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GEOTHERMAL HEAT USE IN SAN BERNARDINO WASTEWATER TREATMENT PLANT

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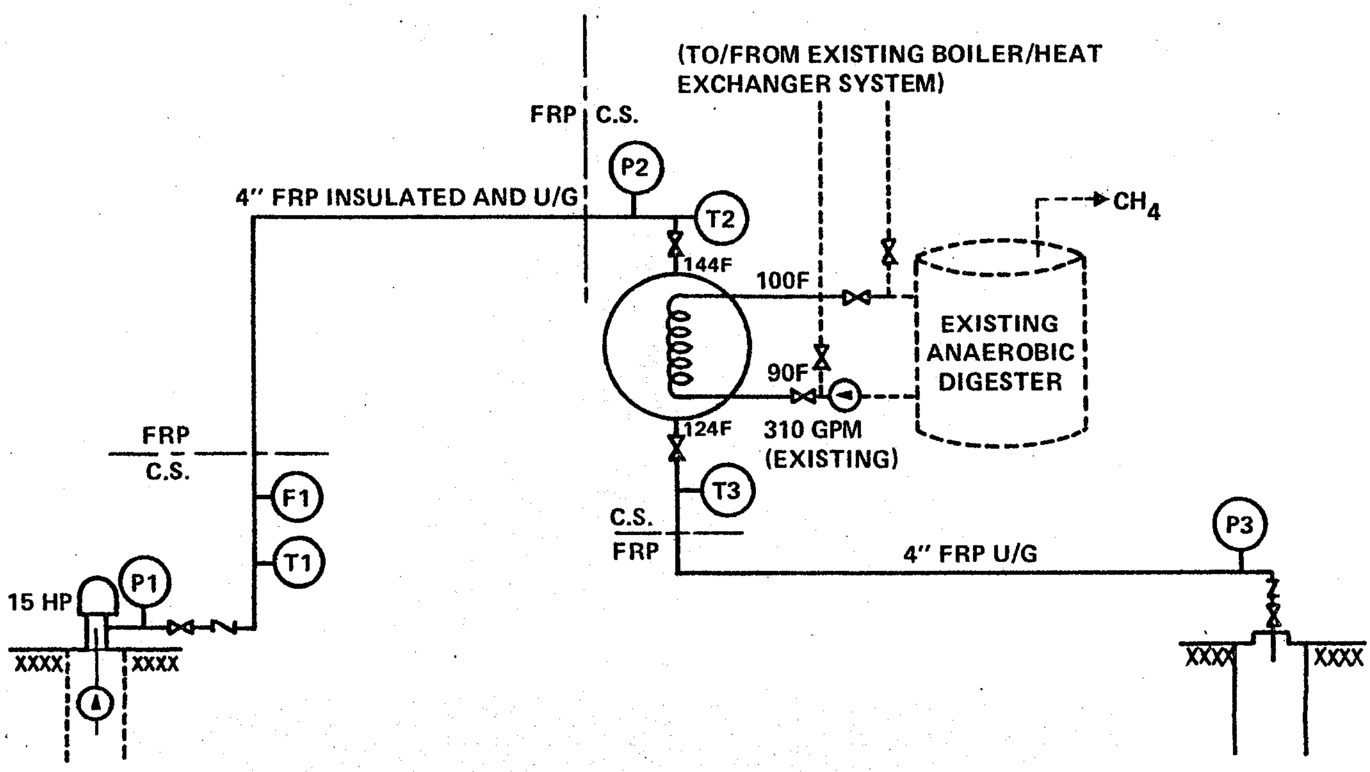

SAN BERNARDINO MUNICIPAL WATER DEPARTMENT

SCIENCE APPLICATIONS, INCORPORATED

COULTER STEWART & ASSOCIATES, INC.

DISCLAIMER

FEASIBILITY OF GEOTHERMAL HEAT USE IN THE SAN BERNARDINO MUNICIPAL WASTEWATER TREATMENT PLANT

FINAL REPORT

For Period September 1980 to June 1981

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Geothermal Energy Division
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1. INTRODUCTION

The material presented herein constitutes the Final Report prepared by the City of San Bernardino and its two subcontractors Science Applications, Inc. and Coulter Stewart & Associates, Inc. on the Department of Energy's Grant DE-FG03-80SF11442 entitled, "Feasibility Study for Wastewater Treatment Utilizing Geothermal Energy in San Bernardino." The study team has developed a system for utilizing nearby low temperature geothermal energy to heat two high-rate primary anaerobic digesters at the San Bernardino Wastewater Treatment Plant. The geothermal fluid would replace the methane currently burned to fuel the digesters. A summary of the work accomplished on the feasibility study is presented in Chapter 2, "Summary and Conclusions."

In order to ascertain potential uses for geothermal energy within the treatment plant, Science Applications, Inc. (SAI) examined the design and operation of the facility and selected potentially viable applications for additional study. Results of these investigations and system descriptions and equipment specifications for utilizing geothermal energy in the selected processes are presented in Chapter 3, "Preliminary Design." Chapter 4 discusses the economic analyses conducted by SAI on the six engineering design cases prepared in Chapter 3.

The environmental setting of the project and an analysis of the environmental impacts that will result from construction and operation of the geothermal heating system are discussed in Chapter 5, "Environmental Analysis." Chapter 6 presents a Resource Development Plan prepared by Cascadia Exploration Corporation. It describes the steps that the San Bernardino Municipal Water Department could follow in order to utilize the resource. A preliminary well program and rough cost estimates for the production and injection wells also are included. Chapter 7, "Implementation Plan", provides the Water Department with a program and schedule for implementing a geothermal system to serve the wastewater treatment plant.

Regulatory, financial and legal issues that will impact the project are presented in the Appendix, "Final Report - Institutional Issues," by Coulter Stewart and Associates. In addition, since public acceptance of the project is important, an outline of a Public Awareness Program is included.

2. SUMMARY AND CONCLUSIONS

The results of the feasibility study for utilizing low temperature geothermal heat in the City of San Bernardino Wastewater Treatment Plant are summarized in this Chapter. For ease of discussion, the study is presented in terms of preliminary engineering design, economic analysis, institutional issues, environmental impacts, resource development, and system implementation.

2.1 PRELIMINARY ENGINEERING DESIGN

On an average annual basis, 21 million gallons per day (MGD) of domestic and industrial wastewater are processed by the treatment plant. In addition to primary and secondary treatment of all wastewater, 3.0 MGD undergo tertiary treatment for reclamation as process water, washdown and irrigation water.

An investigation of the design and operation of the plant and a review of the literature revealed the existence of numerous uses for the lower temperature geothermal resource known to exist near the plant. Potential uses were tabulated and evaluated, including sludge digester heating, sludge disinfection, sludge drying and grease melting. The two alternative heat uses selected as having potential applicability at the San Bernardino plant were sludge drying and digester sludge heating. Additional study proved sludge drying to be clearly uneconomic and therefore, outside the scope of the current geothermal study.

Digester heating, however, appears to be a viable use for the low temperature geothermal heat. Preliminary designs were developed for systems to heat anaerobic digesters using geothermal fluid from two existing wells and from a proposed new well. The five alternate designs listed below will provide heating in place of the existing methane-fueled boiler to one digester, as well as replace both methane-fueled boiler systems, when the plant improvement project described in Section 3.1.2 is carried out.

Case 1: Use Meeks & Daley Well No. 66 to heat one digester.

Case 2: Use Meeks & Daley Well No. 66 to heat two digesters.

Case 3: Use Meeks & Daley Well No. 59 to heat one digester.

Case 4: Use Meeks & Daley Well No. 59 to heat two digesters.

Case 5: Drill a new production well at the plant site and use it to heat two digesters.

If geothermal heat using one of the five designs can be substituted for burning methane to heat the digesters, the methane could be diverted to fuel other equipment, such as the pumps at the sewage influent pumping station currently driven by natural gas engines. Therefore, natural gas consumption at the plant could be reduced significantly.

2.2 ECONOMIC ANALYSIS

An economic analyses was performed on the five engineering designs described in Section 2.1 and a sixth case, in which a private entity develops the geothermal resource and sells energy to the Water Department. In each case, the proposed system was more cost effective than utilizing natural gas. Results also indicated that municipal development would provide cheaper energy than private development, since 100% debt financing is utilized and municipalities do not have to pay taxes.

The most promising engineering designs included heating two digesters with the existing Meeks & Daley Well No. 66 and drilling a new well on the property to heat two digesters. Although the former appears to be more cost effective, the latter is attractive because an autonomous resource is provided and the existing well is freed for potential uses requiring temperatures in excess of 100°F.

Sensitivity analyses also were conducted on key economic variables relating to price and capital cost limit for each case. Variances presented in the analyses did not impact the price of energy to the extent that it was no longer cost competitive with the existing fuel cost. Even the worst case -- utilizing a private developer -- is cost competitive under most circumstances and only uncompetitive under the most pessimistic assumptions.

2.3 INSTITUTIONAL ISSUES

The institutional issues of importance include the legal, financial and regulatory ramifications of the proposed project. The legal status of owning, developing and utilizing geothermal energy is unclear because the State of California defines a geothermal resource as the heat of the earth, while separately defining mineral deposits as including mineral waters and geothermal resources. Therefore, to avoid legal entanglements, water rights should be developed and surface rights and mineral rights should be obtained before developing and using a low temperature geothermal resource.

In seeking financing for the project on the Federal level, only DOE's Geothermal Loan Guarantee Program (GLGP), the DOE/HUD Innovative Grant Program and HUD's Urban Development Action Grant Program have authorized and appropriated funding. If private participation is involved, GLGP should be studied; if not, HUD's programs should be explored. The only fully operational State funds are the Energy Account and Resources Account of the Energy and Resources Fund; however, limited funding and the multitude of uses for these funds make these questionable sources. If this financing does not materialize, the California Alternative Energy Source Financing Authority is another approach. In addition, serious thought should be given to utilizing a local Industrial Development Authority. These last two options would simplify the funding source dilemma and provide greater local controls.

Approval of different aspects of the project could involve six separate city, county and State agencies, depending upon the actual design of the project. The permits listed in Table 2.1 may be required to implement geothermal process heat at the wastewater treatment plant. The Permit to Drill from California Division of Oil and Gas will be required for all project alternatives.

TABLE 2.1
Permitting Requirements

TYPE	AGENCY	PURPOSE
Ministerial	San Bernardino County Engineers	Encroachment Permit
	San Bernardino City Street Division	Street Cut Permit
Discretionary	San Bernardino Planning Commission	Conditional Development Permit
	California Division of Oil and Gas	Permit to Drill
	San Bernardino Department of Environmental Health Services	Water Well Permit
	Regional Water Quality Control Board	Waste Discharge Requirements

2.4 ENVIRONMENTAL IMPACTS

The proposed project will have no adverse impact on the topography, soils or climate of the San Bernardino area. Should the project configuration selected include injection of geothermal fluids at low pressure, the risk of inducing seismic activity will be low. The risk of subsidence from any project alternative is negligible.

Air pollutant emissions from the treatment plant actually will decrease because the amount of natural gas burned will decrease. During construction of the project, however, dust will be generated by excavation of pipe trenches and foundations. The impact will be temporary and minor. The impact of the project on groundwater quality should be negligible.

Impacts on the natural biologic environment will be insignificant. The project will have negligible effects on the economics, land use, population and cultural and historical resources of San Bernardino. A negative impact may be felt on traffic circulation on Orange Show Road, if Meeks & Daley Well No. 66 is chosen, since the pipeline right-of-way will cross the road; however, the interference will last only two to four weeks. Increased noise levels are not anticipated during operation of the project, but heavy construction equipment, such as backhoes and drilling rigs, will create an impact for approximately two months.

Finally, the proposed project will result in the conservation of a significant quantity -- about 5.5×10^9 BTU per year -- of natural gas and a reduction in the Water Department's current annual energy costs of $20,000 per digester heated.

2.5 RESOURCE DEVELOPMENT

A workable production well will be selected, and an injection well may be selected for the project. Based on the preliminary information available, which includes temperature, flow rate and water chemistry, the Meeks & Daley Well No. 66 appears to be an adequate production well; however, more information on its physical condition, as well as on any institutional and financial ramifications of using the well, must be gathered before a determination is reached. Other alternatives do exist, such as using Well No. 59, a warm water well about one-fourth of a mile from the plant, or the City drilling its own production well.

Before selecting the location for a potential injection well, microseismic and other geological data must be analyzed. If an injection well is required, fluids will be injected at low pressure into sedimentary formations; therefore, induced seismicity is unlikely.

A well program and cost estimates of drilling and logging activities also must be prepared for both the production well and injection wells selected to serve the plant.

2.6 SYSTEM IMPLEMENTATION

The development of geothermal energy is a multidisciplinary endeavor requiring close coordination of every participant, if the project is to progress in a timely fashion. Currently the most critical project activity is to obtain financing. Once the financing is available, the project may begin.

Selection of drilling sites will be aided greatly by the resource assessment of San Bernardino currently being conducted by the California Division of Mines and Geology. If the first well drilled by the City is successful, a second well may have to be drilled for injection. If the first well is not successful, a second well will have to be drilled and the first well may be used for injection.

After a determination of well fluid temperatures, chemistry and flow rates is made, the most economical method of spent geothermal water disposal will be selected. Once the necessary fluid disposal permits are obtained, a design contractor will be selected by competitive bid and will start designing the geothermal heating system. Major equipment with extended lead times, i.e., heat exchangers, will be ordered as soon as possible.

Construction will begin when the required permits have been obtained and the final design has been finished. After construction has been completed, the system components will be started up and tested to insure proper operation, and then the entire system will be run until commercial operation is continuous.

3. PRELIMINARY DESIGN

Chapter 3 summarizes Preliminary Design work accomplished by Science Applications, Inc. for the City of San Bernardino. The Chapter is divided into three major sections. The first, Plant Design, provides an overview of the current design and operation of the San Bernardino Wastewater Treatment Plant. In Section 3.2, Investigation of Alternatives, various potential uses for the geothermal heat known to exist in the treatment plant are explored, and the potentially viable heat uses are selected for additional study. Section 3.3, Preliminary Designs, presents system descriptions and equipment specifications for utilization of geothermal energy within the processes selected as viable in Section 3.2.

3.1 PLANT DESIGN

3.1.1 Current Conditions

The City of San Bernardino Wastewater Treatment Plant processes about 21 million gallons per day (MGD) of domestic and industrial wastewater on an average annual basis. The process includes primary and secondary treatment of all wastewater, and tertiary treatment of 3.0 MGD which is reclaimed for process, washdown and irrigation purposes. Figure 3-1 is a layout of the plant showing major process areas and Figure 3-2 provides a simplified flow diagram for the treatment plant (Reference 3.1).

Wastewater enters the treatment plant via the three sewer lines as shown in Figure 3-2. The wastewater undergoes preliminary treatment incorporating bar screens which collect screenings such as rags, sticks and other debris. These are mechanically removed, and deposited into collection bins for

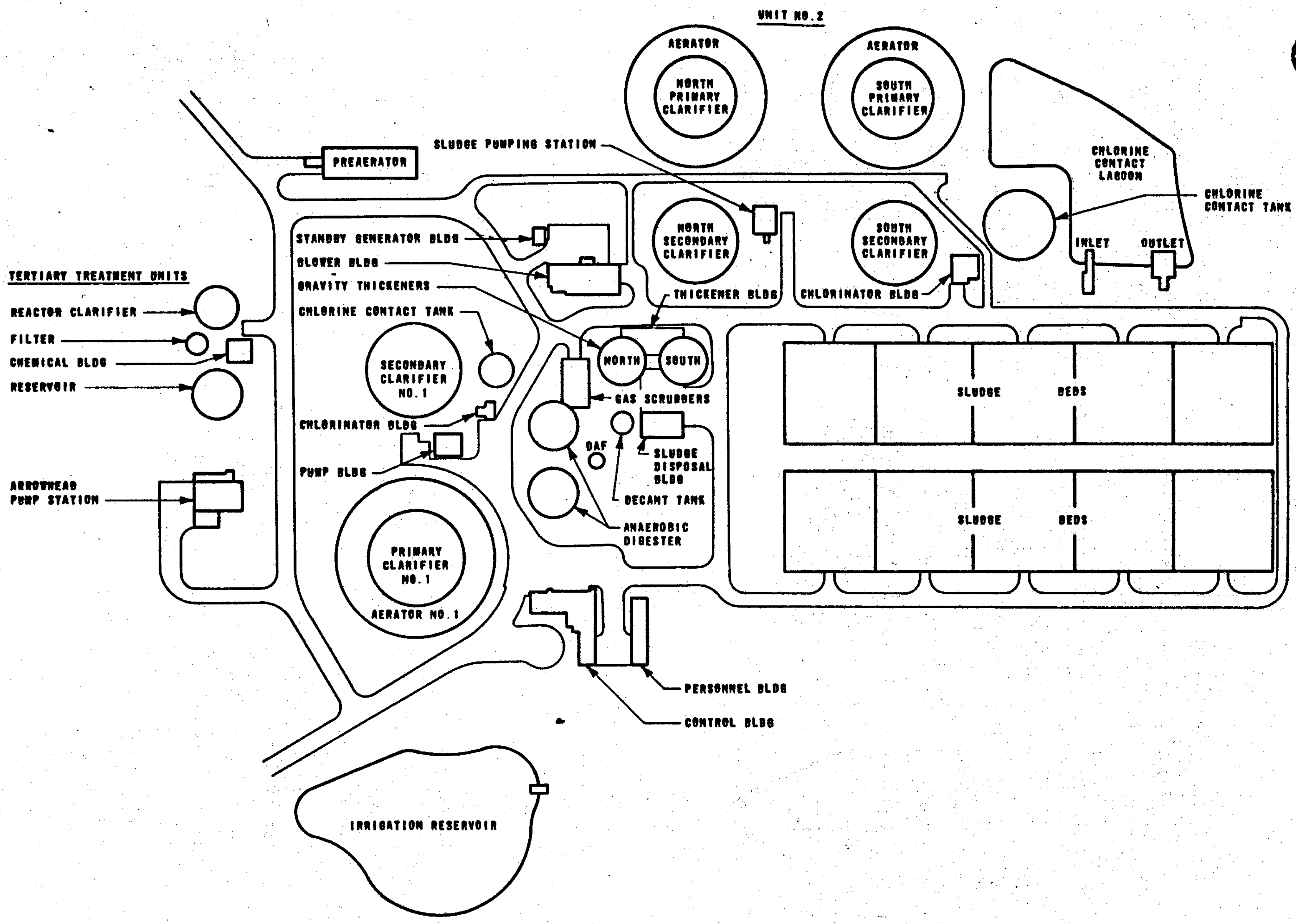

Figure 3-1. Site Plan, City of San Bernardino Wastewater Treatment Plant (From Reference 3.1)

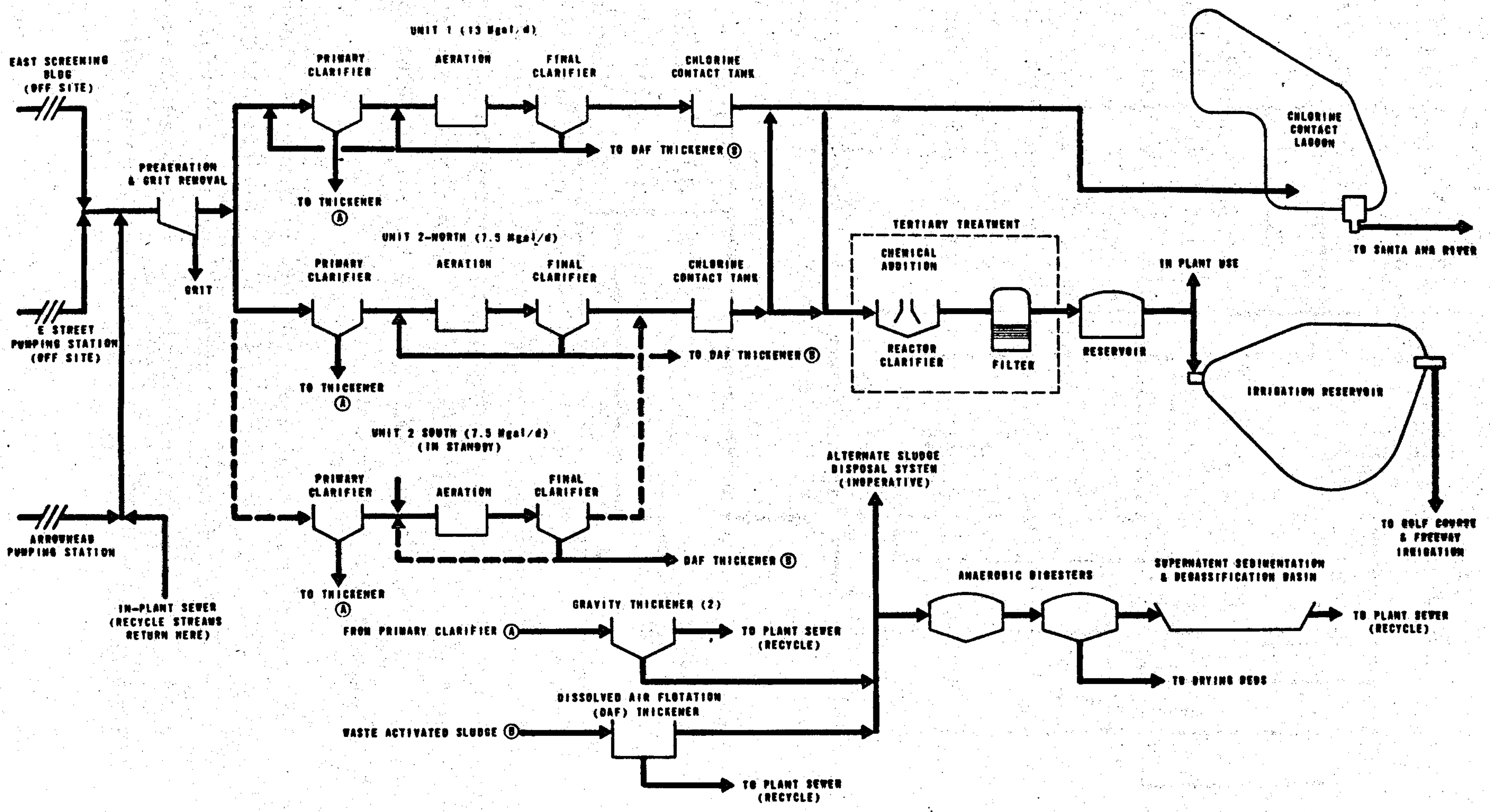

Figure 3-2. Schematic Flow Diagram, City of San Bernardino Wastewater Treatment Plant (From Reference 3.1)

sanitary disposal. Also, grit removal is accomplished by pre-aeration, a process by which air, under pressure, is bubbled through the raw wastewater to encourage floatable material and settleable material to separate more readily.

Following preliminary treatment, the wastewater flows to primary treatment where organic materials are allowed to separate. This is accomplished by reducing the velocity of the wastewater in the Primary Clarifiers, so that these substances will separate from the water carrying them. The solid material, both settled sludge and skimmings, is removed for further treatment, to be discussed later. The liquid portion, or primary effluent, then flows to the aeration system to begin secondary treatment.

Secondary treatment processes are biological processes in which living aerobic (free oxygen demanding) micro-organisms feed on the suspended organic material not removed during primary treatment. The San Bernardino plant uses the activated sludge process, which attempts to duplicate, at a rapidly accelerated rate, the natural breakdown of organic matter in a moving body of water by providing an aqueous environment, a constant source of food, and an adequate oxygen supply for proper maintenance of the feeding microbes. This is accomplished in the Aerators by introducing a culture of micro-organisms (activated sludge) to the primary effluent, along with large quantities of air for respiration of the microbes and for turbulent mixing of the primary effluent and activated sludge.

After aeration, the mixture of primary effluent and activated sludge flows to a Secondary Clarifier (Final Clarifier in Figure 3-2). At this point, settleable materials are again allowed to settle and the activated sludge is pumped back to the aeration system. Gradually, an excessive amount of solids accumulates and has to be removed. This waste activated sludge is treated with the solid material removed during primary treatment.

