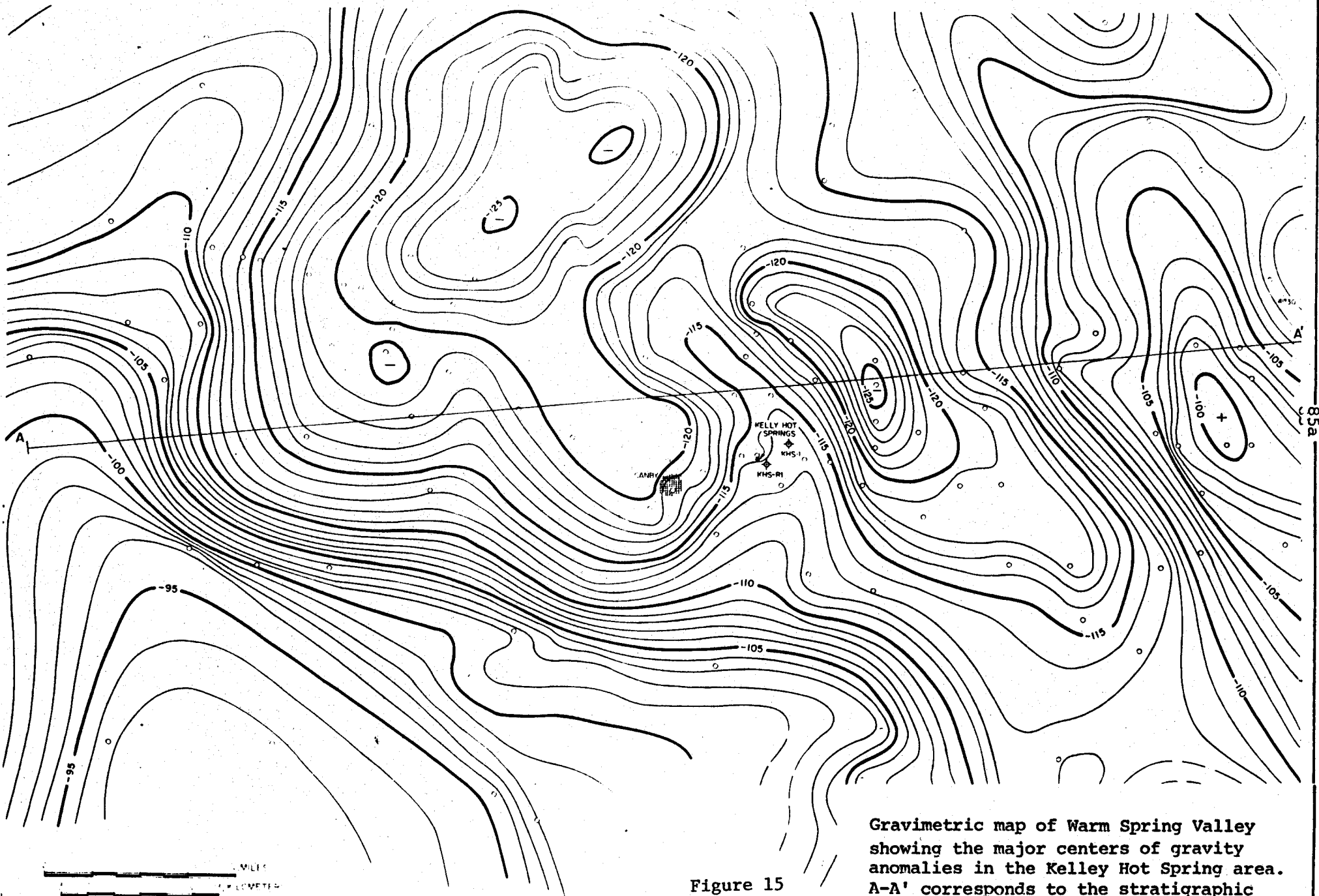


Figure 15

Source: Calif. Div. Mines & Geology  
Open File report 78-5 Sac.