The secondary effluent then flows to the Chlorine Contact chamber and is disinfected by chlorination. In this process, liquid chlorine is evaporated into its gaseous state, the gas is injected at a controlled rate into a water supply, and this chlorine saturated water is allowed to mix with the secondary effluent. Sufficient detention time for thorough chlorine contact is then allowed, and finally the effluent is discharged to an outfall on the Santa Ana River Wash.

A portion of this final effluent is treated for a third time at the tertiary plant, where chemical additives are introduced to help remove any suspended material remaining in the effluent. After chemical treatment in a Reactor Clarifier, the effluent passes through a rapid sand Filter for polishing and then into a storage Reservoir where it is chlorinated again and made available for in-plant use and irrigation. A holding pond is used to store additional water for freeway landscaping and golf course irrigation, off-setting fresh water use at these facilities.

The sludges and other solids collected throughout the treatment process are pumped from their various collection points to the Thickeners, where they are concentrated through settling. This thickened sludge then is pumped to the Digesters. Digestion is a biological process that uses living anaerobic (absence of free oxygen) micro-organisms to feed on the organics. Processes aided by heating and mixing break down the organic materials into a digested sludge and methane gas. The methane gas is collected and can be used to fuel various in-plant engines which drive pumps and compressors, while the well digested sludge is dried atmospherically on 15 sand-bottom Drying Beds and mechanically with one belt prèss.

3.1.2 Proposed Plant Improvements

A recent analysis of the San Bernardino Wastewater Treatment Plant concluded that certain solids handling and aeration processes within the plant must be improved to allow processing of the plant's 28 MGD ultimate design capacity (Reference 3.2). The following improvements were recommended:

a. Aeration - Install new gas and electrically driven blowers, modify the distribution network and install fine bubble diffusion.

b. Thickening - Thicken primary sludge in primary clarifiers and pump directly to digesters, use dissolved air floatation to thicken secondary sludge.

c. Digestion - Rehabilitate and expand existing anaerobic digester complex.

d. Dewatering - Increase mechanical dewatering of sludge by adding more belt press capacity and supplement with existing drying beds.

e. Disposal - Truck dewatered sludge to landfill or have it removed by soil amendment contractor.

The above proposed improvements currently are being considered for approval by EPA and other funding agencies. If approved, design work will begin in 1981 and construction should be completed in 1984.

3.2 INVESTIGATION OF ALTERNATIVES

There are numerous potential uses for low temperature geothermal heat within wastewater treatment facilities. In this section, potential uses are tabulated based on a review of the literature. The heat uses are evaluated, and those uses considered potentially viable for the San Bernardino Wastewater Treatment Plant are selected for further analysis.

3.2.1 Alternatives Considered

A review of the literature was performed to determine alternative uses for low temperature heat within typical wastewater treatment plants. Table 3-1 presents a summary of the results. Potential heat uses identified include sludge digester heating, sludge disinfection, sludge drying and grease melting. Each potential heat use shown in Table 3-1 was screened to determine its compatibility with treatment processes in use at the San Bernardino Wastewater Treatment Plant.

The San Bernardino plant utilizes two high-rate anaerobic digesters in which the contents are heated and mixed to enhance the digestion process. The sludge is maintained at temperatures between 90 and 100°F, within the Mesophilic range. One digester is heated by a methane-fueled boiler, while the other digester receives its heat from in-plant engine jacket cooling systems. Therefore, the sludge digester heating alternative is compatible with the San Bernardino plant.

Anaerobic sludge disinfection at the San Bernardino plant is currently accomplished in the sludge drying beds. The sludge pumped to these beds contains 98% liquid and 2% solids. It must remain in the beds for 60 days before evaporation and drainage have decreased its moisture content to about 50%. Sludge has been shown to be disinfected if stored for 60 days at 68°F (Reference 3.3). Therefore, the sludge drying beds are performing a dual role by providing disinfection as well. That portion of the sludge which is dewatered in a belt press is trucked off site for compositing, which acts to disinfect this sludge fraction. The disinfection by heating alternative in Table 3-1 is not compatible with the San Bernardino plant.

As explained above, sludge drying currently is accomplished in drying beds and with one belt press in the San Bernardino plant. However, as plant influent increases, alterna-

Table 3-1. Low Temperature Heat Uses - Typical Wastewater Treatment Plant

HEAT USE	TEMPERATURE RANGE	REFERENCES
1. Sludge Digester Heating	85-100F (Mesophilic) 120-135F (Thermophilic)	3.3, 3.4
2. Sludge Disinfection a. Pasteurization b. Composting	 158F 131F	3.3
3. Sludge Drying	125-1300F	3.5
4. Grease Melting	205F	3.4

tive methods of sludge dewatering must be implemented (See Section 3.1.2). Therefore, the San Bernardino Water Department is interested in exploring potentially viable methods of sludge dewatering; the sludge drying alternative in Table 3-1 is therefore compatible with the San Bernardino plant.

The San Bernardino plant does not have a grease melting process. The plant is processing municipal waste and has very few industrial customers. Therefore, the character of the scum and grease to be treated is such that it can be processed without any heating. Based on the above, the grease melting alternative in Table 3-1 is incompatible with the San Bernardino plant.

3.2.2 Compatible Alternatives

The two alternative heat uses which have potential applicability at the San Bernardino plant are digester sludge heating and sludge drying. Each of these uses will be explored further in this section.

3.2.2.1 Digester Sludge Heating

The current method of providing heat to the two high-rate primary anaerobic digesters is shown in Figure 3-3. At the San Bernardino plant, the two high-rate anaerobic digesters are kept at a temperature of 90-100°F, which is maintained by circulating sludge from the digester to a heat exchanger where the sludge picks up heat and is returned to the digester. Two heating systems are in use and each is capable of serving the peak needs of either digester (1.5 million BTU/hr). The first system (see Figure 3-3) uses a digester methane-fueled boiler to heat water to 155°F. This water is passed through a spiral plate type heat exchanger where its heat is transferred to sludge circulating on the other side of the exchanger. The water is cooled to 145°F and returned to the boiler for reheating and reuse.

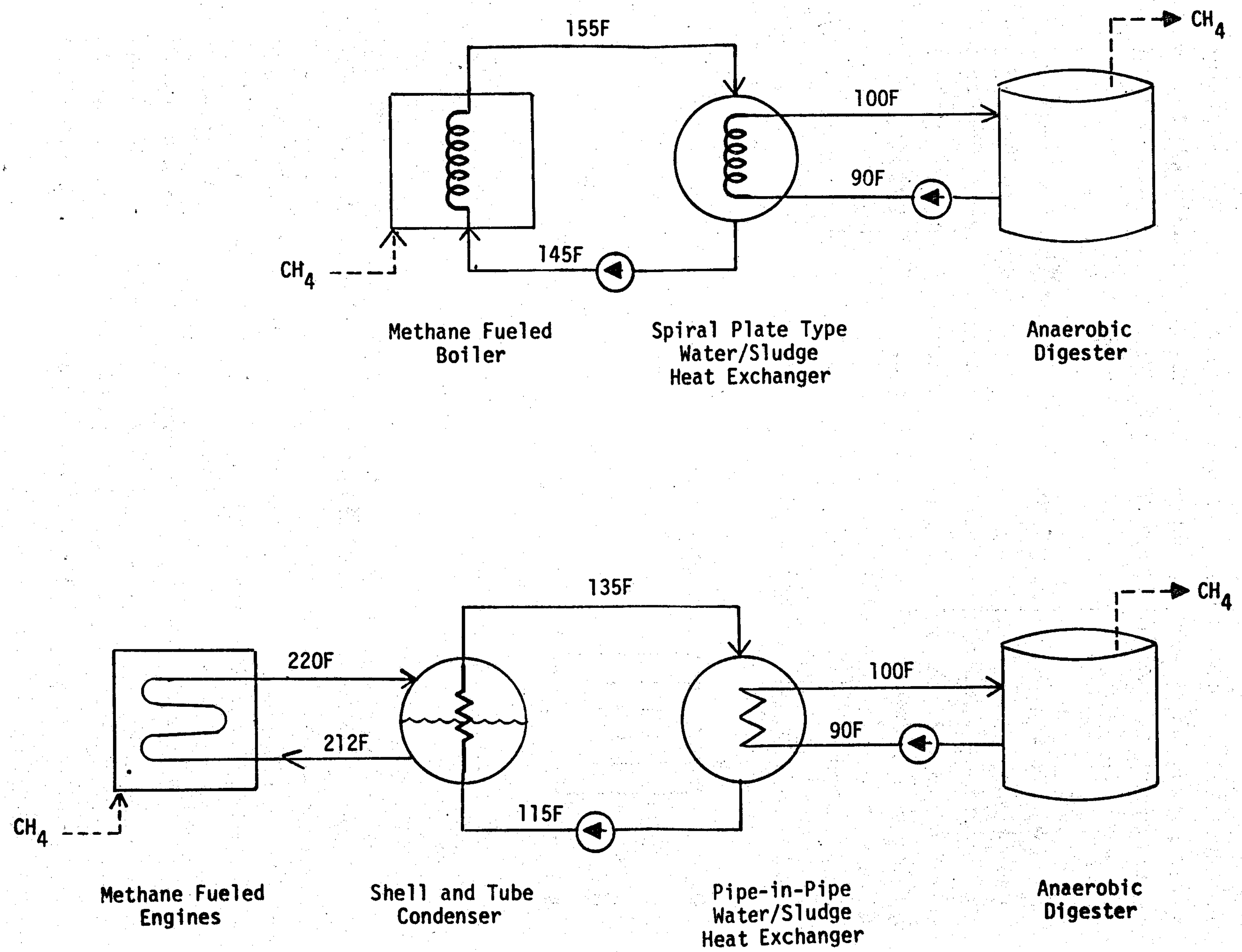

Figure 3-3. Digester Heating System Schematic

The other digester heating system (bottom of Figure 2-1) obtains its heat from the cooling jackets of natural gas- and digester methane-fueled engines which are used to drive plant air blowers. Steam from the engine jackets is condensed in a shell and tube exchanger, thereby heating the water to 135°F. The water is circulated to a pipe-in-pipe heat exchanger where its heat is transferred to sludge circulating on the tube side of the exchanger. The water is cooled to 115°F and returned to the condenser for reheating and reuse.

Of the two digester heating systems described, the one using the methane-fueled boiler lends itself most readily to displacement by geothermal energy. A geothermal well could essentially replace the methane-fueled boiler, freeing the methane previously consumed for other in-plant uses. Geothermal water is available at temperatures of 120 to 145°F from wells within 3200 feet of the digesters. These temperatures are certainly technically sufficient to provide heat to sludge ranging in temperature from 90 to 100°F.

A preliminary analysis was prepared for using geothermal water from Meeks & Daley Well #66 at 145°F to displace boiler derived heat. The installed cost of pipe, valves, fittings and equipment is approximately $150,000. Approximately 5.5 billion BTU of methane would be displaced each year by the geothermal heat, which has a current value of about $20,000 per year. Based on these preliminary costs, digester heating with geothermal fluids has a 7-8 year simple payback period. Therefore, the concept will be pursued in more detail in Section 3.3.

3.2.2.2 Sludge Drying

Currently, sand-bottom drying beds are used for sludge drying at the San Bernardino plant. These beds are currently handling maximum sludge quantities; as wastewater flows continue to increase, alternate means of sludge dewatering will be implemented. As discussed in Section 3.1.2, additional mechanical dewatering with belt presses is being planned to increase the sludge dewatering capacity of the plant. The use of heat for drying may also contribute to increasing the plant's sludge handling capability. In addition, if the sludge can be dried sufficiently, it may have commercial value as a fuel or fuel supplement.

A preliminary investigation was conducted to determine which types of commercially available dryers might lend themselves to sludge drying using low temperature water as a heat source. The dryer type which appeared most compatible is the continuous through circulation type using hot water coils to heat drying air (Reference 3.5). Preliminary discussions were held with the largest manufacturer of continuous through circulation dryers (i.e., conveyor dryers) to develop an understanding of the technical requirements of the dryer. These initial discussions concluded that geothermal temperatures of 120 to 145°F were too low to be practical as a heat source for sludge drying. The minimum practical drying air temperature for sludge drying appears to be about 170°F, which would require water temperatures on the order of 190°F or above (Reference 3.6).

A process schematic, shown as Figure 3-4, was devised to provide 190°F water for a sludge dryer. In this process, geothermal water is used to heat the water/sludge heat exchangers described in Section 3.2.1. The high temperature heat (220°F) from the engine jackets, which was being used for digester heating (via an intermediate water loop), is passed through a new heat exchanger to produce water at 190°F, which is piped to a coil in a conveyor dryer where the water relinquishes its heat to produce drying air at 170°F.

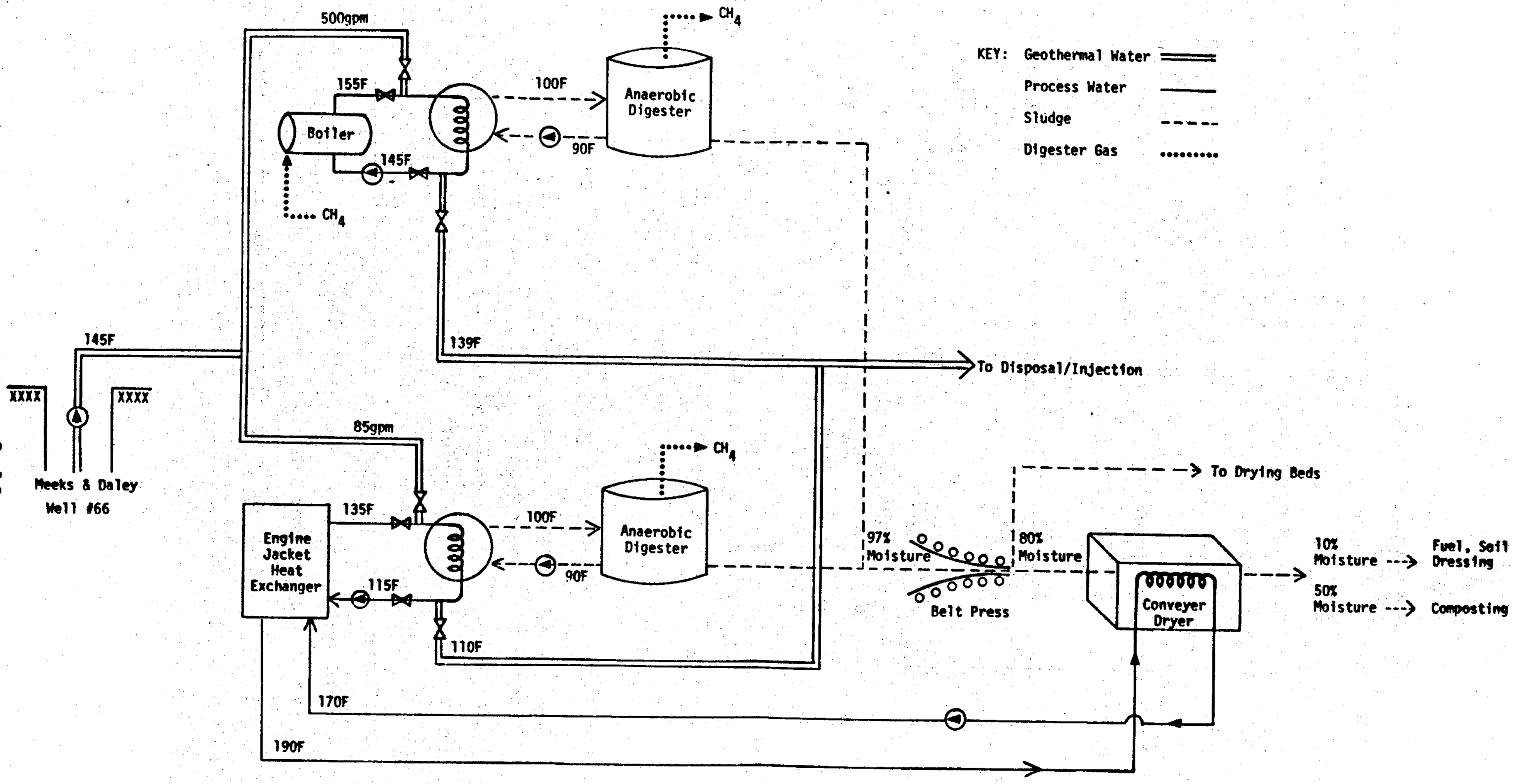

Figure 3-4. Block Flow Diagram - Digester Heating and Sludge Drying

A preliminary payback analysis was prepared for sludge drying using the scheme shown in Figure 3-4. Under normal plant operating circumstances, sufficient blower engines are running to result in 2.5 million BTU per hour of heat being available to the dryer via the engine jacket heat exchange system. The dryer manufacturer estimates that with 170°F drying air, approximately 2500 BTU will be required to evaporate one pound of water from the sludge. Therefore, about 1000 pounds per hour of water can be removed using 2.5 million BTU per hour.

Using these parameters, a conveyor dryer could convert 1290 pounds per hour of belt press paste (80% moisture) to 290 pounds per hour of dried product (10% moisture). The installed cost of the dryer piping and heat exchanger required to accomplish the above would be approximately $200,000 (Reference 3.6). Assuming the dried product can be used as a "solid fuel" with a value of $1 per million BTU, the solid fuel would be worth about $14,000 per year. This results in a simple payback of 14 years, neglecting operating and maintenance costs of the dryer. Therefore, sludge drying using the concept of Figure 3-4 is presently uneconomic and will be pursued no further in this study.

Based on discussions with dryer manufacturers, it is clear that sludge drying efficiency increases very rapidly with increased drying air temperature (References 3.6, 3.7). In addition, flash drying of sludge in cage mill dryers using dried sludge as the fuel is being used in the U.S. (References 3.3, 3.8). Although outside the scope of the current geothermal study, should sludge drying capacity at the San Bernardino plant continue to be exceeded, it is recommended that higher temperature exhaust gas from blower drivers and dried sludge be considered as potential heat sources for conveyor and/or cage mill sludge dryers.

3.3 PRELIMINARY DESIGNS

As reported in Section 3.2, digester heating appears to be a viable use for the low temperature geothermal energy known to exist near the San Bernardino Wastewater Treatment Plant. In this section, preliminary designs will be presented for systems to heat anaerobic digesters using geothermal fluid from two existing wells, Meeks & Daley Well #66 and Meeks & Daley Well #59 (also known as the Riverside Well), and from a proposed new well. These designs will provide heating in place of the existing methane-fueled boiler to one digester. Should the plant improvement project described in Section 3.1.2 be approved, a second methane-fueled boiler and spiral heat exchanger will be installed in parallel with the existing engine jacket heat exhange system. Therefore, designs also will be presented for replacing both methane-fueled boiler systems with geothermal heating systems.

For convenience, the various alternative designs have been organized in terms of the geothermal production well to be used, and the number of digesters to be heated. Table 3-2 below summarizes the general characteristics of each design case.

TABLE 3-2

Alternate Design Case Characteristics

	Production Well	Number of Digesters Served
Case 1	Meeks & Daley #66	1
Case 2	Meeks & Daley #66	2
Case 3	Meeks & Daley #59	1
Case 4	Meeks & Daley #59	2
Case 5	New Well	2

The location of each proposed production well and its associated piping in relationship to the San Bernardino Wastewater Treatment Plant is shown in Figure 3-5. Meeks & Daley Well #66 is located

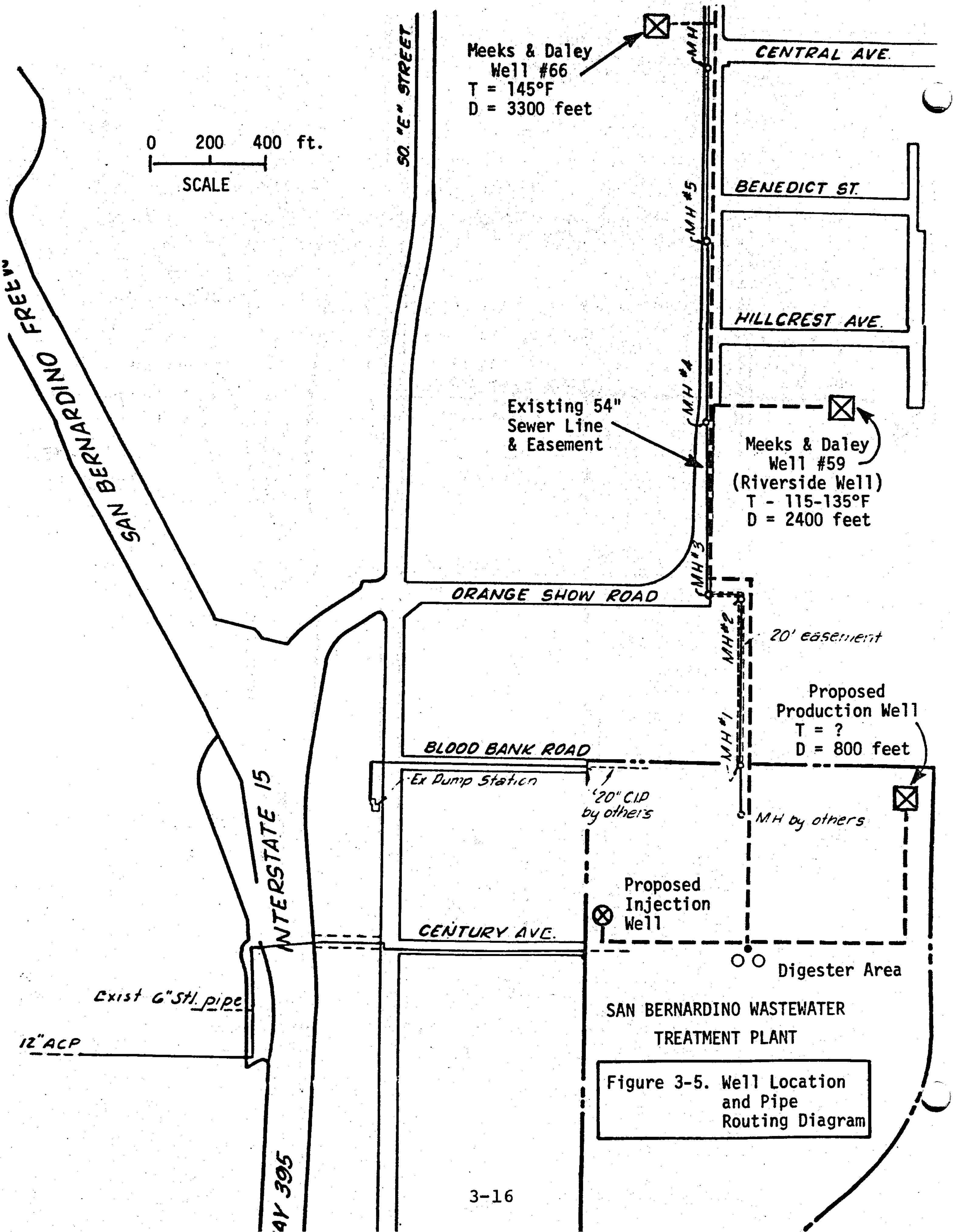

Figure 3-5. Well Location and Pipe Routing Diagram

the greatest distance from the plant (3300 feet), however it produces the hottest liquid (145°F). By contrast, a new well drilled on the treatment plant site would result in only 800 feet of geothermal production piping, while the temperature of the water from that well is unknown.

3.3.1 Design Case 1 - Meeks & Daley Well #66/One Digester

A piping and instrumentation diagram (P&ID) appears as Figure 3-6 for heating one anaerobic digester with geothermal liquid from the existing Meeks & Daley Well #66. The symbols used for all P&ID's in this report are identified in Table 3-3. In Case 1, 155 gpm of geothermal liquid at 145°F is pumped from the well using a multi-stage vertical well pump with a discharge pressure of 45 psig. The liquid's temperature, pressure and flow rate are measured using a spool of above ground carbon steel piping, prior to its being transported via 3300 feet of buried 4-inch diameter fiberglass reinforced plastic (FRP) pipe to the treatment plant. The FRP pipe is factory insulated with a one inch thickness of polyurethane foam encased in a PVC or FRP jacket. The geothermal water loses approximately 1°F during its transport to the treatment plant.

Upon arrival at the plant, the geothermal fluid enters a 200 ft^2 spiral plate heat exchanger, where it gives up 1.5 million BTU/hr of heat to increase the temperature of digester sludge which is circulating on the other side of the exchanger. The geothermal liquid leaves the Geothermal/Sludge heat exchanger at 124°F and is transported via a 4 inch diameter buried and bare FRP pipe to an injection well. Depending upon its quality, the water may be blended with treatment plant tertiary water for use in irrigation systems or discharged to the Santa Ana River in lieu of injection.

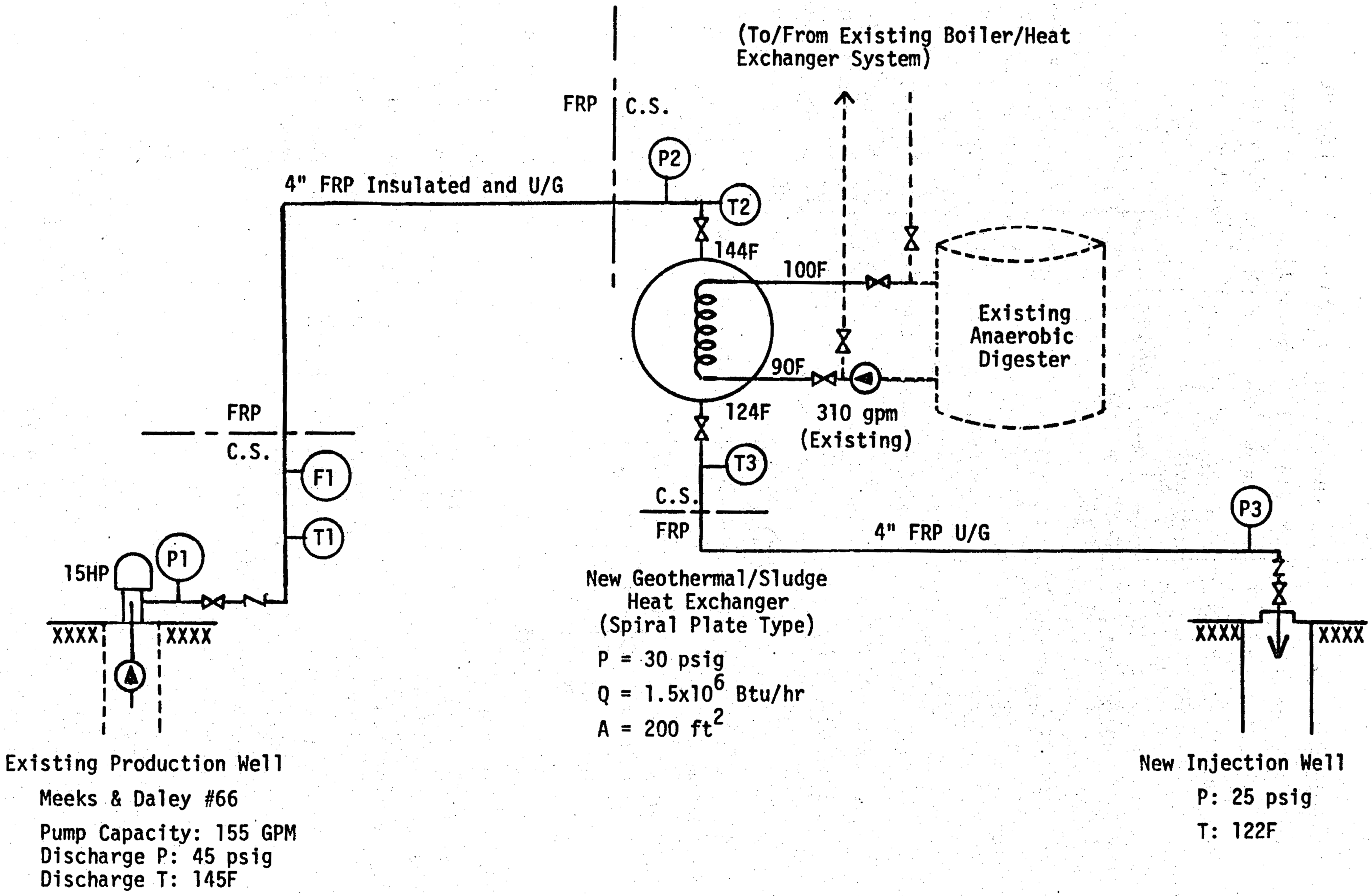

Figure 3-6. Piping and Instrumentation Diagram - Design Case 1 (Heating One Digester with Meeks & Daley #66)

Table 3-3. Key to Drawing Symbols

	Centrifugal Pump
	Gate Valve
	Check Valve
	Globe Valve
	Well Pump Motor
(T4)	Locally Mounted Temperature Gage
(P4)	Locally Mounted Pressure Gage
(F4)	Locally Mounted Flow Indicator/Totalizer
- - - -	Existing Piping and Equipment
———	Proposed Piping and Equipment
FRP	Fiberglass Reinforced Plastic pipe
C.S.	Carbon Steel Pipe

3.3.2 Design Case 2 - Meeks & Daley Well #66/Two Digesters

The P&ID for heating two anaerobic digesters with geothermal liquid from Meeks & Daley Well #66 appears as Figure 3-7. As in Case 1, geothermal liquid is pumped from the well to geothermal/sludge heat exchangers where heat is transferred to digester sludge and then piped to an injection well or to surface discharge and/or use.

Since Case 2 involves heating two digesters, the resulting equipment required is substantially larger than for Case 1. The vertical, multi-stage well pump has a capacity of 310 gpm and a discharge pressure of 40 psig. The production piping is buried 6 inch diameter FRP with a one inch polyurethane foam coating and a PVC jacket, and injection piping is buried 6 inch diameter bare FRP. Because of the higher flow rates in Case 2, the geothermal liquid only loses 0.5°F between the production wellhead and the geothermal/sludge heat exchangers. Two spiral plate heat exchangers with 200 ft^2 of area each are required to heat both digesters. Geothermal liquid flow control between exchangers is provided by manually adjusting the globe valves on the cold side of each exchanger.

3.3.3 Design Case 3 - Meeks & Daley Well #59/One Digester

Figure 3-8 provides the P&ID for a system to heat one anaerobic digester from Meeks & Daley Well #59. As discussed in Chapter 7 of this report, the temperature of the produced liquid from Well #59 has been measured at between 115 and 135°F. Additional temperature measurements of this well, including a temperature profile versus depth, will be completed by the California Division of Mines and Geology (DMG) in 1981. Pending availability of the DMG data, it was conservatively assumed that Well #59 will consistantly produce liquid at 120°F.

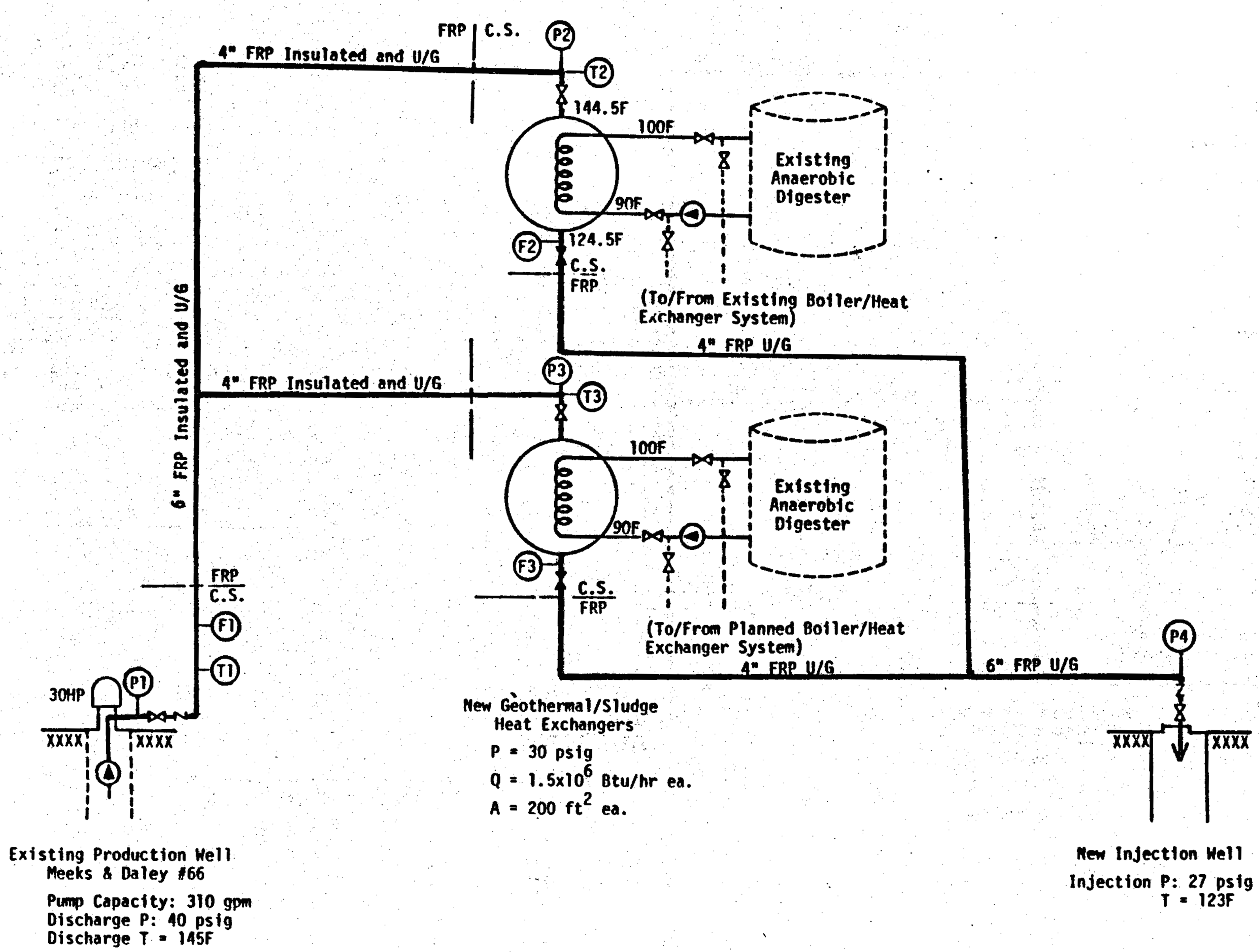

Figure 3-7. Piping and Instrumentation Diagram - Design Case 2
(Heating 2 Digesters Using Meeks & Daley Well #66)

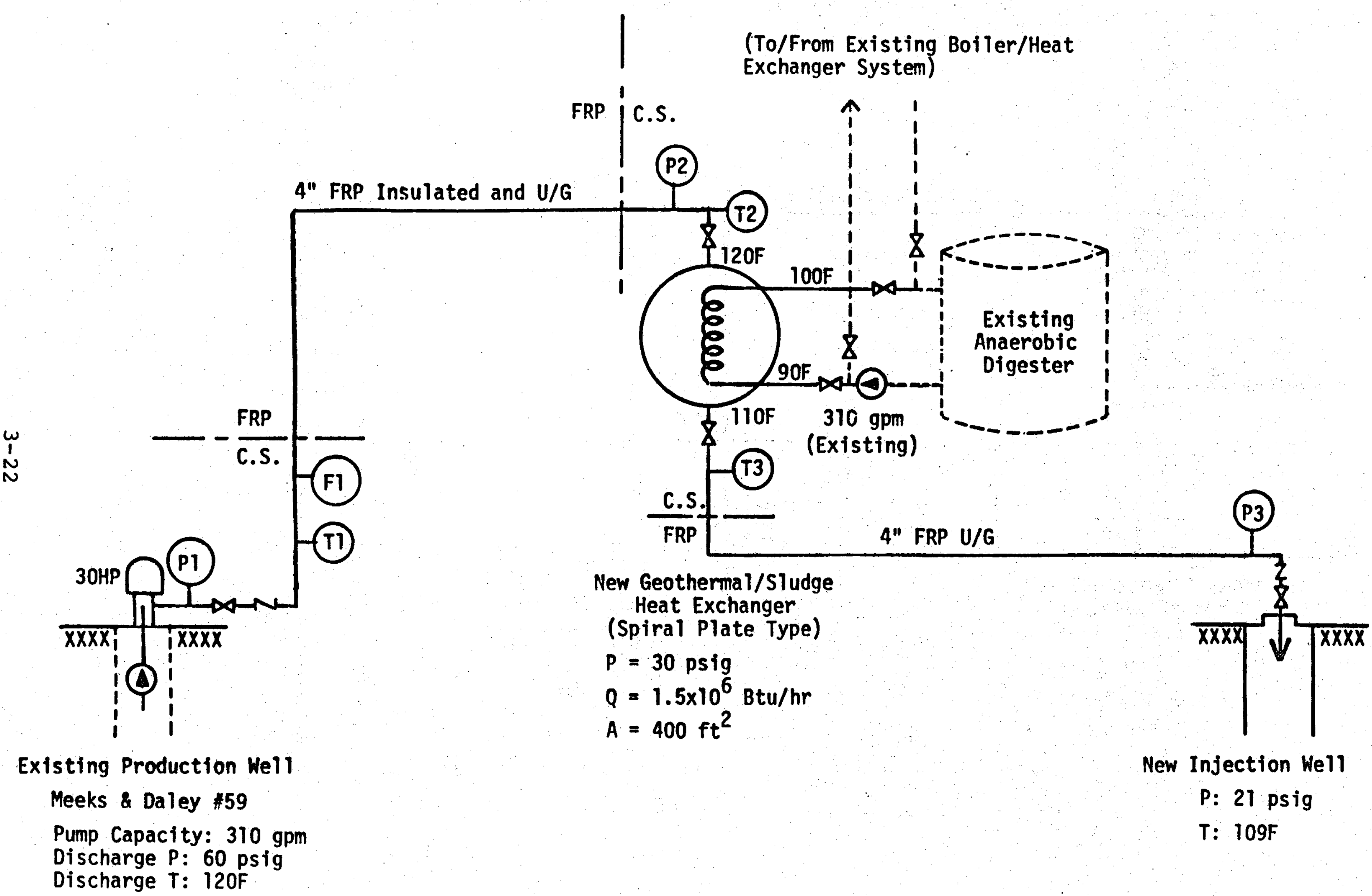

Figure 3-8. Piping and Instrumentation Diagram - Design Case 3 (Heating One Digester with Meeks & Daley #59)

The design concept for Case 3 is identical to the Case 1 concept. However, because of the lower geothermal temperature in Well #59, larger pumps and heat exchangers are required. Liquid is pumped from the well at the rate of 310 gpm with a discharge pressure of 60 psig. The geothermal water loses about 0.2°F while traveling through a 2400 foot long, 4 inch diameter, insulated FRP pipeline.

The liquid is then passed through a 400 ft^2 spiral plate heat exchanger, where it gives up 1.5 million BTU/hr and 10°F. Digester sludge circulating on the other side of the heat exchanger is increased in temperature by 10°F. The cooled geothermal water is then transported via a 4 inch diameter, 800 foot long, bare FRP pipeline to a new injection well or surface discharge.

3.3.4 Design Case 4 - Meeks & Daley Well #59/Two Digesters

The P&ID for heating two digesters with fluid from Meeks & Daley Well #59 is shown in Figure 3-9. The Case 4 design concept is identical to Case 2. The lower geothermal temperature of Well #59 necessitates larger geothermal flow rates and heat exchanger areas than Case 2.

Geothermal liquid is pumped to the surface at the rate of 620 gpm with a discharge head of 50 psig. The fluid loses about 0.1°F as it flows through 2400 feet of 6 inch diameter insulated, buried FRP pipe. The flow splits near the digesters with half going to each of two 400 ft^2 spiral plate heat exchangers. The geothermal liquid is piped via a 6 inch diameter buried, bare pipeline to an injection well or surface discharge, after losing 10°F in the heat exchangers.

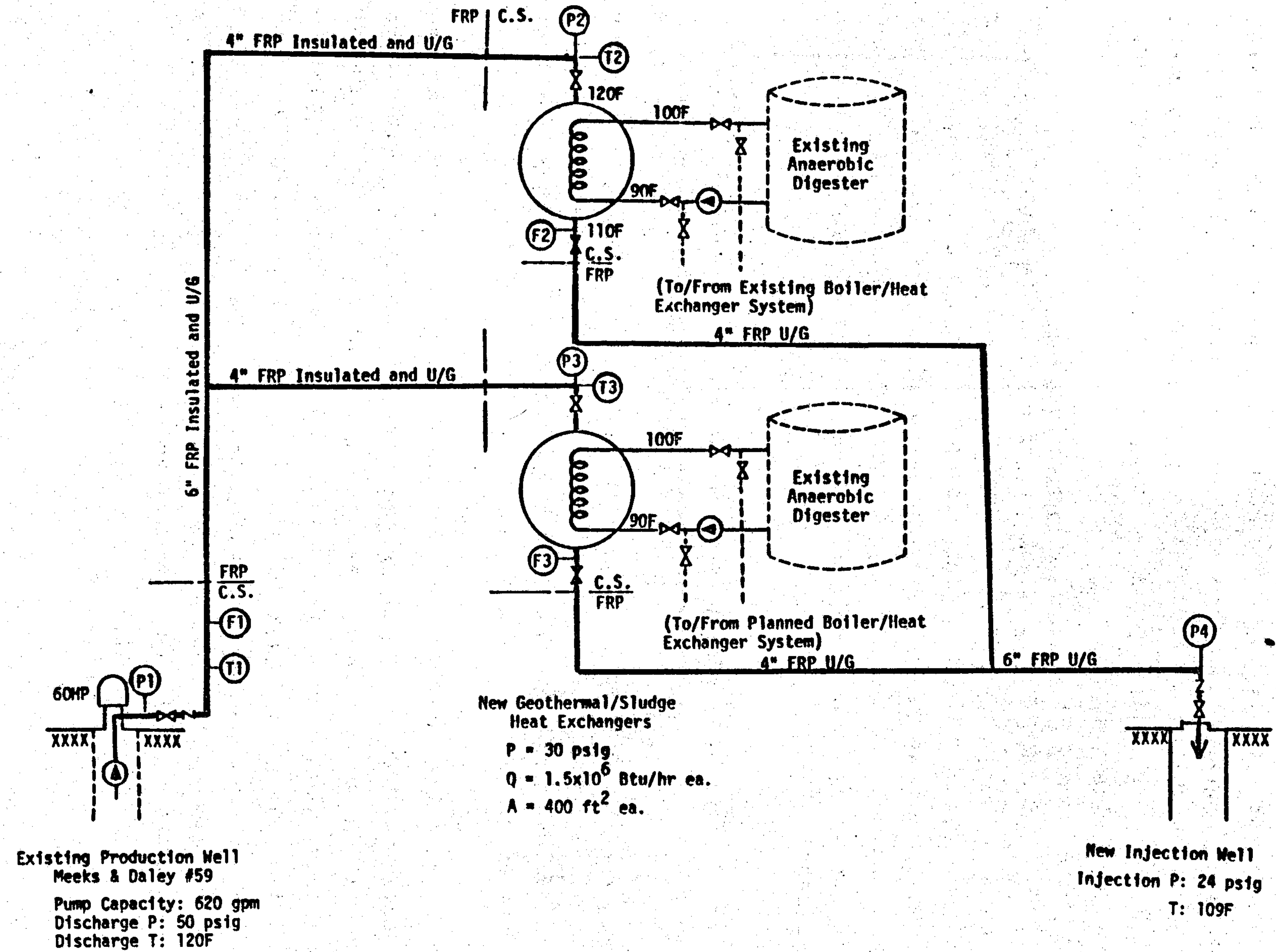

Figure 3-9. Piping and Instrumentation Diagram - Design Case 4
(Heating 2 Digesters Using Meeks & Daley Well #59)

3.3.5 Design Case 5 - New Production Well/Two Digesters

As discussed in Chapter 7, the Water Department may consider drilling its own geothermal production well rather than using an existing well owned by another party such as the Meeks & Daley Company. In Case 5, it is assumed that a 1500 foot deep production well drilled on the wastewater treatment plant property will yield geothermal water at 120°F. The well was assumed to be located near the northeast corner of the plant property, about 800 feet from the digester area.

The P&ID for Case 5 is shown in Figure 3-10. The design concept for Case 5 is identical to that presented above for Case 4. The only differences in equipment result from the proposed well being 800 feet from the digester area instead of the 2400 foot distance between Meeks & Daley #59 and the digesters. Lower piping pressure losses reduce required well pump discharge pressure to 36 psig and the pump motor to 50 hp.

3.4 NATURAL GAS SAVINGS

As discussed in Section 3.2.2, digester heating currently is provided from two sources (See Figure 3-3). One digester obtains heat from combustion of methane gas in a hot water boiler, and the other digester is heated from water heated by engine jacket coolers. After the modifications discussed in Section 3.1.2 have been completed (1983), both digesters will be heated by combustion of digester-produced methane in boilers.

If geothermal heat using one of the schemes shown in Section 3.4 can be substituted for burning methane to heat the digesters, then the methane can be diverted to fuel other equipment in the treatment plant. The Water Department plans to install a pipeline from the digesters to the Arrowhead influent pumping station to transport digester-produced methane to the

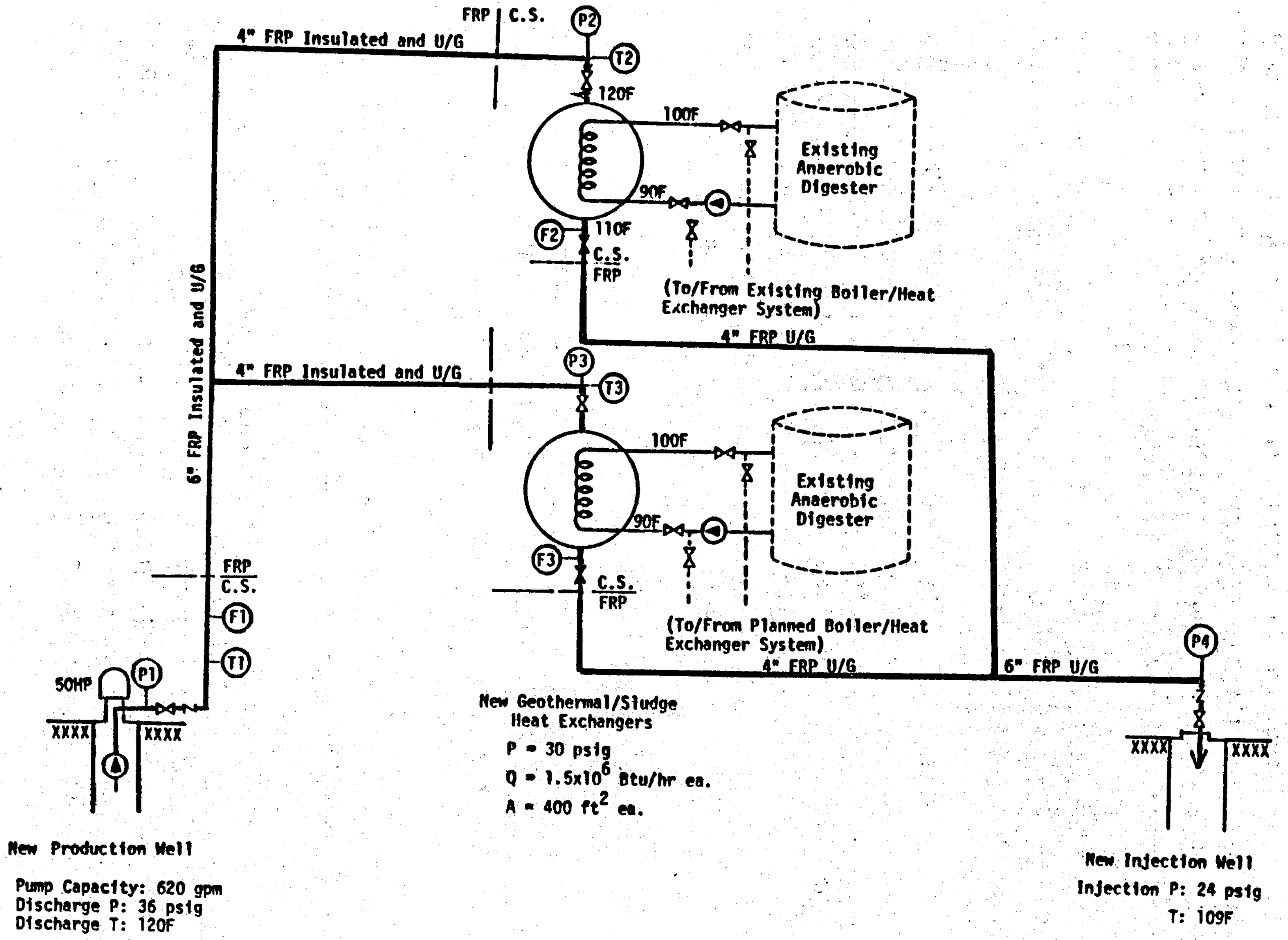

Figure 3-10. Piping and Instrumentation Diagram - Design Case 5
(Heating 2 Digesters Using New Production Well)

engines, that drive the pumps. These pumps are currently driven by natural gas-fueled engines. Methane displaced by geothermal digester heating could be used to supplement this fuel supply, resulting in a reduction in natural gas consumption at the plant.