Gravimetric map of Warm Spring Valley showing the major centers of gravity anomalies in the Kelley Hot Spring area. A-A' corresponds to the stratigraphic section depicted in Figure 8, page 20.

products and ability to manage wastes. Economics and market stability predicated against greenhouse operations, beef feeding and poultry. Sheep and rabbits were rejected on the basis of adaptability to the area and established methods of handling, although the economics appeared to be equal to or better than hogs. Any of the above operations could be added to advantage at a later stage of project development if shown to be economically viable.

#### 5.2.3 Commercial System Alternative

Early in the proposed stage several uses of geothermal energy were examined that might be economically viable in Modoc County. Lumber, mining, agriculture, and manufacturing were considered. Temperatures were not particularly advantageous for any mining or lumbering application except peripherally for space heating. Manufacturing was eliminated for early consideration on the basis of the remoteness of the area and transportation costs, particularly as a primary venture.

Agriculture on the other hand offered good potential because of availability of feedstuffs, useful heat range and diversity of applications.

#### 5.2.4 The No Action Alternative

There is no particular advantage pro or con to the null alternative. The resource is there; an unused land capable of sustaining reasonable alterations is available. The economic base of the county is based on agriculture and silviculture so that there is only the change from a diffuse land/labor extrusive type to a concentrated land/labor intensive type. Without the project the fortunes of the area would continue much as they are. In either case, i.e., with or without the project, the open space, rural character would continue. Similarly, the employment/revenue opportunities would be maintained at their present slow rate of growth and development which may be disadvantageous if the

inflation rate continues to increase.

#### 5.2.5 Site Selection

Initial reconnaissance was made by team members to identify several sites that would be adaptable to an agriculturally-oriented project and which were within reach of a known resource. Ultimately, six sites were selected (see Figure 1). All were appropriate and some advantageous in special ways.

Site #1 had close proximity to Kelley reservoir, ample land, somewhat removed from the highway, and from general view. Elevations were favorable but gravity flow of waste materials and configuration of land forms afforded easy reservoir construction. Disadvantages were road construction and the length of pipeline necessary to connect to the existing well (GRI 1). The site was later removed from further consideration because of extensive archaeological deposits of great antiquity.

Site #2 had physical properties similar to Site #1, except that project access was more direct to Highway 1 but it was very close to Kelley Hot Spring. It, too, was removed from further consideration because of archaeological deposits of great antiquity.

Site #3 has direct access to Highway 299, ample land, favorable elevations and land forms. The area designated for the project is devoid of archaeological sites. Its disadvantage is its remoteness from a known or desirable resource. According to the basic plan, if this site is used then the geothermal water must be piped from a well located at Site #6. The decision to use Site #3 or Site #6 is dependent on land price and economics.

Site #4 has direct access to the highway, ample land for expansion, favorable elevations and reasonably usable land forms. It is 1/4 mile closer to the prospective geothermal well on Site #6 but its use was precluded because of

substantial archaeological deposits of great antiquity.

Site #5 also has direct access to the highway, ample land for expansion, elevations and landforms are usable but may limit gravity flow of liquid wastes. It contains no archaeological or historical deposits. It has a drilled well with usable heat flow but not as high as that predicted at Site #6.

Site #6 has ample land for expansion, favorable elevations and land forms. It is free from archaeological and historical deposits. It has been identified as a site having the highest heat flow in the whole area. Its disadvantage is its remoteness from the highway, necessitating the construction of an all-weather road designed to carry heavy trucks. The proposed route (see Figure has been carefully examined and found free of archaeological and historical sites.

### 5.3 ALTERNATIVE APPROACHES TO PROJECT DESIGN AND EQUIPMENT

The following are criteria on which the preliminary design was modified from the conceptual design.\*

#### MEMORANDUM

To: Team Members

From: Alfred B. Longyear *AL*

Subject: Approach to Preliminary Design

Distribution: Team Members; H. Sullivan, R. Visoria - DOE; G. Budney - ETEC

The purpose of this Memorandum is to set the approach to the Preliminary Design. Except as modified herein, the Conceptual Design configuration will be the guideline for Preliminary Design. Further modifications will be only as agreed between the Engineering Team Members and the Principal Investigator, subject to approval of the Program Manager.

By copy, the DOE/ETEC Project Offices are being advised of this direction.

If any clarification or further definition is required, please contact the Principal Investigator.