Each digester boiler is designed to deliver 1.5 million BTU/hr of heat to 145°F water. The boilers operate about one-third of the hours in a typical year, at an efficiency of approximately 80% which results in a fuel input of about 1.9 million BTU/hr; therefore, the total methane fuel input per boiler per year is 5.5×10^9 BTU/yr.

If geothermal heat is used to heat one digester, thereby displacing one boiler, then an additional 5.5×10^9 BTU/yr of methane will be made available to fuel pump driver engines. Use of this methane will conserve 5.5×10^9 BTU/yr or 55,000 therms of natural gas currently used to fuel the pump engines. Similarly, if two digesters are geothermally heated, approximately 110,000 therms of natural gas can be conserved.

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4. ECONOMIC ANALYSIS

An economic analysis of the designs presented in Chapter 3 was conducted to determine the economic feasibility of using geothermal heat at the San Bernardino Wastewater Treatment Plant. The specific cases analyzed are described briefly below.

Case 1 -	Using Meeks & Daley Well #66 to heat one digester at the plant.
Case 2 -	Using Meeks & Daley Well #66 to heat two digesters at the plant.
Case 3 -	Using Meeks & Daley Well #59 to heat one digester at the plant.
Case 4 -	Using Meeks & Daley Well #59 to heat two digesters at the plant.
Case 5 -	Drilling a new production well at the plant site to serve two digesters.
Case 6 (P) -	A private entity develops the resource for the purpose of selling heat to the Water Department (i.e., Case 5 with private ownership).

In Cases 1-5, the City of San Bernardino Water Department would own all facilities, while in Case 6 a private entity would own the facilities and sell energy to the Water Department at the treatment plant.

4.1 ECONOMIC VARIABLES

The economic analysis was completed using the GEYSER economic feasibility model (Geothermal Energy Yearly Statements of Expenses and Revenues), which projects income statements and cash flow statements in order to compute the return on investment or internal rate of return for the project. The model also can be used to calculate the current price of energy that would be required to make the project economically feasible. Another important feature of the model is that it enables the capital cost limitation for the project to be calculated, in other words, that amount of investment which the Water Department cannot exceed, and still have a profitable internal rate of return at the required discount rate.

Several important variables listed below can have an impact upon the economic feasibility of the project.

- Discount Rate
- Life of the Investment
- Volume of Energy Used
- Price of Alternative Energy
- Capital Costs
- Operating & Maintenance Costs
- Energy Costs (for operating pumps)
- Interest Rate
- Inflation Rates.

A discussion of the economic variables utilized for this analysis is presented below. A sensitivity analysis was performed for each varible in each case.

- Discount Rate - The discount rate, which is the same as the return on investment or internal rate of return, typically accounts for both inflation and an acceptable return on investment. Since the Water Department, as a public service, is not a profit making enterprise, the discount rate would account for inflation and recovery of capital; depreciation. The discount rate selected as appropriate for the San Bernardino Water Department was 10%. On the other hand, the discount rate selected for the private entrepreneur was much higher -- 30% -- in order to secure an adequate return on investment (similar to that required by other private companies pursuing geothermal investments).

- Life of Investment - The expected life of an investment is twenty years, although various components may have different life expectancies. Pipe might be expected to last 50 years, pumps 10 years and heat exchangers 15-20 years. The well could give out after 10 years, although, given the long histories of the existing wells, this situation is not expected. In order to account for replacement capital, an additional $20,000 (in 1981 dollars) is appropriated after 10 years in order to replace pumps and/or heat exchangers in each case.

- Volume of Energy - In each case, the volume of energy was that amount determined necessary according to engineering specifications. This amount is not expected to vary. Nevertheless, a sensitivity analysis was provided for reference purposes. The volume of energy changes requires engineering design changes which impact capital costs and operating costs.

- Price of Energy - The price of energy reflects the current price of the alternative energy. In this case, natural gas from Southern California Gas Co., which is currently $.38 therm.

- Price Inflator for Energy - This is an important variable. If natural gas prices were deregulated completely, the decontrolled price currently would be $.60 per therm. Natural gas prices are scheduled to be completely decontrolled by 1985. For all base cases, it is assumed that energy prices will escalate 20% per year for 5 years and then 10%/yr thereafter. This appears to be a conservative figure in light of price escalations in recent years which are heavily dependent on fuel cost escalations attributable to price increases by OPEC.

- Capital Costs - Capital costs were calculated based upon the engineering designs in Chapter 3 using the Process Plant Construction Estimating Standards from Richardson Engineering, along with quoted prices from vendors. An estimate was prepared for each case and a 10% contingency factor applied. A capital cost escalator of 10%/yr is applied with regard to replacement capital. Capital costs for each case are displayed in Table 4-1.

- Operating & Maintenance - O&M costs were broken down into two categories: operating costs, including service, parts and labor; and energy

Table 4-1. Capital Cost Summary ($1,000s) - San Bernardino Wastewater Treatment Plant Geothermal Feasibility Study, January 1981 Price Level

COST CATEGORIES	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE P(6)
Well	40	40	40	40	80	80
Piping	84	91	68	84	43	43
Heat Exchangers	12	24	24	49	49	49
Pumps	9	13	13	18	13	13
Management & Engineering	40	40	40	40	40	40
TOTAL	185	208	185	232	225	225
10% Contingency	19	21	19	23	23	23
Total Cost	204	229	204	255	248	248

costs. The operating costs have an inflator of 10% per year. The energy costs (electrical for pumping) have inflators of 20% for 5 years and 10% thereafter, which are the same as the price inflator for natural gas. The operating and maintenance costs vary in each case according to design criteria.

- Interest Rate - The interest rate used is similar to that for municipal revenue bonds, approximately 12%. The interest rate for a private entrepeneur is the Prime Rate, currently 19 3/4%. It might be possible to achieve a lower interest rate for a municipal entity. The 12% rate is conservative and depends upon the market for municipal geothermal bonds, for which there is no prior experience in California.

- % Debt - The project will be one-hundred percent debt financing for the municipal entity. For private development, 50% debt, 50% equity financing is assumed.

- Energy Costs - The pumps will be driven by electric power from Southern California Edison at a current price of 10¢ per Kwh. Electric power estimates vary according to horsepower requirements, which, in turn, vary according to design requirements.

4.2 RESULTS

In each of the six cases, the proposed system was found to be more cost effective than utilizing natural gas. Table 4-2 displays the expected return on investment, price, and capital cost limitations for each base case.

Using price of energy displaced by geothermal heat as the decision variable, the cases are ranked in order of economic feasibility, as follows:

Table 4.2 Base Case Summaries - Conceptual Geothermal Systems for San Bernardino Water Department

BASE CASE	INTERNAL RATE[1] OF RETURN	PRICE $/THERM	CAPITAL COST LIMIT - $1000s
Case 1. M&D #66, 1 Digester	39.39%	$.25	$365
Case 2. M&D #66, 2 Digester	125.11%	.18	742
Case 3. M&D #59, 1 Digester	20.00%	.33	269
Case 4. M&D #59, 2 Digesters	66.56%	.24	633
Case 5. Drilling On Site, 2 Digesters	81.30%	.22	653
Case P(6). Private Investor, ≈Case 5	34.58%	.34	296

[1] Internal Rates of Return were calculated using 95% financing rather than 100% in order to avoid extremely high IRR's which are distortive for the purpose of analysis for Cases 1-5.

Table 4.3 Base Case 1

Meeks & Daley Well #66
Heating One Digester

Discount Rate	10%
Life of Investment	20 years
Volume of Energy	54,750 therms/yr
Price of Energy	$.38/therm
Capital Cost	$203,800
Operating Cost (1st yr)	$3,000
Interest Rate	12%
% Debt	100%
Energy Cost (Pumps)	$2,950/yr
Price Inflator	20%/10%
Operating Cost Inflator	10%
Energy Cost (Pump) Inflator	20%/10%
Capital Cost Inflator	10%

All Variables Remaining Constant

Return on Investment	50.97%
Price	$.252/therm
Capital Cost Limit	$365,484

Case	Price of Energy
Case 2	$.18/therm
Case 5	$.22/therm
Case 4	$.24/therm
Case 1	$.25/therm
Case 3	$.32/therm
Case P	$.34/therm

The table shows that the required cost of energy (natural gas) to make the project feasible is in all cases below the price currently paid by the Water Department ($.38/therm). Therefore providing digester heat from geothermal energy exhibits superior economics in all cases studied.

It should be noted that all the municipal cases provided cheaper energy than private development, because a municipality does not need to make a return on its investment, 100% debt financing is utilized and the municipality does not have to pay taxes.

Case 2 (heating two digesters with the existing Meeks & Daley Well #66) and Case 5 (drilling a new well on the property) are the most promising. Although Case 2 appears more cost effective, Case 5 is attractive for two reasons which cannot be quantified in the economic analysis;

1) an autonomous resource is provided, and

2) the Meeks and Daley well is freed for potentially higher uses which require temperature in excess of 100°F.

Tables 4-3 through 4-8 display the base case assumptions for Cases 1 through 6, as well as sensitivity analyses for each of the key variables involved with regard to price and capital cost limit.

SENSITIVITY ANALYSIS

Case 1

CHANGE IN VARIABLE BC = BASE CASE			PRICE $/ THERM	CAPITAL COST $/1000
Discount Rate		5%	$.23	$417
	BC	10%	.25	365
		20%	.29	292
Life of Investment		10 years	.39	196
	BC	20 years	.25	365
		30 years	.20	548
Volume of Energy		40,000 therms	.35	236
	BC	54,750	.25	365
		70,000	.20	500
Price of Energy		$.20/therm	--	138
	BC	.38	25	365
		.50	--	515
Capital Cost		$150,000	.21	--
	BC	203,800	.25	365
		300,000	.32	--
Operating Cost		$2,000/yr	.24	381
	BC	3,000	.25	365
		4,000	.26	350
Energy Cost (Pumps)		$2,000/yr	.24	388
	BC	2,950	.25	365
		4,000	.27	341
Interest Rate		8%	.21	469
	BC	12%	.25	365
		20%	.33	245
Price Inflator* (=Energy Cost Inflator)		15%/8%	.32	261
	BC	20%/10%	.25	365
		50%/15%	.16	791
Operating Cost Inflator		5%	.24	382
	BC	10%	.25	365
		20%	.31	287

*Price Inflator - Assume 20% increase in 1st 5 years; 10% thereafter for Base Case

Table 4.4 Base Case 2

Meeks & Daley Well #66
Heating Two Digesters

Discount Rate	10%
Life of Investment	20 years
Volume of Energy	109,500 therms/yr
Price of Energy	$.38/therm
Capital Cost	$229,155
Operating Cost (1st yr)	5,800
Interest Rate	12%
% Debt	100%
Energy Cost (Pumps)	5,900/yr
Price Inflator	20%/10%
Operating Cost Inflator	10%
Energy Cost (Pump) Inflator	20%/10%
Capital Cost Inflator	10%

All Variables Remaining Constant

Return on Investment	
Price	$.180/therm
Capital Cost Limit	742,068

SENSITIVITY ANALYSIS

Case 2

CHANGE IN VARIABLE BC = BASE CASE			PRICE $/ THERM	CAPITAL COST $/1000
Discount Rate		5%	$.17	$847
	BC	10%	.18	742
		20%	.20	591
Life of Investment		10 years	.26	394
	BC	20	.18	742
		30	.15	1,109
Volume of Energy		70,000 therms	.28	390
	BC	109,500	.18	742
		150,000	.13	1,100
Price of Energy		$.20/therm	--	209
	BC	.38	.18	742
		.60	--	1,303
Capital Cost		$200,000	.17	--
	BC	229,155	.18	742
		300,000	.21	--
Operating Cost		$4,000 /yr	.17	770
	BC	5,800	.18	742
		7,000	.19	722
Energy Cost (Pumps)		$4,000 /yr	.16	785
	BC	5,900	.18	742
		8,000	.20	691
Interest Rate		8%	.16	952
	BC	12%	.18	742
		20%	.22	495
Price Inflator* (=Energy Cost Inflator)		15%/8%	.38	530
	BC	20%/10%	.18	742
		30%/15%	.12	1,514
Operating Cost Inflator		5%	.17	773
	BC	10%	.18	742
		20%	.24	588

*Price Inflator - Assume 20% increase in 1st 5 years; 10% thereafter for Base Case

Table 4.5 Base Case 3

Meeks & Daley #59
Heating One Digester

Discount Rate	10%
Life of Investment	20 years
Volume of Energy	54,750 therms
Price of Energy	$.38/therm
Capital Cost	$204,000
Operating Cost (1st yr)	$4,800/yr
Interest Rate	12%
% Debt	100%
Energy Cost (Pumps)	$5,900/yr
Price Inflator	20%/10%
Operating Cost Inflator	10%
Energy Cost (Pump) Inflator	20%/10%
Capital Cost Inflator	10%

All Variables Remaining Constant

Return on Investment	22.42%
Price	$.329/therm
Capital Cost Limit	$268,515

SENSITIVITY ANALYSIS

Case 3

CHANGE IN VARIABLE BC = BASE CASE			PRICE $/ THERM	CAPITAL COST $/1000
Discount Rate		5%	$ .31	$307
	BC	10%	.33	268
		20%	.37	214
Life of Investment		10 years	.47	143
	BC	20	.33	268
		30	.27	403
Volume of Energy		40,000 therms	.45	139
	BC	54,750	.33	268
		70,000	.26	403
Price of Energy		$.20/therm	--	41
	BC	.38	.33	268
		.60	--	547
Capital Cost		$170,000	.30	--
	BC	203,000	.33	268
		250,000	.36	--
Operating Cost		$3,000/yr	.30	297
	BC	4,800	.33	268
		6,000	.34	250
Energy Cost (Pumps)		$4,000/yr	.29	313
	BC	5,900	.33	268
		7,000	.35	243
Interest Rate		8%	.29	344
	BC	12%	.33	268
		20%	.41	180
Price Inflator* (=Energy Cost Inflator)		15%/8%	.40	182
	BC	20%/10%	.33	268
		30%/15%	.22	589
Operating Cost Inflator		5%	.31	295
	BC	10%	.33	268
		20%	.43	144

*Price Inflator - Assume 20% increase in 1st 5 years; 10% thereafter for Base Case

Table 4.6 Base Case 4

Meeks & Daley #59
Heating Two Digesters

Discount Rate	10%
Life of Investment	20 years
Volume of Energy	109,500 therm/yr
Price of Energy	$.38/therm
Capital Cost	$255,100
Operating Cost (1st yr)	$5,800/yr
Interest Rate	12%
% Debt	100%
Energy Cost (Pumps)	$11,800/yr
Price Inflator	20%/10%
Operating Cost Inflator	10%
Energy Cost (Pump) Inflator	20%/10%
Capital Cost Inflator	10%

All Variables Remaining Constant

Return on Investment	149.06%
Price	$.239
Capital Cost Limit	$632,983

SENSITIVITY ANALYSIS

Case 4

CHANGE IN VARIABLE BC = BASE CASE			PRICE $/ THERM	CAPITAL COST $/1000
Discount Rate		5%	$.23	$729
	BC	10%	.24	633
		20%	.27	496
Life of Investment		10 years	.33	319
	BC	20	.24	633
		30	.21	947
Volume of Energy		70,000 therms	.38	264
	BC	109,500	.24	633
		150,000	.18	1,010
Price of Energy		$.20/therm	--	149
	BC	.38	.24	633
		.60	--	1,224
Capital Cost		$200,000	.22	--
	BC	255,100	.24	633
		300,000	.26	--
Operating Cost		$4,000/yr	.23	663
	BC	5,800	.24	633
		7,000	.25	613
Energy Cost (Pumps)		$8,000/yr	.20	727
	BC	11,800	.24	633
		13,000	.25	603
Interest Rate		8%	.22	826
	BC	12%	.24	633
		20%	.29	416
Price Inflator* (=Energy Cost Inflator)		15%/8%	.28	450
	BC	20%/10%	.24	633
		30%/15%	.18	1,314
Operating Cost Inflator		5%	.23	667
	BC	10%	.24	633
		20%	.30	473

*Price Inflator - Assume 20% increase in 1st 5 years; 10% thereafter for Base Case

Table 4.7 Base Case 5

Drilling a New Well on the Site to Heat Two Digesters

Discount Rate	10%
Life of Investment	20 years
Volume of Energy	109,500 therms
Price of Energy	$.38/therm
Capital Cost	$248,860
Operating Cost (1st yr)	$5,800/yr
Interest Rate	12%
% Debt	100%
Energy Cost (Pumps)	$9,800
Price Inflator	20%/10%
Operating Cost Inflator	10%
Energy Cost (Pump) Inflator	20%/10%
Capital Cost Inflator	10%

All Variables Remaining Constant

Return on Investment	
Price	$.223/therm
Capital Cost Limit	$652,504

SENSITIVITY ANALYSIS

Case 5

CHANGE IN VARIABLE BC = BASE CASE			PRICE $/ THERM	CAPITAL COST $/1000
Discount Rate		5%	$.21	$747
	BC	10%	.22	653
		20%	.25	519
Life of Investment		10 years	.31	345
	BC	20	.22	653
		30	.19	977
Volume of Energy		70,000 therms	.35	300
	BC	109,500	.22	653
		150,000	.16	1,014
Price of Energy		$.20/therm	--	190
	BC	.38	.22	653
		.60	--	1,218
Capital Cost		$200,000	.21	--
	BC	248,860	.22	653
		350,000	.26	--
Operating Cost		$4,000/yr	.21	681
	BC	5,800	.22	653
		7,000	.23	634
Energy Cost (Pumps)		7,000/yr	.20	719
	BC	9,800	.22	653
		11,000	.23	624
Interest Rate		8%	.20	840
	BC	12%	.22	653
		20%	.27	436
Price Inflator* (=Energy Cost Inflator)		15%/8%	.27	465
	BC	20%/10%	.22	653
		30%/15%	.16	1,346
Operating Cost Inflator		5%	.21	685
	BC	10%	.22	653
		20%	.28	499

*Price Inflator - Assume 20% increase in 1st 5 years; 10% thereafter for Base Case

Table 4.8 Base Case P

A Private Investor Develops the Resource
under Conditions for Base Case 5

Discount Rate	30%
Life of Investment	20 years
Volume of Energy	109,500 thers/yr
Price of Energy	$.38/year
Capital Cost	$248,860
Operating Cost (1st yr)	$5,800/yr
Interest Rate	19.75%
% Debt	50%
Energy Cost (Pumps)	$9,800/yr
Price Inflator	20%/10%
Operating Cost Inflator	10%
Energy Cost (Pump) Inflator	20%/10%
Capital Cost Inflator	10%

All Variables Remaining Constant

Return on Investment	34.58%
Price	$.337/therm
Capital Cost Limit	$296,025

SENSITIVITY ANALYSIS

Case P

CHANGE IN VARIABLE BC = BASE CASE			PRICE $/ THERM	CAPITAL COST $/1000
Discount Rate		20%	$.25	$467
	BC	30%	.34	296
		40%	.43	207
Life of Investment		10 years	.38	250
	BC	20 years	.34	296
		30 years	.33	308
Volume of Energy		70,000 therms	.53	145
	BC	109,500	.34	296
		150,000	.25	451
Price of Energy		$.20/therm	--	98
	BC	.38	.34	296
		.60	--	538
Capital Cost		$200,000	.29	--
	BC	248,860	.34	296
		300,000	.38	--
Operating Cost		$4,000/yr	.33	307
	BC	5,800	.34	296
		7,000	.34	288
Energy Cost (Pumps)		$8,000/yr	.32	312
	BC	9,800	.34	296
		12,000	.36	276
Interest Rate		15.00	.32	314
	BC	19.75	.34	296
		25.00	.35	277
Price Inflator* (=Energy Cost Inflator)		15%/8%	.39	237
	BC	20%/10%	.34	296
		30%/15%	.25	478
Operating Cost Inflator		5%	.33	304
	BC	10%	.34	296
		20%	.36	268
% Debt		0%	.48	181
		50%	.34	296
		100%	.19	820

*Price Inflator - Assume 20% increase in 1st 5 years; 10% thereafter for Base Case

A reassuring observation from Cases 2 and 5 is that variances indicated in the sensitivity analysis do not impact the price of energy to the extent that it is no longer cost competitive with the existing fuel cost. Even if the inflator (the variable with the highest impact) is lowered to 15% for the first 5 years and 8% thereafter, the price of energy is still less than $.38/therm.

Using these conservative parameters, it appears that the project is clearly cost competitive. Even the worst case, utilizing a private developer, is cost competitive under most circumstances and is only uncompetitive under the most pessimistic assumptions.

In addition, in all of the sensitivity tests, the capital cost limitation is higher than the prepared capital cost estimates, except when the price of energy is reduced to $.20/therm (a most unlikely event). Most of the capital cost limits appear to be remarkably high, due in most part to the impact of energy cost inflation and inflation in general. For example, expenditures of $50,000 in 1981 will be $125,000 in 1986 with a 20% inflation factor. As long as the interest rate on debt is so much lower than energy price inflation, the investment will provide a very high internal rate of return in the form of lower energy costs.

5. ENVIRONMENTAL ANALYSIS

In this Chapter, an analysis of the environmental impacts which will result from construction and operation of the geothermal heating system described in Chapter 3, "Preliminary Design", are discussed. Chapter 5 is divided into two main sections; Section 5.1 discusses the environmental setting of the project and Section 5.2 describes the expected impacts on the environment from the San Bernardino Geothermal Wastewater Treatment Project.

5.1 ENVIRONMENTAL SETTING

The environmental setting of the San Bernardino area, in terms of physical, biological and socioeconomic characteristics, is presented in this section. Two documents were used as primary sources for this data and should be consulted for more detailed information. They are the San Bernardino Valley Wastewater Management Facilities Plan: Phase I Volume 1 Existing Conditions (Reference 5.1) and the Final Environmental Impact Report: San Bernardino Facilities Plan (Reference 5.2).

5.1.1 Physical Environment

The physical environment is discussed in terms of topography, soils, geology, climate, air quality, water resources and water quality.

5.1.1.1 Topography

A variety of topographical features, including mountains, hills, watercourses and alluvial plains, are evident in the vicinity of the proposed project (Figure 5-1). The San Gabriel Mountains to the northwest and the San Bernardino

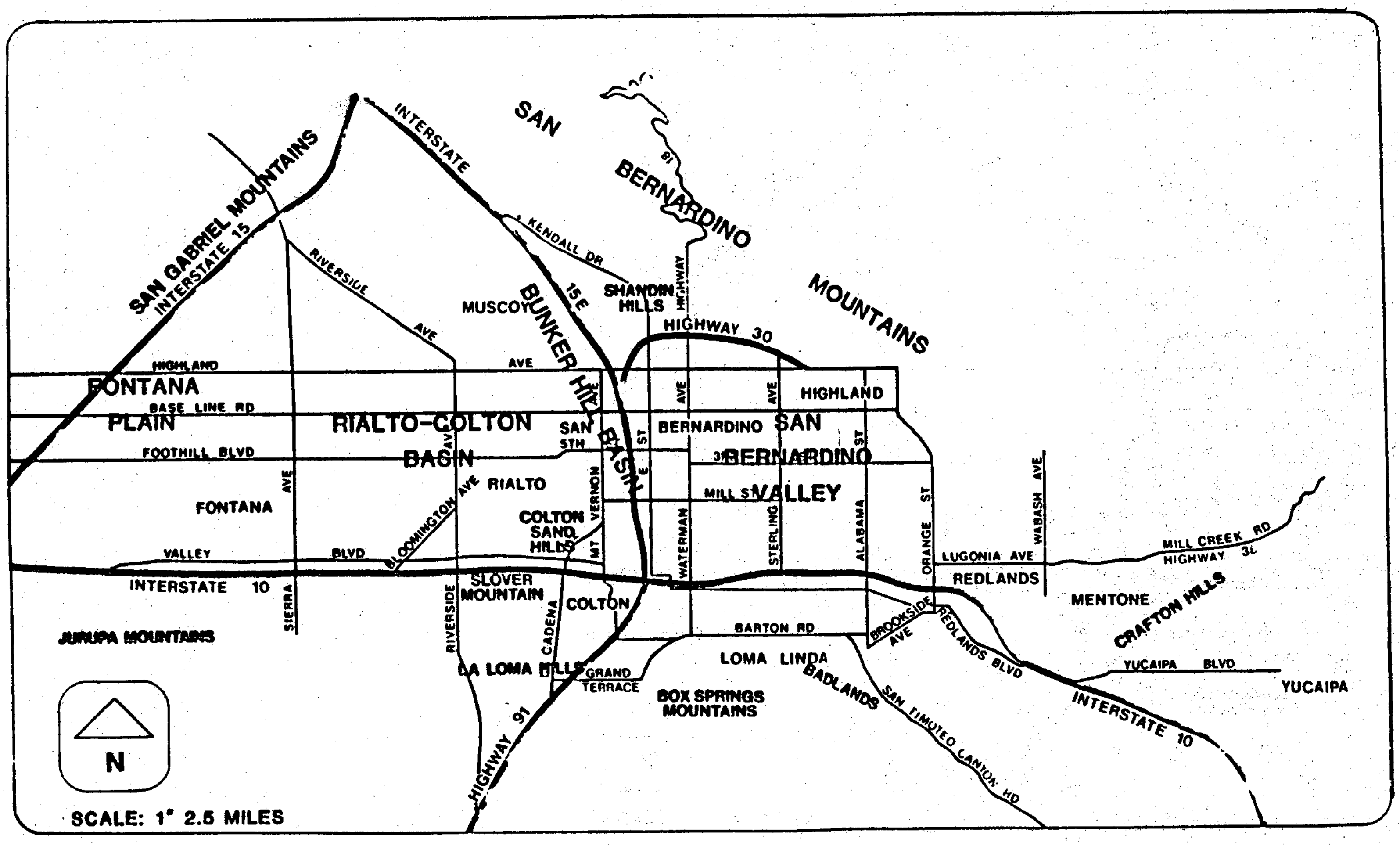

Figure 5-1. Major Topographic Features

Mountains to the north are separated by Cajon Pass and the San Andreas Fault. The San Bernardino Mountains reach a maximum elevation of 11,502 feet at Mount San Gorgonio, the highest peak in Southern California. Several other hills and lesser mountains are distributed throughout the area. Streams and watercourses originate in the mountains and the San Timoteo Badlands. Deposition by the Santa Ana River and Mill Creek have contributed to the larger alluvial fans in the San Bernardino Valley. Smaller fans and alluvial plains, including the Yucaipa Plain in the southeast and the Fontana Plain to the west, also have resulted from deposition by various creeks and waterways.

5.1.1.2 Soils

The Soil Conservation Service has identified 21 soil associations in the San Bernardino Valley Area. These associations have been divided into three major groups based on soil characteristics, slope and erosion. Group 1 soils are found on recent alluvial fans and plains and consist of deep, permeable soils having no development in the profile. They are characterized by moderately rapid permeability and a slow runoff rate. The proposed geothermal project will be constructed in these Group 1 soil types. Group 2 soils, found on older alluvial fans and terraces, consist of silty or sandy loam in the surface layer with clay loam in the subsoils and substratum; the lower horizons contain clay pan. These soils show a slight to moderate erosion hazard, good drainage characteristics and moderate to slow permeability. Group 3 soils, located on crystalline, sedimentary and granitic bedrock, are found in the Chino Hills, at the base of the San Gabriel and Jurupa Mountains, and in small areas along the San Bernardino-Riverside County lines. These soils are well drained, with moderately slow to moderately rapid permeability within the subsoils.

5.1.1.3 Geology

The geology of the San Bernardino area is quite varied. Beginning with marine deposition, igneous intrusion and volcanic activity, the basic bedrock of the area has undergone metamorphism, repeated uplift, erosion and deformation to create the mountains and hills surrounding the San Bernardino Valley. Erosion of the mountains resulted in fluvial and alluvial deposition at the mountain bases and on the valley floor.

One of the most significant natural features is the size and number of faults, including the San Andreas, the San Jacinto, which is the most active, and a number of minor faults (Figure 5-2). The southwestern portion of the county has experienced large earthquakes historically. The known epicenters of major earthquakes in the San Bernardino area are also shown in Figure 5-2. From 1890 to 1923, the San Bernardino area experienced five major seismic events estimated at 6 or greater on the Richter Scale; five have been attributed to the San Jacinto Fault and one to the San Andreas. Since 1923, four additional seismic events of magnitude greater than 6 have occurred in the San Bernardino area. In view of this, future events can be expected to occur. Ground rupture, shaking and liquefaction are potential hazards associated with seismic activity. Other potential geologic hazards include subsidence, landslides and slope failures.

5.1.1.4 Climate

The climate in San Bernardino is semi-arid, with hot, dry summers and cool, periodically rainy winters. In addition to the influence of the San Gabriel and San Bernardino Mountains and Pacific Ocean, the principal meteorological factor impacting the weather is the presence of a semipermanent eastern Pacific high pressure cell. During the summer, this system prevents storms in

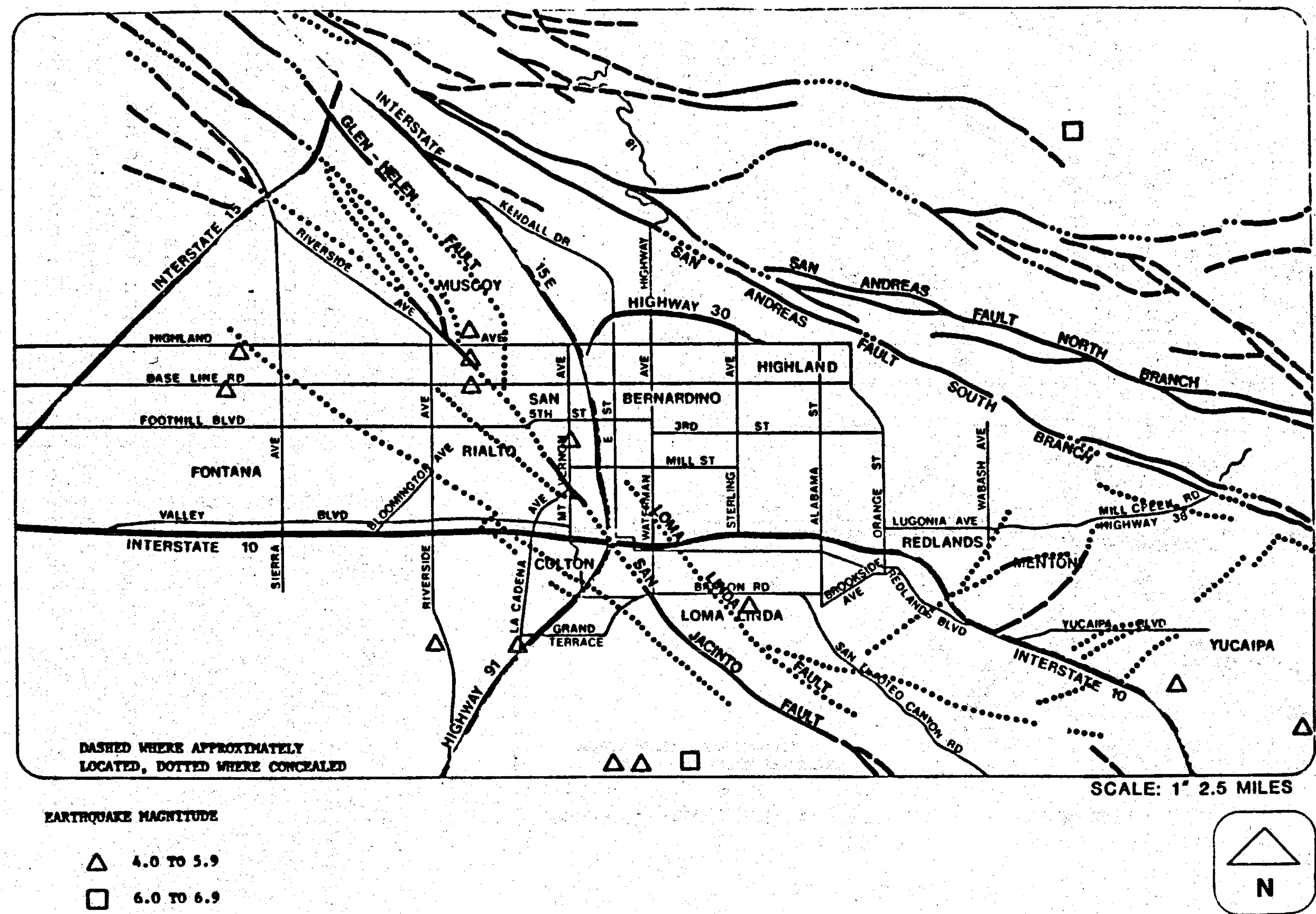

Figure 5-2. Location of Major Faults and Earthquake Epicenters

the Pacific from moving ashore; maximum daily temperatures average between 87 and 95°F. In the winter, the cell subsides and the oceanic storms move onto land; maximum daily temperatures average between 63 and 71°F. Annual precipitation averages 13 inches, however, less than 15% of this total falls from May through October. The prevailing wind pattern is the sea breeze - land breeze regime, although strong northeasterly Santa Ana winds infrequently whip through the northern mountains and deserts.

5.1.1.5 Air Quality

The net daily input of air pollutants in the San Bernardino Valley is fairly consistent -- about 70% mixture of carbon monoxide, oxides of nitrogen and hydrocarbons from cars, with the remainder being a complex mixture from stationary sources. In the winter, the greatest pollution problems are carbon monoxides and oxides of nitrogen due to the surface inversions and air stagnation during the night and early morning hours. The combination of longer daylight hours and brighter sunshine in the summer causes a reaction that forms more of the photochemical smog. Table 5-1 presents air quality data for San Bernardino and vicinity.

Photochemical oxidant is probably the most serious contaminant problem. The San Bernardino area experiences some of the highest ozone concentrations in the South Coast Air Basin. The principal reason for ozone being considered the most serious pollutant is that ozone is the manifestation of photochemical smog and the principal irritant in smog. Emissions in the San Bernardino area aggravate the condition, but the main causes are emissions and smog-forming atmospheric conditions in the Los Angeles - Orange County coastal plain area which cause ozone to form in the drifting air mass passing over San Bernardino. Poor visibility is another manifestation of smog and is poor throughout the upper Santa Ana Basin.

Table 5-1. 1978 Air Quality Monitoring Data in Study Area - Violations of State Standards and Annual Maximum Hourly Averages

Monitoring Station	Ozone		Carbon Monoxide[a]		Sulfur Dioxide[a]		Nitrogen Dioxide	
	Days[b]	Max[c]	Days[b]	Max[c]	Days[b]	Max[c]	Days[b]	Max[c]
Riverside	179	0.39	0	9	0	0.034	0	0.22
San Bernardino	163	0.36	0	13	0	0.040	0	0.12
Fontana	183	0.42	0	13	0	0.044	3	0.30
Redlands	165	0.39	0	9	-	-	0	0.21

[a] Violations for carbon monoxide refer to the 12-hour standard; those for sulfur dioxide refer to the 24-hour standard; the 1-hour standards for these contaminants were not violated.

[b] Number of days violating state standard for indicated pollutant.

[c] Single highest one-hour (24-hour for SO_2) average of the year in parts per million.

Source: South Coast Air Quality Management District, January, 1979 (3).

Suspended particulate matter and sulfate are also serious pollutants. Sulfate is a particulate contaminant formed chemically from sulfur dioxide emissions. This pollutant concentrates in Fontana, where the principal source is probably a steel mill.

The South Coast Air Basin, including San Bernardino, has been projected by the Southern California Association of Government's Air Quality Management Plan (AQMP) to be in violation of ambient air quality standards by 1987. The County is projected to be in compliance with the national NO_2 standard in 1987, but in violation of the more stringent state standards. State and federal motor vehicle control programs should assist the steady decrease of carbon monoxide emissions; but, even with a 43% decrease, the County still may not meet the national standards. However, if the proposed AQMP is adopted and implemented, it is claimed that the entire South Coast Basin will be in compliance with national standards for ozone, CO and NOx by 1987.

5.1.1.6 Water Resources and Water Quality

The principal watercourse in this area is the Santa Ana River, which has a drainage area of 854 sq. mi. River flow consists primarily of winter storm runoff and sewage treatment facility discharges. The Santa Ana River, Mill Creek and Lytle Creek contribute 80% of the surface inflow, which either is diverted for domestic use, irrigation, artificial groundwater recharge and export, or percolates through the stream beds to the water table. Groundwater, which has been the principal source of water for economic development in the area, is pumped from a large basin bordered by the San Gabriel and San Bernardino Mountains and the Badlands as shown in Figure 5-3. In 1976, 83% of total water production was pumped from the basins, which are

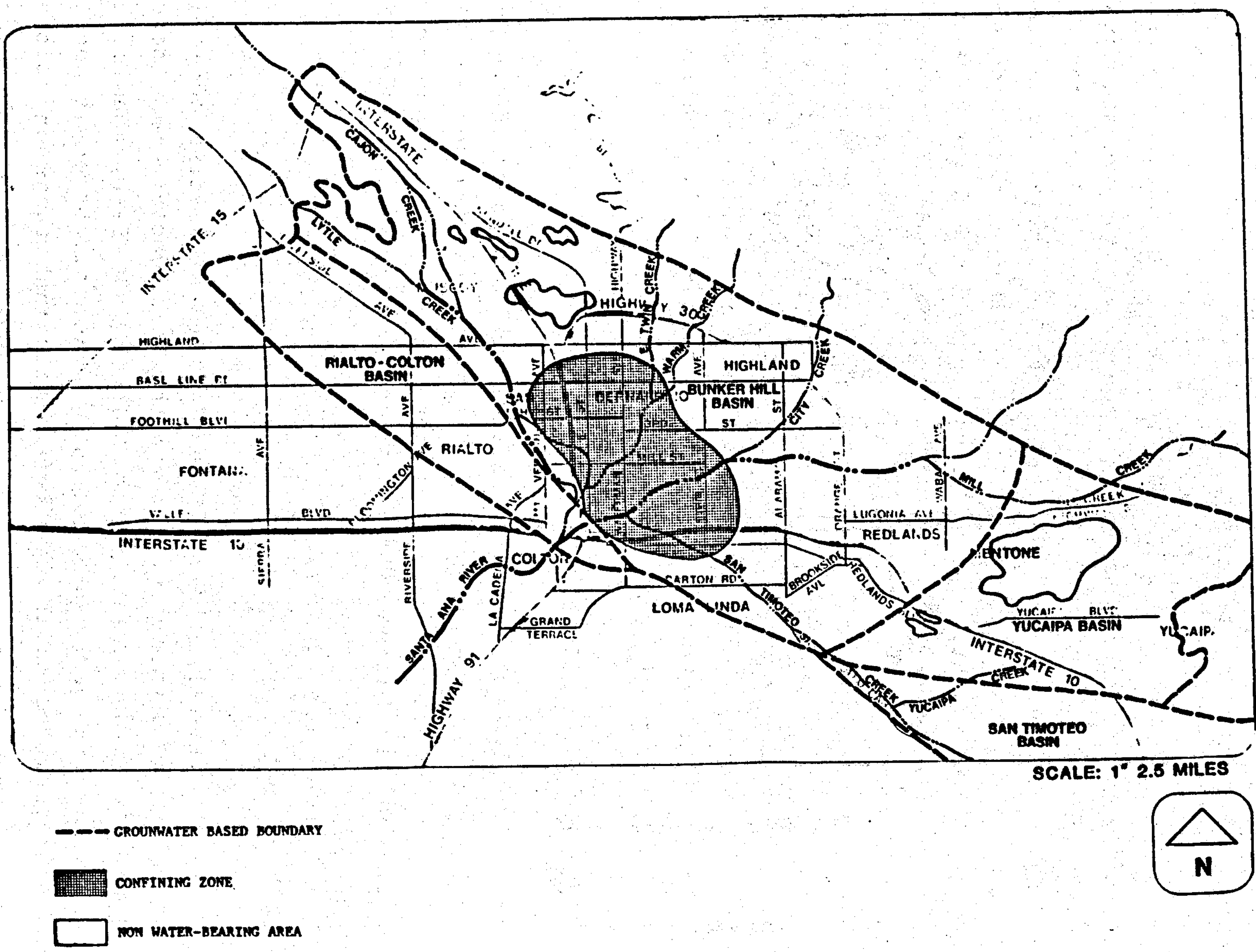

Figure 5-3. Surface Streams and Groundwater Basins

replenished by runoff from the mountains, infiltration from stream flows and irrigation waters, artificial recharge, precipitation, and wastewater discharges.

Water quality throughout the San Bernardino Valley Municipal Water District is generally good, with an average total hardness ($CaCO_3$) of 167 mg/l and total dissolved solids (TDS) of 287 mg/l. Since the groundwater's most beneficial use is as drinking water, the Santa Ana Regional Water Quality Control Board set water quality objectives consistent with drinking water standards. Surface water quality data from 1973-1978 averaged mean TDS levels less than 250 mg/l. Nitrate-nitrogen levels were greater than 1.0 mg/l and water hardness varied from moderately hard to hard. Since 1972, the San Bernardino Valley Municipal Water District has been importing water from the California Water Project to replenish groundwater basins, sell to retail water producers and store in the groundwater system. The quality of this water is generally high.

5.1.2 Biological Environment

The diverse elevational range and topography of the San Bernardino Valley area which includes flat, desert-like terrain, undulating foothills and steep mountain slopes, supports a complicated vegetation community and a variety of wildlife habitats.

5.1.2.1 Flora

In general, five different plant communities occur in this area. Beginning at the foothills, coastal sage scrub predominates to 3000 feet. From 3000 to 5000 feet, chamise or greasewood is the dominant species. Chaparral, which is denser and shrubbier, occurs in the same altitudinal range on moister slopes and heavier soil. The more sheltered valleys and canyons to about 5000 feet contain southern oak woodland. Finally, the montane coniferous forest community is found from 5000 to 9000 feet in the San Bernardino Mountains.

The existence of riparian plant communities along the beds of the tributaries and major washes of the Santa Ana River plays a critical role in stabilizing the integrity of the substratum and banks, thus preserving the quality of the groundwater and surface flows throughout the area. In addition, the riparian habitat provides shelter, water and a variety of food for wildlife. At higher elevations, alder, willow and cottonwood predominate, while in the lower elevations, California sycamore and mule fat are the dominant species.

Transition zones, which provide more habitat diversity occur at the interface of the two plant communities. Dominant species from each community result in higher floral diversity then either adjacent community.

Most of the land on the floodplain below the mountains and foothills is developed for urban and agricultural use, including citrus groves with eucalyptus windbreaks residential landscaping, buildings and supporting services such as roadways. Natural vegetation consists of introduced annual grasses and weeds.

San Bernardino County has more rare and endangered plant species than any other county in the State of California. A listing of the endangered flora can be found in Appendix Table 2 of Reference 5.2.

5.1.2.2 Fauna

The diversity of topographic features, microclimatic zones and vegetation communities provides a great variety of wildlife habitats. The riparian habitats support the most diverse fauna, including bee-eating and insectivorous bird species, owls, hawks, bats, rodents and racoons. Transient populations include bobcats, coyotes and mule deer. Amphibian and reptile species are also present. A highly diverse fauna is also present in the montane coniferous forest, which supports many of the species that frequent the riparian habitats. The chamise chaparral, chaparral and southern oak woodland support a moderately diverse fauna including birds, rodents and reptiles. The coastal sage scrub has a less diverse fauna, with mostly birds, rodents and reptiles. Urbanized and agricultural areas contain common rodents, birds and lizards. Detailed species listings can be found in Appendix Table 3 of Reference 5.2.

The California Department of Fish and Game has designated as rare two species with populations living in the area. They are the Stephen's Kangaroo Rat (Dipodomys stephensi) and the Southern Rubber Boa (Charina bottae umbratica). The latter species is confined to montane, forested areas of the San Bernardino Mountains, while the former is reported to occur near urbanized areas in the Santa Ana River Basin.

5.1.3 Socioeconomic Characteristics

The socioeconomic characteristics presented in this section include land use, economic activity, population and cultural resources.

5.1.3.1 Land Use

Existing land use patterns and projections of use are presented in detail in both references. Residential and agricultural lands account for the majority of land use, amounting to 70% of the developed area. According to Southern California Edison's report "Land Use: Eastern Division, San Bernardino

County, 1975," from 1974 to 1995, 9,125 acres will be converted from undeveloped and agricultural land to some form of urban land use. The largest increase is expected to occur in the residential land use category, with manufacturing land use next. Agricultural and undeveloped land, which comprised 52% of all land in the East Valley in 1974, were expected to decrease.

5.1.3.2 Economic Activity

The economic base of the San Bernardino County is oriented heavily toward manufacturing, wholesale and retail trade, services and government. When contrasted with the economy of California as a whole, the economy of this area is more greatly influenced by government employment, while manufacturing activity accounts for less of the base. Transportation is also important to the economic base due to the completion of the 560 acre Southern Pacific Railroad classification yard and the migration of several motor trucking terminals to the area. Norton Air Force Base and the new Veterans Administration hospital contribute to the significant military and governmental payroll.

Per capita personal income in the County in 1976 amounted to $5,692, a 40.7% increase over 1972 levels. Based on state income tax returns, San Bernardino County ranked twelfth among the state's 58 counties in median income per tax return.

5.1.3.3 Population

Population in San Bernardino County increased 13.2% from 1970 to 1978. Between 1977 and 1978 the Riverside - San Bernardino - Ontario SMSA experienced the largest population increase of any SMSA in California. According to estimates by the Southern California Association of Governments (SCAG), the population will continue to increase from 1980 to 2000. The county is expected to grow 24.3% between 1980 and 1990 and 11.2% between 1990 and 2000. SCAG currently is directing a program aimed at balancing employment with population in the county by reducing the overall length and number of commuter trips to Los Angeles County and by promoting economic vitality within the region. If this program can be implemented successfully, the local economic base and local industrial and commercial development will be affected significantly.

5.1.3.4 Cultural Resources

Due to the historical background with influence from native Indians, Spanish missionaries, Mexicans, Mormon homesteaders and Anglo-American settlers, the area is rich in cultural resources. Records at the San Bernardino County Museum indicate that 40 significant archeological sites have been identified.