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Enclosure: Criteria for KHSAC Preliminary Design

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\* Memoranda, May 23, 1980. F. Longyear to team members; i.e., approach to Preliminary Design.

CRITERIA FOR KHSAC PRELIMINARY DESIGN

1. Except as modified herein, the Conceptual Design direction shall be used in the Preliminary Design.
2. Site 6 (north of Highway 299, T42N, R10E, S20, SW 1/4 of SE 1/4) is the supply well site.
3. The primary facility location is also in Site 6, connecting easterly to the existing north-south road that runs through S20, SE 1/4 of SE 1/4 to Highway 299. During construction this road will be improved to handle livestock and feed trucks. An alternative is to locate the facility in Site 3, contiguous with Highway 299, connected by a transite buried pipeline to the supply well in Site 6. The Preliminary Design will focus on the integrated Site 6; however, construction planning will consider the 3/4 mile pipeline to reach Site 3 as an option.
4. The single supply well configuration will be as defined in Conceptual Design.
5. The reinjection well is to be eliminated. Primary use of spent geothermal fluids will be for makeup water in the manure flush and in the methane generation system. Waste waters that have been purified by the methane generation process will be reused for manure flushing in the breeding, gestation, growing and finishing buildings. Spent geothermal fluids and/or fresh water flush will be utilized in the farrowing and nursery buildings. Unconsumed geothermal fluids and purified waste waters from the holding ponds, downstream of the methane generators, will be disposed of through overland spray and/or natural drainage.
6. Based upon the quality of water from Kelley Hot Spring as measured to date, the primary heat exchanger is to be deleted. The radiant heating in the floor areas is the only area in which a fresh water loop and heat exchanger is to be utilized.
7. The construction shall be planned to accelerate the admission of bred sows into the system. Planning shall consider use of operational personnel in finishing the interior of the buildings and installing of the equipment.
8. The lineal footage of fin tube heat exchangers in the ceilings of the swine raising buildings are to be reassessed. The air handling equipment (fans) specifications and locations are to be assessed for economic compliance with animal requirements.
9. Sprouted grain growing equipment is to be added to produce sprouted barley. This will be sized to displace about 20 percent of the commercial feed in the breeding, gestation and lactation formulae.
10. The incinerator is to be deleted and replaced with a caustic tank with safety lid. The tank is to be sized to dispose of dead piglets up through nursery size. Adult swine dead carcasses are to be disposed of through hauling off site to a solid waste or rendering facility.
11. Gravity tank system will be used for waste flushing in lieu of the previously considered high-flow pumping system. Care should be exercised in designing an economic, quiet system for minimizing stress on the animals.
12. The methane system will utilize geothermal heating and thermophilic bacteria. Methane will be scrubbed for removal of  $H_2S$  and  $CO_2$  and will be transported at low pressure to the boundary of the livestock raising areas.
13. The 300 KW electric generating system is to be deleted. A 100 KW emergency standby power supply system will be included. Methane is to be offered to the Surprise Valley Rural Electrical Cooperative. Power will be purchased from that Cooperative.
14. By rearranging the pen layouts in the farrowing building and reshaping but not resizing the building, two additional farrowing pens are to be included in each of the 18 rooms. This will increase the sow herd to 1,350 pregnant and farrowing sows.
15. Commercial agricultural practices must be used in all design efforts. The objective will be to maintain high standards of health, pork productivity and minimize operating costs, and especially capital costs. It is requested that the design effort be continuously reviewed with the objective of reducing capital costs.

AGRESCIENCE CONCEPTUAL DESIGN OPTIONS SELECTED

Paragraph	Trade Study	Design Option Selected	Key Selection Factors
III. A.2.	Gutter Type	flush gutter under slats	health, sanitation, cost
III. A.3.	Slat Material	aligned fiber composites	commercial, sanitation, durability, cost
III. A.4.	Aquaculture	not selected	programmatic
III. A.5.	Feed Source	mill on site	cost
III. A.6.	Growth of Feed Sprouts	not selected	programmatic
III. A.7.	Feed Contents	existing non-proprietary formulations	commercial practice
III. A.8.	Alcohol Production Byproduct Use	not selected	unavailable
III. A.9.	Protein Extraction	not selected	no commercial demonstration
III. A.10.	Finish Hog Weight	228 pounds	current practice and facilities
III. A.11.	Water Disposal	field irrigation	environmental, conservation, cost

The following are identified Trade studies carried out by various team members that have led to the project design as presented in the Final Technical Report, August 1980, "Kelley Hot Spring Agricultural Center Preliminary Design" and is reproduced here as it appears in Appendix A of that report.