5.2 ENVIRONMENTAL IMPACTS OF PROPOSED ACTION

The environmental impacts which may result from the San Bernardino Geothermal Wastewater Treatment Plant Project are discussed in this section. The section is organized similarly to Section 5.1 to allow ready cross-referencing between the two sections.

5.2.1 Impacts on Physical Environment

The proposed project will have no adverse impact on topography, soils or climate of the San Bernardino area. The project's impact on geology, air quality and water quality are discussed below.

5.2.1.1 Geologic Hazards

Two potential geologic hazards have been evaluated for the proposed geothermal system - seismic hazard and subsidence. Experiments conducted in earthquake control in Colorado (Reference 5.3) used high pressure water injection to trigger earthquakes. In these experiments, the fluids were injected at pressures that caused fracturing of rocks. The experiment also showed that reducing injection pressure below a threshold level significantly reduced the probability of induced seismic activity. If injection is used in this project, the risk of inducing seismic activity will be low because injection of geothermal fluid will be done at the prevailing low pressures into porous strata.

Subsidence is not a potential geologic hazard from the proposed project. Over 210,000 acre-feet of water are currently pumped from the San Bernardino basin each year. The proposed project will pump only 75 to 300 AF per year. Therefore, the impact of the project on subsidence will be negligible. If the proposed project includes injection of all geothermal fluids produced, which should reduce the risk of subsidence to a negligible level.

5.2.1.2 Air Quality Impacts

The air pollutant emissions from the San Bernardino Wastewater Treatment Plant will decrease as a result of the proposed project. Digester-produced methane currently used to fuel a boiler will be displaced by hot geothermal fluids. The methane will be diverted to fuel engine driven pumps which currently use natural gas for fuel. The net result of the project will be to decrease natural gas burning at the plant by about 5 1/2 million cubic feet per year. This will result in lower air emissions from plant operations.

During construction of the project, excavation of pipe trenches and foundations will cause temporary generation of dust in the immediate vicinity of the pipeline right-of-way between the well and plant, and at the plant itself. This impact will be both temporary and minor.

5.2.1.3 Water Quality

The proposed project should have no impact on groundwater quality. One project alternative is to inject spent fluid. All fluids produced for heat removal will be injected into the same reservoir from which they were removed.

One alternative to injection is to mix the spent geothermal fluid with the secondary or tertiary effluent from the San Bernardino Wastewater Treatment Plant. The plant currently discharges approximately 15,000 gpm of treated effluent to the Santa Ana River and 2,000 gpm from tertiary treatment for in-plant and freeway irrigation uses. The addition of between 155 and 610 gpm of spent geothermal fluid should have a minimal impact on the quality of these plant discharges.

5.2.2 Impacts on Biologic Environment

The impact of the proposed project on the natural biologic environment will be insignificant. The pipelines from existing wells to the plant site will follow existing rights-of-way which have been previously disturbed for pipeline installation. The remainder of project work will occur within the wastewater treatment plant boundaries. As the plant has been previously landscaped, the impact of trenching, foundation excavation and injection well drilling on the natural biologic environment will be insignificant.

5.2.3 Impacts on Socioeconomic Environment

It is expected that the proposed project will have negligible impacts on land use, economics and population of the San Bernardino area. The anticipated impacts of the project on cultural resources, circulation, noise and energy consumption are discussed below.

5.2.3.1 Impacts on Cultural Resources

The facilities to be constructed in the proposed project will be located on previously disturbed areas at the wastewater treatment plant and/or existing pipeline rights-of-way. Therefore, no significant impact on historical or cultural resources is expected.

5.2.3.2 Circulation

In the event that Meeks and Daley Well #66 is chosen for geothermal fluid production, the pipeline right-of-way will cross Orange Show Road. Trenching activities and pipeline installation will interfere with motor vehicle traffic on this road for two to four weeks. The average daily traffic volume on Orange Show Road was about 19,000 in 1977. This negative impact on traffic circulation will be of short duration, and arrangements will be made with the City Traffic Department to assure that motorists can reach their destinations by alternate routes.

5.2.3.3 Noise

The main noise impact of the proposed project will be due to heavy construction equipment such as backhoe's and drilling rigs. These noise impacts will be temporary. Injection well drilling is expected to take less than one month and all trenching and backfilling should be accomplished in less than two months.

During operation of the project, no increased noise levels are anticipated.

5.2.3.4 Impact on Energy Consumption

Implementation of the proposed project will result in saving about 5 1/2 million cubic feet of natural gas per anaerobic digester heated. In addition to reducing the City of San Bernardino Water Department's annual energy costs by $20,000 per digestor heated, a significant quantity of natural gas will be conserved.

REFERENCES

5.1 San Bernardino Valley Wastewater Management Facilities Plan: Phase I, Volume 1 Existing Conditions, 1979.

5.2 Final Environmental Impact Report: San Bernardino Facilities Plan, 1980.

5.3 Raleigh, D.B., J.H. Healy and J.D. Bredehoeft, "An Experiment in Earthquake Control at Rangely, Colorado", Science 191, 1230-1237, 1975.

6. RESOURCE DEVELOPMENT PLAN

The Resource Development Plan presented in this Chapter describes the steps which the San Bernardino Municipal Water Department should follow in order to utilize geothermal process heat in their wastewater treatment plant. A preliminary well program and rough cost estimates for the production and injection wells also are included; however, since many unknown variables are involved in the project well specifications, the cost estimates are only preliminary figures. The Meeks and Daley Well No. 66 is proposed as the candidate production well.

In order to achieve the goal of the Resource Development Plan, which is to provide guidelines for the rapid implementation of geothermal energy in the wastewater treatment plant, the following objectives must be fulfilled:

- Evaluation of the Meeks and Daley No. 66 Well.
- Evaluation of the San Bernardino geothermal resource.
- Plan of resource development.
- Preliminary well program and cost estimates.

6.1 EVALUATION OF THE MEEKS AND DALEY WELL

In 1966, the now defunct R. and W. Drilling, Inc. drilled a well on South Arrowhead near Central Avenue in San Bernardino for the Meeks and Daley Water Company. The well, referred to as the Meeks and Daley Well No. 66, produces thermal water at temperatures of about 138°F. The San Bernardino Board of Water Commissioners proposed using this well as a production well for the geothermal heating of the sludge digesters at the wastewater treatment plant located about one-half mile south of the well. An evaluation of the present status of the Meeks and Daley Well No. 66 was conducted to determine its suitability for use as a production well.

6.1.1 Assemble and Analyze Data Available for the Well

Evaluating the status of the well must begin by assembling and analyzing available data, including the driller's log, water chemistry analysis, temperature logs, and conversations with local persons who are knowledgeable on the status of the Meeks and Daley Well No. 66.

6.1.1.1 Driller's Log and Drilling and Completion Information

A driller's log of the Meeks and Daley Well No. 66 was made at the time the well was drilled in May 1966, but no lithologic log is available. According to the driller's log (see Figure 6-1), the well originally was drilled to a depth of 975 feet. Discussions with a number of knowledgeable persons revealed that subsequently the well was backfilled from 700 feet to 975 feet because poor water quality was encountered at this depth.

The diameter of the well is 20 inches. According to a representative of Timescal Water Company in Corona, 61 feet of 12-inch diameter column appear in the top portion of the well, followed by 160 feet of 10-inch diameter column. A pump and some other equipment owned by the Meeks and Daley Water Company is located at a depth of 243 feet within the well. Since only 1.5 inches of clearance exist between the well casing and the pump, it is difficult to put a probe or any other instruments down the well without removing the pump.

The well was cased throughout the depth of the hole with 20-inch diameter 6 gage casing. The casing was perforated

STATE #E-96bb

MEEKS AND DALEY WATER COMPANY

60.0 feet West of Arrowhead Avenue - 90.0 feet North of Central Avenue

Diameter - 20 Inches, 6 Gage Casing - Double
Depth - 975 Feet
Drilled - May, 1966
Drilled by - R. & W. Drilling, Inc.

0	Ft.	to	60	Ft.	sand and gravel
60	Ft.	to	64	Ft.	clay
64	Ft.	to	210	Ft.	blue silt and sand
210	Ft.	to	220	Ft.	gravel and rock - up to 4 inches
220	Ft.	to	244	Ft.	blue clay and gravel
244	Ft.	to	255	Ft.	gravel and rock - up to 4 inches
255	Ft.	to	262	Ft.	brown clay and gravel
262	Ft.	to	280	Ft.	brown clay
280	Ft.	to	290	Ft.	small gravel
290	Ft.	to	310	Ft.	brown clay and gravel
310	Ft.	to	315	Ft.	sand and gravel
315	Ft.	to	351	Ft.	brown clay and gravel
351	Ft.	to	379	Ft.	blue clay and sand with streaks
379	Ft.	to	385	Ft.	blue clay
385	Ft.	to	387	Ft.	brown sand, fine
387	Ft.	to	398	Ft.	blue fine sand, tight
398	Ft.	to	415	Ft.	blue clay with gravel streaks
415	Ft.	to	450	Ft.	blue sandy clay
450	Ft.	to	461	Ft.	cemented sand and gravel
461	Ft.	to	467	Ft.	blue sandy clay
467	Ft.	to	503	Ft.	blue sandy clay with gravel
503	Ft.	to	570	Ft.	brown sand and gravel
570	Ft.	to	575	Ft.	brown sand and gravel - up to 4 inches
575	Ft.	to	612	Ft.	brown sandy clay
612	Ft.	to	617	Ft.	black sticky clay
617	Ft.	to	635	Ft.	brown clay
635	Ft.	to	695	Ft.	gray sand and gravel - up to 4 inches
695	Ft.	to	703	Ft.	tight sand, small gravel, brown clay
703	Ft.	to	745	Ft.	tight sand and small gravel
745	Ft.	to	791	Ft.	silt, fine sand with blue clay
791	Ft.	to	801	Ft.	cemented sand and pea gravel
801	Ft.	to	809	Ft.	tight sand and small gravel
809	Ft.	to	867	Ft.	sand and gravel - up to 4 inches
867	Ft.	to	885	Ft.	sand and gravel - tight, clean
885	Ft.	to	930	Ft.	sand, pea gravel - tight with clay
930	Ft.	to	939	Ft.	sand and gravel, small
939	Ft.	to	955	Ft.	sand and gravel and rocks
955	Ft.	to	967	Ft.	sand, silt with streaks of clay
967	Ft.	to	975	Ft.	brown and blue clay

Figure 6-1. Driller's Log from Meeks and Daley Well No. 66

MEEKS AND DALEY WATER COMPANY
(Continued)

Static Water Level: May 24, 1966 - 69.0'

Temperature: 120°F

Perforated with Mills Mechanical Knife

2½" x 3/8" Blade

Perforations

503-ft. to 575-ft. - 8 cuts @ 12"
575-ft. to 635-ft. - 4 cuts @ 12"
635-ft. to 745-ft. - 8 cuts @ 12"
745-ft. to 791-ft. - 4 cuts @ 12"
791-ft. to 955-ft. - 8 cuts @ 12"

Figure 6-1 (Cont'd): Driller's Log from Meeks and Daley Well No. 66

at all hot and cold water bearing strata, using a Mills Mechanical Knife with a 2-1/2 inch by 3/8 inch blade. The perforation zones above the 700 foot depth include the following strata:

1. 503 to 575 feet (brown sand and gravel layer)
2. 575 to 635 feet (brown and black clay)
3. 635 to 700 feet (brown clay, gray sand and cobbles up to 4 inches in size)

The driller's log shows that the Meeks and Daley Well No. 66 is located primarily in brown and blue clay, sand, gravel and cobbles from 3 to 5 inches in size. These sediments probably can be classified as alluvial valley fill deposits such as those blanketing much of the San Bernardino Valley (Dutchee and Garrett, 1963). The Meeks and Daley Well No. 66 is located on or very near the Loma Linda Fault. The San Jacinto Fault, which strikes northwestward across the San Bernardino Valley, parallels the Loma Linda Fault and passes very near the well.

The well was drilled with a cable tool rig. No drilling fluids were used and no open hole or electric logs were run before the well was cased. The well was pumped for 72 hours after it was drilled, and a flowage of 2000 gallons per minute (gpm) was recorded (verbal communication with Larry Rowe, 1980).

6.1.1.2 Water Analyses

In May, 1980, Geothermal Surveys, Inc. of Pasadena performed a water analysis on samples taken from the Meeks and Daley Well No. 66. The results of this analysis and the water chemistry analysis performed in March-April, 1979 by Edward S. Babcock and Sons, Inc. of Riverside are displayed in Table 6-1. The well appears to contain slightly to moderately alkaline water. Sodium and chloride seem to be the most concentrated

Table 6-1. Analyses of Water Samples from the Meeks and Daley Well No. 66

	Geothermal Surveys, Inc. Tested May 1980	Edwards S. Babcock and Sons, Inc. Tested March-April 1979
Sodium mg/l	112	114
Potassium mg/l	1.2	2
Calcium mg/l	5	5
Magnesium mg/l	2.4	1
Silica mg/l	27	-
Carbonate mg/l	-	21
Bicarbonate mg/l	-	18
Sulfate mg/l	-	31
Chloride mg/l	-	120
Total Dissolved Solids (at 180°C) mg/l	-	360
pH	7.0	8.7

ions, with sulfate, bicarbonate, and carbonate occurring in less concentrated forms. The water, considered to be good quality, is used for irrigation purposes by the Meeks and Daley Company. According to the figures in Table 6-1, the minor silica and carbonate content of the water (27 mg/l and 21 mg/l) is a good indication that scaling should present no serious problems.

6.1.1.3 Analyses of Temperature Data

At the time it was drilled, the Meeks and Daley Well No. 66 had a standing water level of 69 feet with a temperature of 120°F, as shown on the driller's log in Figure 6-1. About three years ago at certain intervals, the well began to flow artesian at a rate of 1,350 gpm; the water temperature was 135°F to 140°F. Geothermal Surveys, Inc. (GSI) attempted a thermal log in May 1980; the results are displayed in Table 6-2 and in Figure 6-2. The well was flowing 875 gpm artesian at the time the thermal survey was performed. The high artesian flow appeared to be responsible for the well being isothermal. As shown in the thermal log in Figure 6-2, the well was only logged to a depth of 160 feet. Several unsuccessful attempts were made by GSI to probe to a greater depth. This penetration problem must be investigated further in the well program phase. The inability of the temperature probe to reach depths greater than 160 feet may be explained by one or more of the factors listed below:

a. The well is blocked by an unknown obstruction at 160 feet such as: debris in the well, parting or buckling in the casing, rock in the casing, etc.

b. The artesian flow of the well at the time of the thermal survey may have been too excessive to allow the temperature probe to drop below a depth of 160 feet.

c. The temperature probe was unable to get past the pump equipment which Meeks and Daley set inside the well.

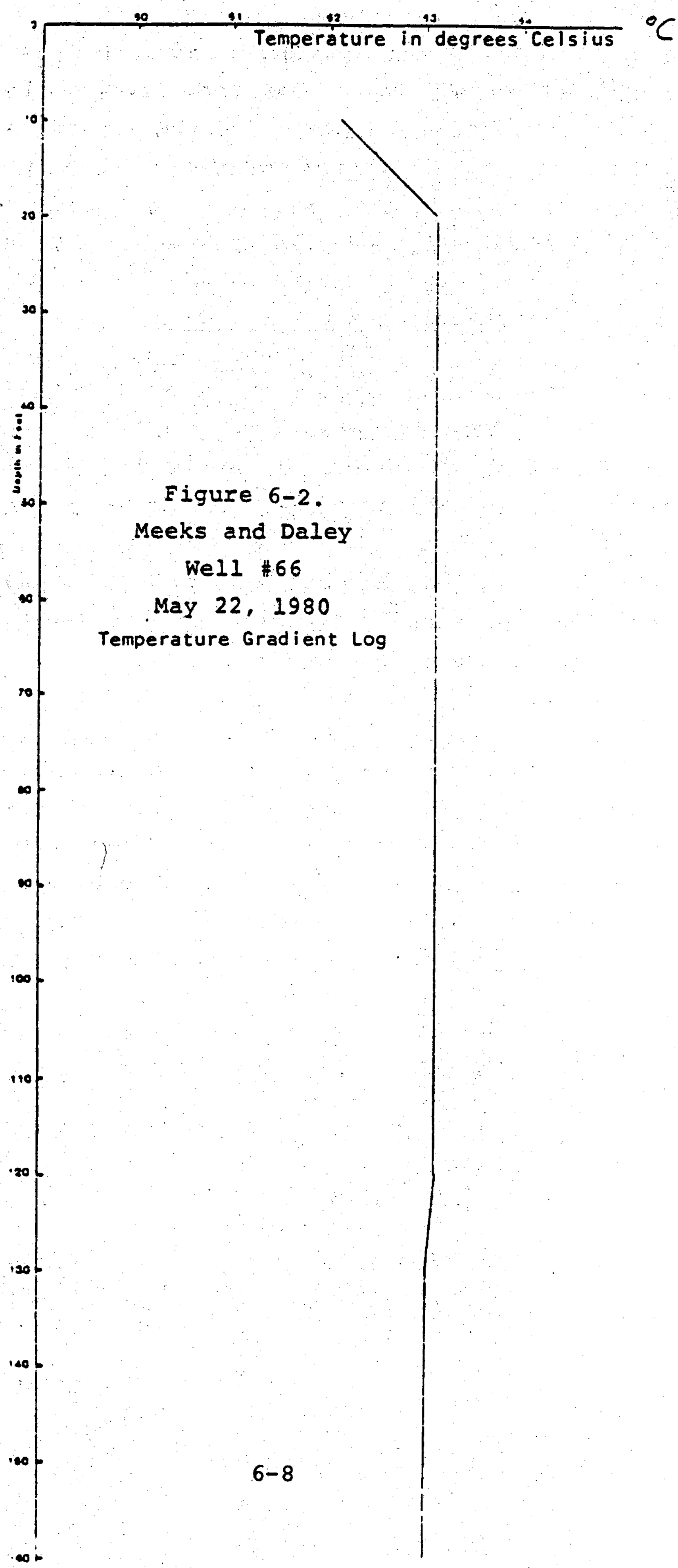

Figure 6-2.
Meeks and Daley
Well #66
May 22, 1980
Temperature Gradient Log

Table 6-2. Thermal Survey Data from Meeks and Daley Well No. 66*

Flow: (Artesian)	875 gpm	
Temperature at outflow:	55°C 131°F	
Field pH	7.0	
Temperature at depth:	20 ft.-	63.1°C 145.6°F
	160 ft.-	63.0°C 145.4°F
Thermal Gradient:	20 - 160 ft -	.07°C/100 ft. .13°F/100 ft.

*From analysis performed by Geothermal Surveys, Inc. in May 1980.

A more complete thermal analysis and a determination of the condition of the well bore must be performed in order to ascertain completely the present status of this hole.

6.1.2 Determine Additional Data to be Obtained for the Well

A determination must be made of the additional data which should be collected in order to assess the condition of the well and learn more about the geology of the area.

6.1.2.1 Additional Chemical Analyses

Although the two water chemistry analyses run on well samples appear to be sufficient to determine the chemical nature of the water, if possible, at least one additional water sample should be obtained for additional analysis of the silica ion concentration. Only one silica determination has been made and special precautions are necessary when making silica determinations. In addition, the silica values from the No. 66 Well might be compared with those of other wells in the vicinity, since silica concentrations can be used to infer geothermal reservoir temperatures.

6.1.2.2 Determine Physical Condition of the Well

Before a decision can be made on employing Well No. 66 as a production well for this project, the physical condition of the well must be assessed by using either a feeler gauge instrument, electronic caliper log or a TV log or photolog. In order to determine the condition of the casing and the open hole, the Meeks and Daley pumping equipment must be removed. Once this is accomplished, a feeler gauge instrument, which measures the diameter of the hole, can be run down the length of the well to determine if any blockages, obstructions or caving exist.

In addition, an electronic caliper log, used to measure the condition of the casing, can be lowered into the well. As the log is raised, data is transmitted to a caliper graph on the surface, which produces a curve revealing the depth at which the casing has been worn, split or cracked. The third method that can be used is a TV log or photolog, in which a camera with a 120° angle lens is lowered into the well to photograph the casing. If the well water is reasonably clear, stereo pictures of breaks, oversized perforations, or scale deposits can be obtained to an accuracy of one-tenth of a foot.

In order to study the hydrologic characteristics of the geologic formation or formations producing the water, a pump test can be run, however the well must be in a static, not artesian, condition. By starting the pump and allowing the well to flow, the operator can evaluate how much water the well is capable of producing. As stated in Section 6.1.1, a 72-hour pump test was run after the well was drilled and the well produced 2000 gpm.

6.1.2.3 Well Logs

Since the Meeks and Daley No. 66 is a cased well, no electric logs such as spontaneous potential or electric log resistivity can be run, however, well survey methods which can be used include a temperature log, compensated neutron log, gamma ray log and a spinner survey.

The temperature log (see Section 6.1.3) is a downhole method used to determine the temperature gradient throughout the hole. After the well is cleaned and reconditioned, if necessary, a new temperature log should be run to the bottom depth in order to obtain an accurate thermal gradient. If the well continues to flow artesian, a temperature gradient with meaningful results cannot be obtained; however, it would be possible to make an estimate as to the true temperature gradient. Artesian flow usually stops at the well in the summer. When flow stops, temperatures can be measured and gradients calculated.

The compensated neutron log (CNL), which can be run in either cased or uncased liquid-filled holes, is used primarily to identify porous formations and determine their porosity (Schlumberger, 1972). Usually, the CNL is run with a gamma ray log that aids in separating the sand layers from the shale or clay layers. In a geothermal area, if the hot water is produced from sand layers and not fractures, the ability to make this distinction is important and may facilitate locating the zones of hot water entry into the well.

As a non-nuclear source tool, the gamma ray log is appropriate for this application, since no radioactive source tools can be used in California's groundwater system. The log measures the amount of gamma decay in the lithology, which is compared to the percentage of naturally occurring radioactive minerals in each strata.

A spinner survey may be run to determine the zones of water entry into the well. Since the well is perforated from a depth of 503 feet to total depth, the spinner survey would tell which zones in this interval are water producing horizons. With this information, a temperature survey could be run to determine the cold water and warm water zones. Then the cold water zones could be sealed off to prevent warm and cold water from mixing within the well.

6.1.2.4 Prepare and Conduct Well Test Program

Once the investigator has decided which well surveys and logs to use in testing the well, a well test schedule must be developed. A prototype well test program for the Meeks and Daley Well No. 66 appears in Section 6.5.

6.2 EVALUATION OF THE GEOTHERMAL RESOURCE

In addition to evaluating Well No. 66, the geothermal resource of the entire area should be investigated. The geothermal evaluation should include literature review; studies of photo geology, surface geophysics, and geochemistry; and an analysis of the data generated by the resource evaluation study.

The California Division of Mines and Geology (DMG) is initiating a geothermal assessment study in San Bernardino as part of their program to investigate the low temperature hot waters of California; Les Youngs of DMG was contacted for more information about their work plan for the assessment. The original plan and estimated costs of geothermal resource evaluation were drafted prior to SAI's knowledge of the DMG's work. In order to avoid any duplication, the areas in which DMG is planning to conduct work are noted.

6.2.1 Library Research

The initial stage of a geothermal resource evaluation should be a thorough literature search in order to determine the nature of the geologic, hydrologic, geochemical and geophysical data base which already exists. Data gathered during this search may preclude the need for certain surveys and assist in the interpretation of other data collected during the course of the evaluation program.

Since the DMG also is conducting a literature survey, another literature search probably will not be necessary. However, if needed, a computer generated search of available geologic literature can be produced by Ms. Kay Collins, Applied Information and Documentation, Inc. of Denver, whose firm, Cascadia Exploration, previously assembled pertinent technical literature and data.

6.2.2 Geologic Mapping

The San Bernardino geothermal activity is thought to be fault controlled and the existence of thermal wells and springs is related to the locations of the major fault systems, such as the San Andreas, San Jacinto and Loma Linda Faults.

Utilizing the data generated from aerial photo surveys, field mapping data, and information assimilated from the geologic literature, a fault map and a geologic map of the area has been prepared. The DMG has studied an orthophotoquad sheet of the City and prepared a fault map using information gleaned from their literature survey. The map shows the faults in the San Bernardino area and the locations of 60 hot water wells from old reports. DMG's map shows a strong relationship between the location of the thermal wells and the faults.

6.2.3 Geophysics

Surface and downhole geophysical methods are useful in delimiting the geothermal reservoir and yielding data on subsurface thermal dynamics. Some of the commonly used geophysical techniques for geothermal exploration are temperature gradient surveys, electrical surveys, passive seismic surveys, and gravity surveys.

The DMG plans some geophysical work in the San Bernardino area, such as resistivity soundings around the location of the sewage treatment plant in southern San Bernardino and in the Harlem Springs and Arrowhead Springs areas. Although no magnetic surveys are being performed in the cultured areas of San Bernardino due to the magnetic interference presented by automobiles, pipelines, etc., a magnetic survey in the more remote Arrowhead Springs area is being considered.

6.2.3.1 Gravity Survey

A gravity survey of the San Bernardino Valley was compiled and analyzed by Willingham (1968), using a two-dimensional analysis of the gravity data to approximate the extent of the basement rocks below the alluvial deposits of the valley and locate the position of major faults. A Bouguer gravity map was prepared from this study. Due to inadequate subsurface control, the Willingham (1968) gravity survey lacks a great deal of accuracy. Additional subsurface control data and detailed gravity stations are required to provide a more accurate interpretation of this data (Fife, et.al., 1976).

The DMG has outlined plans to conduct gravity surveys in the Arrowhead Springs and Harlem Springs areas of San Bernardino. No further work on gravity studies is recommended.

6.2.3.2 Electrical Surveys

Electrical techniques are useful in geothermal exploration because many geothermal areas are centers of anomalously high electrical conductivity (Combs and Muffler, 1972). Usually hot water has a greater dissolving power, is more saline and therefore, more electrically conductive than in areas in which cool water is present (Meidav and Tonani, 1972). The DMG is planning to perform resistivity soundings in the San Bernardino area as part of their geothermal assessment plan. No further electrical surveys are recommended for the area.

6.2.3.3 Passive Seismic Surveys

When used in tandem with other geophysical or geologic evidence, microearthquake seismic surveys aid in determining the gross limits of a geothermal area and defining active fault planes (Meidav and Tonani, 1972). However, since it is difficult to interpret the noise anomalies shown by the microearthquake survey when a great deal of cultural noise is present, conducting passive seismic surveys in San Bernardino may be impractical if too much urban noise exists.

A survey should be made, however, of the previous seismic work which has been performed in the San Bernardino area. For example, Hadley and Combs (1974) studied microearthquake distribution in the area in order to detail the microseismicity of the region. Allen, et.al. (1965) compiled data from over 10,000 earthquakes in Southern California to determine relationships between seismicity and geologic structure.

6.2.3.4 Temperature Gradient Surveys

Temperature gradient measurements are a useful geophysical method for defining a geothermal resource. Temperature gradients are measured in shallow holes, extrapolated to great depths and then plotted on a contour map to show the limits of a geothermal field (Meidav and Tonani, 1975). Three to four temperature gradient measurements may be adequate to determine the depth to the geothermal source.

The existence of wells suitable for this purpose in the San Bernardino area should be determined by contacting the California Division of Water Resources in Sacramento during the planning stages of the temperature gradient survey. If none are available, three or four shallow gradient holes will need to be drilled to depths of approximately 100 feet to 500 feet.

As part of their geothermal assessment work, the California Division of Mines and Geology plans to locate accessible hot wells and springs in the San Bernardino area and perform temperature measurements, which will be tabulated and incorporated into a model of the local geothermal reservoir scene.

6.2.4 Geochemistry

Geochemical techniques of geothermal exploration involve water sampling of thermal wells and springs, followed by chemical analyses of the samples and interpretation of the results. The data gathered aids in estimating the minimum temperature expected at depth, making inferences about the chemical characteristics of waters at depth, and determining the source of recharge water. The ratios of components in the water samples can be utilized in chemical geothermometry to estimate the minimum reservoir temperature of the geothermal system.

DMG plans to conduct a well survey of accessible thermal wells in San Bernardino, collect geochemical water samples and prepare a map showing the locations of wells and the chemistry of the water samples.

Two phases of the geochemical survey -- water, geochemistry and mercury soil geochemistry -- are recommended for the San Bernardino geothermal resoûrce development plan.

6.2.4.1 Water Geochemistry and Geothermometry

The DMG plans to conduct a well inventory and gather water chemistry data from as many wells as possible in San Bernardino. In conducting this survey, more information can be obtained on the existence and locations of warm wells, water levels or artesian flow in wells, trends in the chemical constituents of the water, and the depth of thermal water circulation.

In addition, the DMG hopes to conduct some chemical geothermometry analyses. No further water geochemistry analysis is recommended.

A review of the literature should be performed to locate other work in this area. For example, a portion of the work of Jarzabek (1980) involves a geochemical reconnaissance of thermal waters along the San Jacinto Fault zone in San Bernardino. Wells were sampled and a geothermometry analysis showed a reservoir temperature of 120°C from the Arrowhead Springs area. The geothermal gradient of the San Bernardino area had been determined to be 31°C per kilometer with a depth of circulation of 3.3 kilometers (Jarzabek, 1980).

6.2.4.2 Mercury Soil Geochemical Surveys

A mercury soil geochemical survey of the San Bernardino area is recommended. The discovery of excess mercury in the soil often indicates a strong correlation with geothermally active regions (Matlick and Buseck, 1975). A reconnaissance mercury survey should be run initially to determine the overall distribution of mercury in the area. If excessive man-made contamination exists or if the geothermal system lacks mercury, then it is questionable whether the mercury soil survey will provide an accurate determination of the location of geothermal upwelling.

In conducting the survey, soil samples are collected at points that are evenly distributed across the survey area, then dried, sieved and analyzed. A thin gold film Hg detector instrument is used to measure the amount of Hg in ppb contained in the soil sample. This technique is described more completely in Phelps and Buseck (1980) and Matlick and Buseck (1975).

6.2.5 Analysis of Data

The data generated in the evaluation of the San Bernardino geothermal resource must be analyzed and interpreted in order to develop a preliminary geologic reservoir model of the potential resource. The nature of the resource and a description of the surface and subsurface geothermal manifestations must be determined so that a geologic picture of the area can be assembled, and the geothermal resources can be related to the geology.

After assimilating this data, potential sites for production and injection wells need to be suggested. Then, preliminary boundaries of the San Bernardino geothermal reservoir can be outlined, using data from the geothermal assessment program.

6.3 PLAN OF RESOURCE DEVELOPMENT

The Resource Development Plan presented in this section recommends avenues for selecting a workable production well and injection well for the San Bernardino geothermal process heat wastewater treatment plant.

6.3.1 Use of Meeks and Daley No. 66 for the Production Well

The Meeks and Daley Well No. 66 appears to be a suitable candidate for the sewage treatment plant production well, based on the scanty information that is already available about the properties of the well. The temperature (135°F) and the flow of the water (about 875+ gpm), as well as the desirable water chemistry properties, indicate that the No. 66 Well would be an adequate production well. However, certain well surveys, such as an electronic caliper log, a photolog and a feeler gauge, should be run to determine the physical condition of the well and whether it is in adequate shape for use as a production well.

In addition, the institutional and financial ramifications of using the well must be weighed before a decision is reached. Since this well is used to produce irrigation water during part of the year, the City would have to dispose of the excess water when the Meeks and Daley Company does not need it. The City also must consider whether the rental cost charged by the Meeks and Daley Company for use of this well is economical.

6.3.2 Alternatives to the Meeks and Daley Well No. 66

Certain alternatives to using the Meeks and Daley No. 66 as a production well do exist and should be analyzed by the City. Some of these alternatives are discussed in this section.

The City of Riverside has rights in a warm well, the Meeks and Daley No. 59, which is located about one-fourth mile northeast of the sewage plant near Hillcrest Avenue. The water chemistry for No. 59, taken from the water quality files of the San Bernardino Valley Municipal Water District, is described in Table 6-3. Water temperatures are between 116°F and 136°F, and the water chemistry is similar to that of the No. 66 Well (Table 6-1), except that it is much more concentrated in bicarbonate and less concentrated in chloride and total dissolved solids. One possible advantage of the Meeks and Daley No. 59 is that Riverside uses this water, so potentially San Bernardino could remove the heat from the water for the sewage digester and return the cooled water to Riverside. In this way, the City of San Bernardino would not need to dispose of the well water, as would be the case with the No. 66 well. More information must be obtained before deciding either to use or reject this well as a viable candidate.

As a second alternative, the City could decide to drill its own production well, rather than use an already existing well. In this case, the expenses and institutional factors involved in paying to use another party's well would not exist. The City could drill the well on the large parcel of land it owns at the wastewater treatment plant. Also, the City may be able to reach a mutually acceptable agreement with the National Orange

Table 6-3. Chemical and Physical Water Analysis from Meeks and Daley Well No. 59*

Temperature:	47°C - 58°C 116°F - 136.4°F
Sodium mg/l	75-116
Potassium mg/l	2
Calcium mg/l	5
Magnesium mg/l	1
Silica mg/l	-
Carbonate mg/l	18
Bicarbonate mg/l	46-125
Sulfate mg/l	23-28
Chloride mg/l	36-103
Total Dissolved Solids mg/l	225
pH	8.5

* From San Bernardino Valley Municipal Water District, water quality analysis files

Show which owns a large parcel of land adjacent to Meeks and Daley Well No. 66. One liability, however, is that the new well may produce water with an inadequate temperature for this project.

6.3.3 Potential Injection Well Sites

Microseismic and other geological data which are available for San Bernardino must be analyzed before selecting the location of a potential injection well. Since the San Jacinto and Loma Linda fault systems are so close to the sewage treatment plant, the fault network must be studied closely before the injection well site is selected. Should the City decide to drill a production well in which cold water is produced, the cold well might be traded to Meeks and Daley for Well No. 66, or the cold well could be used as an injection well instead of a production well. These decisions should not be made until all environmental issues are considered carefully.

6.3.4 Prepare a Well Program and Cost Estimates for Production and Injection Wells

A well program and cost estimates of drilling and logging activities must be prepared for the production and injection wells which will serve the San Bernardino Wastewater Treatment Plant. A well log program should be conducted on the Meeks and Daley No. 66 to attempt to determine where the warm water producing strata are located. If the resource is located at 200 feet or less, for example, it may be advisable to drill a new hole. In this case, a shallower hole could avoid the cold water layers that may exist deeper inside the well and cause mixing of the warm water with cold water layers. It also may be a good idea to drill a new well and use the Meeks and Daley No. 66 as a backup well.

6.4 PRELIMINARY WELL PROGRAM AND COST ESTIMATES

This section presents a preliminary well program for both the production and injection wells, along with cost estimates for these services, which were obtained by a telephone survey. The cost figures should be used for preliminary estimating purposes only, because too many well parameters and project specifications are unknown.

1. Determine the present condition of the Meeks and Daley Well No. 66.

   A. Have Meeks and Daley Company pull their water pump out of the well - approximately $2,000.

   B. Tests for condition of casing.

      1. Use of derrick truck to suspend tools - $330 - $400 per day, plus $2.10 per mile over 150 mile round trip.

      2. Run feeler gauge down well - $265.

      3. Run TV log or Photolog - $285 - $395 for 1000 ft. minimum plus $30 - $35 per hour for two man crew (takes about 3-6 hours).

      4. Hole caliper test (if casing is seen to be damaged) - $300.

      5. Sonar jet (to clean perforated casing if necessary) - $1150 (200 ft. of 20-inch casing).

   C. Well logs and tests to run on Meeks and Daley Well No. 66 after verifying the well to be in good physical condition.

      1. Temperature survey - $560 - $770, minimum depth of 200 ft.

      2. Gamma ray log - $340 - $740.

      3. Compensated neutron log - $1340.

      4. Pump test - $5,000 - $10,000

2. Production/Injection Well Drilling Costs

   A. 12-inch diameter well drilled and completed - assume 700 ft. deep well - $50 - $60 per ft. - $35,000 - $42,000, plus expendables.

   B. 10-inch diameter well drilled and completed at 1500 ft. depth - $130,000 to $150,000.

3. Slim Hole Wells (for Resource Evaluation Purposes)

   A. 6-inch to 7-inch bore with 5-inch casing - assume 1000 ft. deep well - $16 - $18/ft. - $16,000 - $18,000, plus expendables.

6.4.1 Contacts

The following well surveying and well logging companies were contacted by telephone to obtain estimates on the costs to perform tests on the Meeks and Daley Well No. 66:

1. McCullough (N.L. Industries)
   (213) 537-9330
   Contact: Bob Irvin

2. Schlumberger
   El Centro Depot
   (714) 344-6520
   Contact: Steve Garcia

3. Waterwell Redevelopers, Inc.
   Yorba Linda
   (714) 779-2425
   Contact: Brad Challacombe

4. Well Surveys
   Oxnard
   (805) 647-3281
   Contact: Clark Wigley

The following well drilling companies were telephoned to determine costs of drilling an injection well.

1. McCalla Bros. Pump and Drilling Co.
   Redlands
   (714) 793-2913
   Contact: Bill Province

NOTE: McCalla Drilling Company bought out the R&W Drilling Company that originally drilled the Meeks and Daley Well No. 66 in 1966. McCalla also has the drilling equipment and some of the well records from the R&W Drilling Company.

2. Moreno Valley Drilling Service
   Bloomington
   (714) 877-0220
   Contact: Marvin Fernandez

NOTE: This drilling company has the capability of drilling shallow holes only, to a maximum of 120 feet in depth.

3. Yost Well Drilling and Pump Service
   San Bernardino
   (714) 884-0913
   Contact: J.R. Yost

6.5 CONCLUDING REMARKS

This Resource Development Plan will assist the City of San Bernardino in choosing a workable site/alternative for a production well and reinjection well for the Wastewater Treatment plant. The cost schedule shown in Table 6-4 presents a rough estimate of the cost of implementing the three phases of this plan. Much of the work associated with this plan has already been completed by the California Division of Mines and Geology and the San Bernardino Municipal Water Department. The costs shown in Table 6-4 are estimates for completing resource development planning.

Table 6-4. Schedule of Costs to Complete Resource Development Plan

TITLE	SUBTASK COSTS	ESTIMATED COST OF ENTIRE TASK
EVALUATION OF THE MEEKS AND DALEY WELL NO. 66		
Assemble and Analyze Data Available for the Well		
Driller's Log and Drilling and Completion Information}		Completed by Water Dept.
Analyses of Water From Well }		
Analyses of Temperature Data }		
Determine Additional Data to be Obtained for the Well		
Additional Chemical Analyses	$ 300	
Determine Physical Condition of the Well	$ 4,000	
Types of Well Logs Which May be Useful	$ 3,000	
Prepare and Conduct Well Test Program	$ 7,000	
		$14,300
EVALUATION OF THE GEOTHERMAL RESOURCE		
Library Research and Analysis of Literature}		Completed by DMG
Mapping		
Analysis of Aerial Photographs }		Completed by DMG
Field Checking }		
Prepare a Fault Map and Geologic Map}		
Geophysics		
Gravity Survey	None	
Electrical Surveys	None	
Passive Seismic Surveys	$ 200	
Temperature Gradient Surveys (est. 4 to 5 holes)}		To be Completed by DMG
Geochemistry		
Water Geochemistry and Geothermometry}		Completed by DMG
Mercury Soil Geochemical Surveys	$ 4,000	
Analysis of Data	$ 1,500	
		$ 5,700
PLAN OF RESOURCE DEVELOPMENT		
Analysis of Using Meeks and Daley No. 66 for Production Well	$ 1,000	
Analysis of Alternatives to the Meeks and Daley Well No. 66	$ 2,000	
Analysis of Potential Injection Well Sites	$ 700	
Prepare a Well Program and Cost Estimates for Production and Injection Wells	$ 1,500	
		$ 5,200

7. IMPLEMENTATION PLAN

This Implementation Plan provides the Water Department with a program and schedule for implementing a geothermal system to serve the wastewater treatment plant. The development of geothermal energy is a multidisciplinary problem which requires the interaction of various groups including engineers, geologists, drillers, management and government agencies. In order for the project to progress in a timely fashion, each sector must be coordinated with every other. The overall process for implementation is diagrammed in Figure 7-1, the schedule is provided in Figure 7-2 and a diagram of cost vs time is provided in Figure 7-3.

Work has already been started to obtain financing for the proposed project. This critical activity must be completed before significant additional work on the project may begin. As shown in Figure 7-2 once project financing has been obtained (Item 1) and a final resource development plan completed (Item 2), the production well drill sites will be selected.

The California Division of Mines and Geology is performing a resource assessment of San Bernardino, including analysis of seismicity, resistivity, gravity and well fluid data collected in the vicinity of the wastewater treatment plant. DMG's data are being made available to the Water Department, including temperature logs of existing wells, in order to help with the selection of drilling sites.

Certain permits and environmental documents must be obtained before drilling may begin. Since this project is not exploratory, prior to obtaining a permit to drill, a Conditional Development Permit (Figure 7-2, Item 4) or an exemption thereto plus an accompanying environmental document, either an exemption, negative declaration or EIR, is required from the City which is the lead agency in this case.

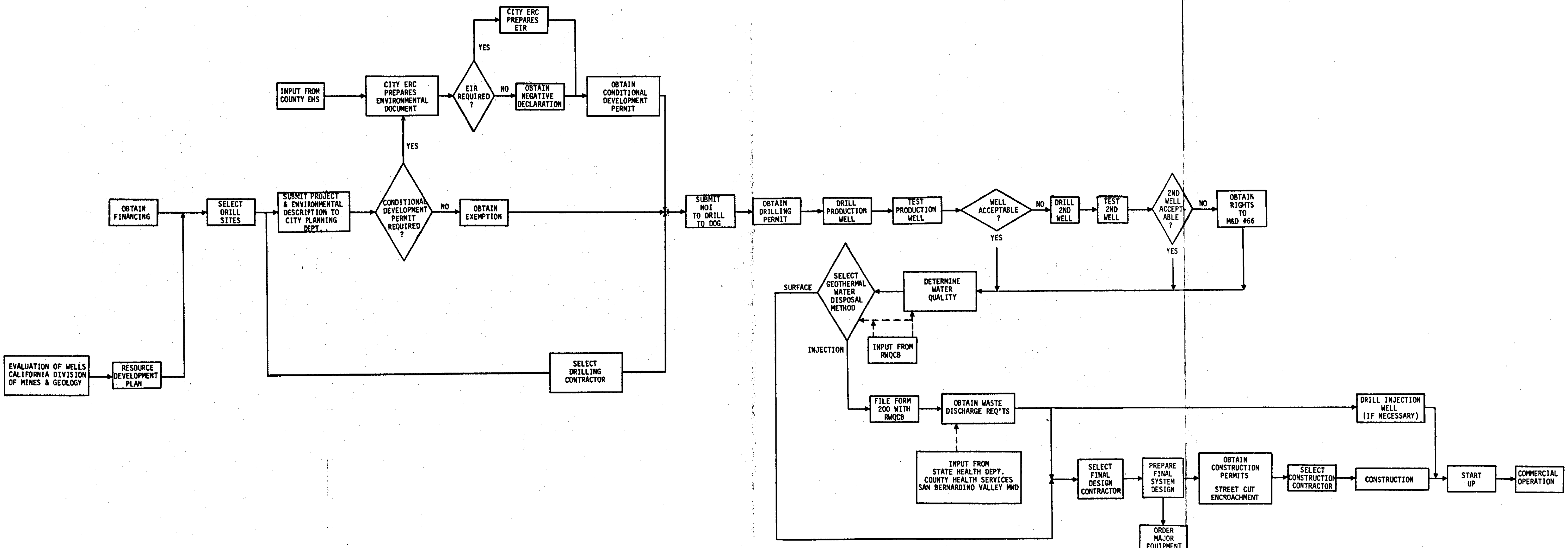

Figure 7-1. Project Implementation Diagram

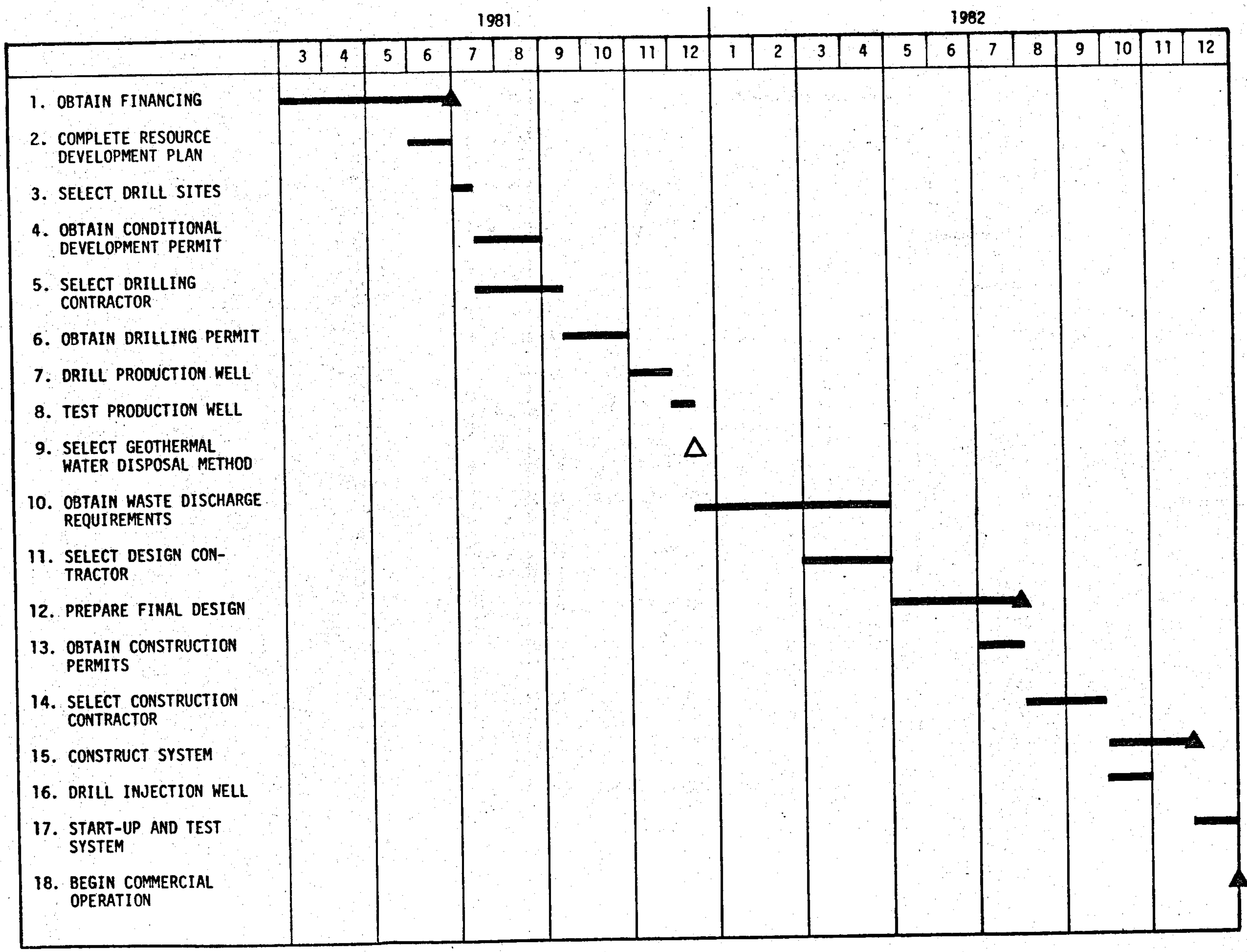

Figure 7-2. Project Schedule

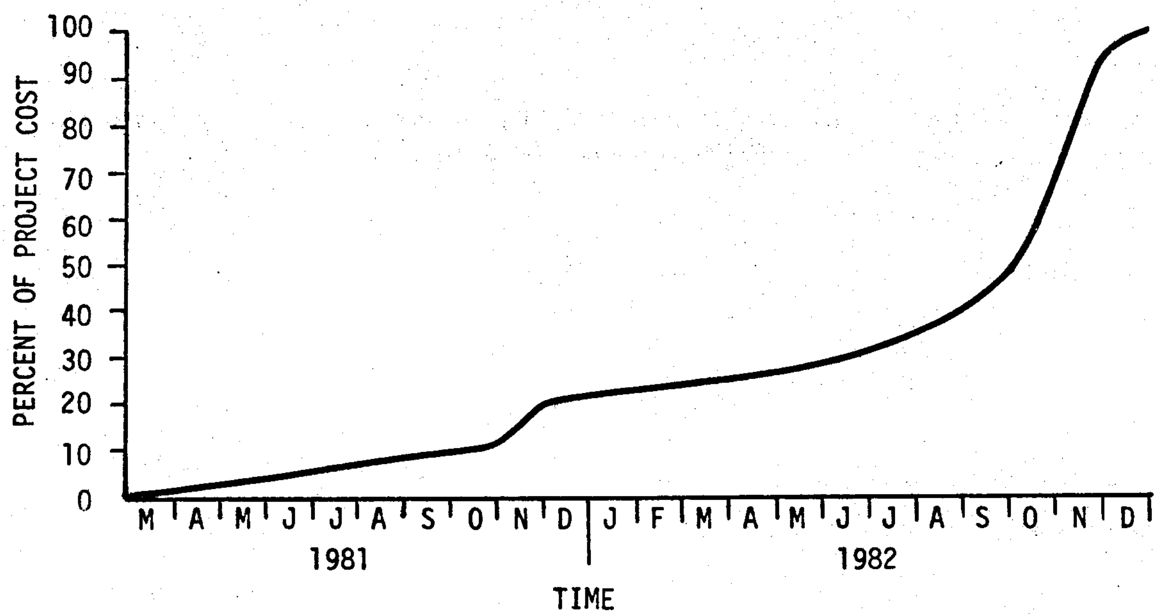

Figure 7-3. Percentage of Dollars Spent as a Function of Time for Project Implementation

Any and all production or injection wells will require a Permit to Drill from the California Division of Oil and Gas (DOG) (See Appendix "Institutional Issues" by Coulter Stewart & Associates, Inc.) It would be prudent to obtain permits for three wells at this time because the process will probably take 30-40 days (Figure 7-2, Item 6).