TABLE 4-6 SHEET 1 OF 2

## CIVIL, ELECTRICAL, AND MECHANICAL CONCEPTUAL DESIGN OPTIONS SELECTED

Paragraph	Trade Study	Design Option Selected	Key Selection Factors
III.B.2.	Building Type	pre-engineered metal with steel panels	cost
III.B.3.	Insulation Type	loose fill cellulose, fireproofed	cost, building type
III.B.4.	Insulation Thickness	7-1/2" in walls, 8" in ceilings	R factor, building type, insulation type
III.B.5.	Floor Type	brush and smooth finish concrete	agriscience criteria applications
III.B.6.	Gutters	flat cross section, sloped	efficiency, cost, ease of construction, sanitation and maintenance
III.B.7.	Swine Effluent Ponding	matched cut and fill, film sheet liners	normal practice, cost
III.B.8.	Swine Waste Solids Separation	mechanical separator	cost, ease of operation
III.B.9.	Manure Transport	flush with recycled water	agriscience criteria, cost, conservation
III.B.10.	Human Wastes Disposal	septic tank and leach field	cost, local practice
III.B.11.	Pig Carcass Disposal	gas fired incinerator	health, efficiency
III.B.12.	Floor Heating	black steel pipe in concrete	agriscience criteria, thermal design
III.B.13.	Space Heating	fin tube in supply air plenum	cost, compatibility
III.B.14.	Wall Heating	not selected	cost
III.B.15.	Exhaust Air Heat Recovery	not selected	cost, "essentially unlimited" heat supply
III.B.16.	Cascade Heating System	space heating, floor heating, methanation	cost, thermal requirements
III.B.17.	Type of Geothermal Piping	uninsulated asbestos cement	cost, experience
III.B.18.	Thermal Storage	not selected	cost
III.B.19.	Primary Heat Exchanger	stainless steel plate type	cost, ease of maintenance
III.B.20.	Deicing of Sidewalks	rock salt	cost
III.B.21.	Geothermal Supply Pump	vertical turbine	engineering experience

TABLE 4-6 SHEET 2 OF 2

## CIVIL, ELECTRICAL, AND MECHANICAL CONCEPTUAL DESIGN OPTIONS SELECTED

Paragraph	Trade Study	Design Option Selected	Key Selection Factors
III.B.22.	Geothermal Reinjection Pump	split case horizontal centrifugal	ease of repair and replacement
III.B.23.	Methanation Tank	metal roof, concrete base, metal or concrete walls	cost, design factors
III.B.24.	Methanation Heating	recirculation through heat exchanger	agitation method, existing practice, cost
III.B.25.	Methane Slurry Agitation	recirculation	existing practice, cost
III.B.26.	Methane Storage	steel tank with compressor	cost, end use
III.B.27.	Methane Water Usage	recycling except farrowing and nursery	cost, conservation, agriscience criteria
III.B.28.	Methane Gas Cleaning	compressor aftercooler condensing	cost, end use
III.B.29.	Methane Use	internal combustion engine generators	programmatic goal, existing practice
III.B.30.	Methane Backup system	purchase of electricity	cost, reliability
III.B.31.	Air Handling	ceiling entrance, exhaust fans	agriscience criteria application
III.B.32.	Humidity Control	air changes	cost
III.B.33.	Cooling Method	evaporative	cost, suitability, practice
III.B.34.	Geothermal Backup System	electrical with manual control, backup well and pump	cost, safety
III.B.35.	Site Work	normal agricultural practice	cost, suitability
III.B.36.	Lighting	fluorescent	cost, practice
III.B.37.	Wiring	flexible metallic sheathed cable	cost, agricultural practice
III.B.38.	Power System	480 volt, 3 phase, 60 Hz	loads, standards, utility preference
III.B.39.	Engine Generators	internal combustion	practice
III.B.40.	Transformers	utility provided	cost
III.B.41.	Hazardous Electrical Areas	methane and grain handling	safety
III.B.42.	Outside Wiring	buried	cost, ease of operation

6. RELATIONSHIP BETWEEN SHORT-TERM USE OF MAN'S ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

As it now stands the project will be the first attempt in the United States to harness geothermal energy for the type and scale of agricultural complex proposed. Furthermore, it is the first time the geothermal reservoir on the Modoc plateau has been considered for direct heat applications at least on a commercial scale.

Kelley Hot Spring has been flowing for many centuries and aside from recreational, aesthetic and minor therapeutic use, the heat thus removed from the reservoir has not been used.

The installations and operations proposed here will use a smaller heat flow ( $\pm 200$  gpm) - (325 gpm) than that flowing regularly from the spring. The land required for a 1360 sow unit is  $\pm 7$  acres for buildings and possibly up to 10 acres of ponds.

It will provide irrigation water for  $\pm 190$  acres of small grain land plus produce nearly as much electricity from methane as the project uses. It can utilize about 60% of the feed wheat and barley now grown in the county, and may invite expansion of area farmers to grow milo or field corn which are not now raised in the county.

The project (1360 sows) will produce 29,363 or 6,692,484 lbs. of marketable hogs annually. Nearly all residual waste material is usable for fertilizer or soil additives that will improve considerably the friability and productivity of native soils.

According to the Final Technical Report on the Preliminary Design, the project will mean the following:

Total investment in structures & equipment	\$5,092,240
Initial livestock and feed	550,000
Labor and personnel	214,000/yr
Value of hogs produced--1983 projected price*	\$3,707,636/yr
Value of Biogas sales--1983 projected price	148,938
Projected average heat requirements	$5.5 \times 10^6$ Btu/hr.
Gals. hot water extracted annually (est.)	*288,000/day

Inasmuch as the soils and vegetation on the chosen sites are common and widespread in the Warm Springs Valley and there are what appear to be reasonable balances between gains and losses of other parameters, it is reasonable to expect that long range productivity on the proposed scale or its four-fold expansion will far outpay the moderate cost in land and geothermal resources.

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\* Includes inflation rate 1980-1983, but not beyond.

## 7. ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

Energy relationships utilizing geothermal resources embody two basic concepts: 1) the best type of utilization that wastes the least amount of the resource, and 2) the relative ability of geothermal energy to replace other means of energy economically.

### 7.1 COMPARISON OF UTILIZATION TYPES

The two principal ways of using geothermal heat are its conversion to other forms--principally electricity, and 2) its direct application of heat to some environment where heat per se performs a stated function.

While there are systems that convert low temperature waters to electrical energy, they do not appear to be economical except under special circumstances, usually recovery of waste or byproduct heat where the cost per kilowatt supplied conventionally is substantial. Conversion efficiency is also an important consideration. The state of the art efficiency of high quality dry steam conversion is of the order of 16% of the resource extracted. The proposed project expects to take water at wellhead temperature of 1200°F and extract 160°, discharging it at about 130°F. While this is much better than the electrical efficiency, it contains usable heat which could be cascaded into other uses between the 130° and 90°F or to average ambient air temperature range. The economics of extraction and application begin to dictate how such heat could be used. At this stage of the project additional cascade uses have been considered but their inclusion at this point overburdens the initial investment and obscures the principal objective.

## 7.2 ENERGY FORM AND GEOTHERMAL POTENTIAL

Energy for heat and electricity can be derived from a variety of fuels; solar, geothermal, wind and water. For the purposes stated here, fuels, especially fossil fuels, while technically feasible, entrain unfavorable economics and are in short supply. Water power in the area has already been developed for general use and has little more usable resource given common conversion techniques currently applied. State of the art techniques for converting light and wind energy are not yet economical for this area. This agricultural complex displaces nearly 350,000 gallons of fuel oil yearly and the production of methane as a necessary waste management tool will replace about 300,000 gallons of fuel oil (this latter figure is probably very conservative). This totals a potential saving of 650,000 gallons of fuel oil annually.

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