During the period that the Water Department is obtaining the two permits discussed above, a contractor will be selected on a competitive bid basis to drill the proposed wells (Figure 7-2, Item 5). The first production well will be drilled at the site of the wastewater treatment plant, using resource information to select a site on the plant property. This is essentially a risk free opportunity. If the well is not suitable for production, it will be available if needed as an injection well. If the well is successful, a second well may have to be drilled for injection purposes. If the well on the Water Department's property is not successful, a second well will be drilled on the Orange Show Grounds adjacent to the Meeks and Daley well.

Should either production well yield temperatures above about 120°F, the well will be flow tested (Figure 7-2, Item 8) for approximately two weeks to determine its ability to produce large quantities of fluid and the chemical constitutants of the fluid. If neither well is successful, the Water Department may choose to negotiate with Meeks and Daley for the use of Well #66 or drill a third well.

Once a viable production well has been identified, the Water Department must determine the optimum method of geothermal water disposal to be used for the proposed project. Depending upon the disposal method selected, additional permits may be required. If injection of spent geothermal fluid is contemplated an additional permit (Waste Discharge Requirements) is required from the Santa Ana Regional Water Quality Control Board (Figure 7-2, Item 10). The statutory processing time for this permit is 120 days. The Santa Ana Board will call upon the State Health Department, the County Environmental Health Services Agency and the San Bernardino Valley Municipal Water District for review and comment. The County Department of Environmental Health Services is empowered to issue a permit for water wells unless the California Division of Oil and Gas specifically includes each well to be drilled in its Drilling Permit. If the geothermal fluid is of suitable quality to be blended with the existing wastewater treatment plant effluent or tertiary water without significantly changing the composition or quality of that effluent, then no Water Quality Control Board Permits will be required. For the purposes of this Implementation Plan it was assumed that injection will be required, as this alternative has the largest impact on project schedule.

During the period that Waste Discharge Requirements are being obtained, the Water Department will select a final design contractor by competitive bid. The contractor will commence the final system design after the necessary permits have been obtained (Figure 7-2, Item 12). Major equipment, with extended lead times, will be ordered as early in the design process as necessary.

An additional permit must be obtained before construction may begin (Figure 7-2, Item 13). A detailed description of permitting requirements is presented in the Appendix. A Street Cut Permit from the City Street Division will be required for laying pipe down any street or sidewalk. With these and all other permits necessary for the proposed project, processing times can be minimized by keeping the agencies up to date on activities, so they are aware of scheduling requirements. Contact with permitting agencies early in the process is recommended. Applications should be submitted on a timely basis pursuant to the statutes concerning each permit.

The Water Department will competitively select a contractor to construct the proposed system after the final design has been completed and all construction permits have been received. (Figure 7-3, Item 14). The system will be constructed, and injection well drilled (if required).

The system basically consists of preinsulated fiberglass reinforced plastic pipe which will run from the well head to a pad supporting the heat exchangers (see Section 3.3, Preliminary Design), which, in turn, are connected to pipe entering the digesters. After the geothermal fluid has been utilized, it is piped using uninsulated fiberglass reinforced plastic pipe to an injection well or other point of discharge. The pipe is placed in trenches three feet deep and three feet wide, which are then back filled.

Various valves and gages will be installed in the system as required. Depending upon the final design, some asphalt paved streets may have to be torn up and repaved. The plastic pipe is very light and is easily installed. The system should be very straightforward and no unusual problems are anticipated with construction.

After construction has been completed, the system will be started up and tested in order to determine if all of the components and subsystems are operational (Figure 7-2, Item 17). The system will be debugged until commercial operation is continuous.

APPENDIX

FINAL REPORT - INSTITUTIONAL ISSUES

Geothermal Process Heating Feasibility Study
Wastewater Treatment Plant
San Bernardino Municipal Water Department

FINAL REPORT-INSTITUTIONAL ISSUES

Financing
Permits
Social
Legal

Prepared by:
Coulter H. Stewart

Prepared for:
The San Bernardino Board of Water Commissioners
and
The United States Department of Energy
Grant Number DE-FG03-805F1142

February 1981

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INSTITUTIONAL ISSUES

CONCLUSIONS AND RECOMMENDATIONS:

The principal legal, regulatory and financing issues confronting the San Bernardino Wastewater Treatment Plant Geothermal Project revolve around the three issues of hot water source, geothermal water quality and method of disposal.

From a legal, regulatory and financing standpoint the ideal project would consist of a new geothermal well located on the plant property, whose hot water is of good enough quality (less than 535 ppm TDS) to blend with the plant effluent without materially affecting the volume of total effluent. In this case only one discretionary permit is required, the geothermal well drilling permit from the California Division of Oil and Gas. Such a project could conceivably be financed from cost savings which would accrue to the Sewer Fund as natural gas is displaced as the primary fuel for heating the digesters.

If the project must utilize someone elses resource some distance away and be reinjected into formation, the legal, permitting and financing issues multiply.

Since the local financing feasibility of the project depends a great deal upon the future price of natural gas, a special natural gas price forecast has been prepared and included in the financing section. It concludes that the price of natural gas will rise from the present 38¢ per therm to 68¢-76¢ per therm by 1985 when post April 1977 natural gas prices are decontrolled.

The key social issue posed by this project is that of public acceptance. This is especially true if the project must be financed or reimbursed from local funds. Therefore a Public Awareness Program is presented for implementation.

Financing the project depends upon project size, hence the cost. The larger the project, the greater the need to turn to outside funding sources such as State and Federal Grants and loans or Development Authority Revenue Bonds. Twelve financing options are disucssed in detail. External financing sources involve their own costs due to such factors as interest, timing and coordination. Larger projects tend to be forever developing but never quite developed. As project cost is reduced, project viability increases significantly as natural gas cost savings can then be applied to the project.

QUARTERLY REPORT

San Bernardino Project

PERMITS:

As many as six permitting agencies could be involved in approving six different aspects of this project. They are:

a) City of San Bernardino Planning Department

b) City of San Bernardino Street Department

c) County of San Bernardino Engineering

d) San Bernardino County Health Department

e) California State Department of Transportation

f) California Regional Water Quality Control Board- Santa Ana Region

g) California Division of Oil & Gas

The extent to which each of these agencies would become involved depends upon the final design of the total project. The key project variables are:

a) Well location

b) Pipeline route

c) Method of disposal of geothermal water

d) Chemistry of geothermal water

e) Type of well

No attempt will be made here to anticipate the final project configuration or, composition. Rather the requirements and procedure concerning each permit will be presented. The easy to obtain permits or "ministerial" permits are described first. The "discretionary" permits are presented second.

MINISTERIAL PERMITS:

Encroachment: If County or State rights of way are crossed by a pipeline carrying geothermal water to or from the Wastewater treatment plant an encroachment permit must first be obtained from either the County Engineer or the State Department of Transportation District Office. A permit fee is paid to the appropriate agency. Such a permit can be issued within 2-8 weeks. If there is no other lead agency an environmental impact report can be required.

Street Cut: If the project involves laying pipe down a city street or sidewalk, a Street Cut Permit must first be obtained from the San Bernardino City Street Department. A fee is charged dependent upon the surface area of the actual cut.

DISCRETIONARY PERMITS:

Conditional Development Permit: The project may or may not require a conditional development permit. Such a determination is made administratively within the department. If a Conditional Development Permit is required, an environmental document must also be prepared pursuant to the California Environmental Quality Act (CEQA).

The Conditional Development Permit is issued by the Planning Commission subject to appeal to the City Council. If no permit is required then no environmental document is required by the City.

Environmental Review: The environmental document is prepared by the Environmental Review Committee (ERC) composed of representation from the Planning Department, Building & Safety Department and Engineering. Depending upon the scope of the project, the ERC can:1) grant a categorical exemption from CEQA under certain provisions as contained in Title 14, Article 8 - Categorical Exemptions, Section 15101, 15103, 15104 of the California Administrations Code (see attached 3.4) ; 2) Issue a negative declaration which finds that the project will "Not have a significant effect on the environment", and that any potentially significant effects can be mitigated by certain measures". Such a decision is issued on the attached form 3.5; 3) Require that an Environmental Impact Report be prepared for the project if any significant environmental impacts are expected to result from the project.

Assembly Bill 884, whch became law in 1978, imposes strict timelimits upon lead agencies for making the environmental decisions required under CEQA. These time limits are set forth in Title 14, Sections 15054.2 and 15054.3 of the California Administrative Code. They are summarized as follows:

1. Within 45 days after accepting an application as complete, the lead agency must decide whether the project will need an EIR or negative declaration. If this decision is negative, the exemption is granted.

2. Within 105 days a decision on a negative declaration is issued.

3. Within one year a decision on a project for which an environmental impact report was deemed necessary, must be issued.

Well Drilling, Reworking, Abondonment (P Report): Chapter 4 of Division 3 of the California Public Resource Code (Sections 3700 et al) sets forth the State Policy with regard to Geothermal energy operations. Authority is vested in the State Oil and Gas Supervisor to assure that "wells for the discovery and production of geothermal resources be drilled, operated, maintained and

and abandoned in such manner as to safeguard life, health, property and the public welfare, and to encourage maximum economic recovery."

Any person, including any individual, firm, corporation, or other association, intending to drill for or utilize geothermal resources must first obtain a drilling or operating permit from the State Oil and Gas Supervisor. For a detailed definition of Geothermal Energy-Legal Status see the appropriate section of this report.

Prior to drilling, reworking or abandoning a geothermal well in California, a Notice of Intention shall be submitted to the appropriate district office (in this case Long Beach) of the California Division of Oil & Gas and approval received. Such notice is required for prospect wells, development wells, temperature observations wells, low temperature wells and water disposal wells.

The Notice of Intent (see figure 4,1) shall be accompanied by the following:

a) Designation of Agent (figure 4.2)

b) Indemnity or Cash Bond (figure 4.3)

c) An Application Fee

The bonding requirements for a low temperature geothermal well are set forth in Sec. 3725.5 of the California Public Resources Code: "Any person who engages in the drilling, redrilling, maintaining or abandoning of any low temperature well shall file with the supervisor an individual indemnity bond in the sum of two thousand dollars ($2,000) for each well less than 2,000 feet deep, ten thousand dollars ($10,000) for each well 2,000 feet deep or deeper but less than 5,000 feet...."

A blanket 100,000 dollar bond can be filed, if desired, covering operations involving more than one well. In the case of low temperature wells that would not be necessary.

The fee schedule per well as presented in section 1932 of Title 14 of the California Administrative Code is:

a) $25-less that 250'

b) $200 - 250' to 1000'

c) $500 - more than 1000' deep

A low temperature goethermal well is defined in the same code section 1920.1 as a well drilled to discover, evaluate, produce or utilize low-temperature geothermal fluids where the fluids will be used for their heat value".

<u>Exploratory Projects - Environmental Review</u>: If an applicant desires to drill an exploratory well or wells as opposed to a development well, the California Division of Oil & Gas not only issues the drilling permit but also becomes the "lead agency" for compliance with the California Environmental Quality Act (CEQA). See California Public Resources Code, Section 3715.5.

A Geothermal exploratory project is defined in Section 21065.5 of the California Public Resources Code as "a project composed of not more than six (6) wells and associated drilling and testing equipment, whose chief and original purpose is to evaluate the presence and characteristics of geothermal resources prior to commencement of a geothermal field development project as defined in Section 65928.5 of the Government Code: "Wells included within a geothermal exploration project must be located at least one-half mile from geothermal development wells which are capable of producing geothermal resources in commercial quantities."

If the project is exploratory by law the division "shall complete all its responsibilities pursuant to the California Environmental Quality Act, including public and agency review and approval or disapproval of the project, within 135 days of acceptance of a complete application for such project".

In such an exploratory project the applicant must submit a complete project and environmental description to the Sacramento Office of the Division of Oil & Gas before the drilling request NOI is sent to the district office in Long Beach. This procedure for completing the CEQA requirements before submitting the NOI took effect in October 1980. A complete application, pursuant to Section 1683.4 of the California Administrative Code, shall include:

1. A statement declaring that the purpose of the proposed project is to discover or evaluate the presence of geothermal fluid and that the surface location of each well in the project is at least one-half mile from the surface location of an existing well capable of producing geothermal fluid in commercial quantities.

2. The following information in narrative form: A) A description of the project including a regional map showing the location of the proposed well (s) and B)A statement of whether or not the project is compatible with existing zoning and State and local plans as described in the Division's application instructions for gèothermal exploratory projects; C) A description of the environmental setting; D) A description of probable short term and long term environmental effects of the project; E) A description of measures acceptable to the project sponsor which mitigate the project's probable environmental effects; F) A description of any significant adverse environmental impacts which the project sponsor cannot mitigate.

3. A statement that the sponsor agrees to provide additional environmental information the Division may need to complete any environmental documents required by CEQA.

The Division must determine within 30 days of receipt of the application whether or not it is complete and, if so, whether the project will require a Notice of Exemption, a Negative Declaration or an EIR.

The Division usually adheres to the following timetable in issuing a final decision after acceptance of the application:

a) Exemption - 10days

b) Negative Declaration - 30-60 days

c) Environmental Impact Report - 135 days

The Division is currently processing its first low temperature geothermal exploratory project application for the City of Susanville. This should provide an interesting benchmark for how the Division will treat such applications.

The Division has no jurisdiction beyond the drilling site. Therefore other elements of the total project such as distribution lines, heat exchangers and disposal methods (other than wells) should be considered as part of the development project and would require environmental documents from the City as the "lead agency" along the lines indicated previously in Section 3.

The Division evaluates the environmental information submitted by the applicant against the "Environmental Checklist Form". (see form 4.4)

Whether the drilling project is exploratory or development, once the environmental determination has been issued by the appropriate lead agency, the applicant should submit the Notice of Intent to Drill as previously described, Office of the Division of Oil & Gas for a drilling permit. (see form 4.1)

The Division issues its final decision on the project in a "Notice of Determination". (see form 4.5)

If the applicant wishes to rework or abandon an existing well capable of producing geothermal energy in commercial quantities, a "Rework/Supplementary Notice"is filed with the district office. (see form 4.6) No environmental documentation need be filed.

SURETY COMPANIES

$2,000 bonds for low-temperature wells

Fireman's Fund Insurance Co. (John W. Cowley) Walnut Creek,Ca ($20)
Industrial Indemnity Co. (J.F. Teghtmeyer) P.O. Box 80965, San Diego, Ca. ($20)
Insurance Co. of the West (Carolyn Stone) 2565 Camino Del Rio South San Diego, Ca. 92108 ($100)

$5,000 bond

The Ohio Casualty Insurance Co. (John F. Bryan) 350 Sansome St. San Francisco, Ca. 94104 ($25)
United States Fidelity and Guaranty Co., 650 Howe Ave., Sacramento, (916) 929-2741 ($30)

DISCRETIONARY PERMITS CONTINUED:

Water Well Permit: The San Bernardino County Department of Environmental Health Services is empowered to issue a permit for water wells. Specifically their permit requirements cover the extraction or injection of water whether hot or cold. This permit does not apply to geothermal development and injection wells if the California Division of Oil & Gas "explicitly includes" each geothermal development and injection well in its permit. Any hot water injection well not covered in the Division of Oil & Gas as permit must receive a permit from the San Bernardino County Department of Environmental Health Services.

The County Code in these matters has been adopted by the City of San Bernardino by reference and as such the County is responsible for enforcement within the City.

Procedurally there is only a day or two involved in processing at the County. The information presented to the County includes well site, depth, volume of water, quality of water and other well specifics including who will drill the well.

The County will ask the SBVMWD for comments on conformity with the basin management plan and the State Health Department for comments on the domestic water impacts of injection into the specific zone. Assuming there is no degradation of domestic water and no impact on the basin management plan,the County will then issue a permit. Coordinating these comments could take a few weeks.

Therefore once the planning is complete the City Water Department can present the injection well plan to the State Health Department and the SBVMWD for their comments in advance of the application to the County. With these comments available at the time application is made to the County Environmental Health Services Agency the injection well permit should be issued almost immediately.

DISCRETIONAY PERMITS CONTINUED:

Water Quality Discharge Permit: State, Regional, Water Quality Control Boards. There are four ways to dispose of the geothermal water once it has been used. They are:

a) Blend with tertiary/irrigation water

b) Discharge to wastewater treatment plant;

c) Direct discharge to a new point entering a stream or tributary; and

d) Reinjection
   1. Same aquifer
   2. Different aquifer

No Water Quality Discharge Permit is required if the geothermal water is of suitable quality to blend with the tertiary water supply.

No Discharge Permit is required if the geothermal water is blended with the existing wastewater plant effluent provided that there is no significant change in the composition (TDS, salinity, chemicals, etc.) or the quantity of that effluent.

In other words the San Bernardino Wastewater Treatment Plant is already permited to discharge 18 million gallons per day of effluent at 535 ppm TDS into the Santa Ana River. (For effluent limits See figure 5-1). If the addition of geothermal water does not degrade the quality of water leaving the plant i.e. cause the TDS limit to be exceeded then the San Bernardino Water Department need not apply to the Water Quality Control Board for a Water Discharge Permit.

If the standards are projected to be exceeded an Application to Discharge must be filed with the Santa Ana Regional Water Quality Control Board in Riverside, California. Such an application (see form 200 & 200 Appendix figures 5-2, 5-3) contains the following information:

a) Project sponsor
b) Discription of project = location, facilities
c) Type of discharge
d) Quantity of waste
e) Source of Water Supply
f) Environmental Impact Report (Document)

Form 200 must be filed with the Regional Board six months prior to the time such a discharge would begin. The Regional Board then notifies the United States Environmental Protection Agency (EPA). At the end of the six month period a National Pollutant Discharge Elimination System Permit to Discharge can be issued. Such a permit is issued by the Regional Water Quality Control Board on behalf of the E.P.A.

For a permit to discharge directly into a stream or tributary the same procedure outlined above is followed.

If reinjection of the geothermal water is contemplated, the applicant must file Form 200 with the Regional Board to obtain

Waste Discharge Requirements. The information required is the same as indicated above. By statute, the Water Quality Control Board must act on this application within 120 days after receipt of a completed application.

During each of the above permit reviews the County Health Department acts as a consultant but not necessarily a permitting agency to the Santa Ana Regional Water Quality Control Board.

A fee is required at the time application is made to the Regional Board for a Waste Discharge Permit or for Waste Discharge Requirements. (See figure 5-4)

LEGAL STATUS:

The California Public Resources Code defines Geothermal Resources as follows: PRC Section 6903,

> "For the purposes of this chapter Geothermal Resources shall mean the natural heat of the earth, the energy, in whatever form, below the surface of the earth present in, resulting from, or created by, or which may be extracted from such natural heat, and all minerals in solution or other products obtained from naturally heated fluids, brines, associated gases and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas or other hydrocarbon substances."

The Public Resources Code also defines a mineral reservation when state lands are involved as follows: PRC Section 6407, as amended,

> "Mineral deposits reserved to the state shall include all mineral deposits in lands belonging to, or which may become, the property of the state, including but not limited to oil and gas, other gases including but not limited to, non hydrocarbon and geothermal gases, sodium, gold, silver, metals and their compounds, alkali, alkali earth, sand, clay, gravel, salts and mineral waters, uranium, trona and geothermal resources".

The legal right to own, develop and utilize geothermal energy for direct heat purposes is not at all clear. The State of California, as can be seen from the above definitions, treats geothermal resource as the heat of the earth and separately defines mineral deposits as including mineral waters and geothermal resources.

The federal and state courts have ruled in three cases brought by various parties involved in the development of the Geysers Geothermal Steam Field in northern California. These cases all dealt with the issues of ownership of and access to the geothermal resource. These issues necessitated a clarification of the definition of geothermal energy so that the courts could answer the question of resource control.

The questions can be framed as follows:

Is Geothermal Energy a mineral or is it water?

Is Geothermal Energy suis generus i.e., unique unto itself?

Does ownership of the geothermal resource vest with surface owner, mineral; or water rights control and ownership?

Mineral vs. Water Rights:The three guiding California cases are:

1-Pariani vs. The State of California (Final Decision in the California Court of Appeals, May 20, 1980)

2-United States vs. Union Oil Company of California (Final Decision in the 9th Circut Court of Appeals 1977)

3-Geothermal Kinetics, Inc. vs.Union Oil Company of California (Final Decision of the 3rd District Appellate Court).

In short these cases conclude that the geothermal steam resource at the Geysers is distinct from the local groundwater, is in fact chemical laiden and toxic and is utilized similarly to coal, oil or gas and as such is a mineral. Therefore whoever controls/owns the mineral estate controls/owns the geothermal resource. Conversely surface estate owners and those who possess water rights but not mineral rights cannot interfer with the exploration for and extraction of the geothermal resource at the Geysers.

Surface Rights: Rights of the surface owner have been obscured as well but a recent decision memo from the Department of Interior Office of the Solicitor sheds light on the rights of surface owners to protect against encroachment brought on by geothermal development and use as it concerns lands patented under the Stock-Raising Homestead Act of 1916. The memo states "There is nothing in the law that permits a lessee of the government to utilize the surface of the leased area for anything other than the mining or the removal of geothermal resources. Hence, utilization of the lands for greenhouse purposes would not be consistant with the scope of the rights reserved to the United States or its lessees". The....1970....Steam Act..."was never intended to make the surface of the lands subject to a variety of industrial developments without the land owner's consent or without the payment of compensation or other consideration."

To avoid any legal entanglements concerning the development and use of a low temperature geothermal resource the rights to water, surface and mineral should be obtained. Water is included due to the fact that it is not only the transportation medium for the direct heat resource but also is not always chemically distinct from the local groundwater even when heated. It would seem that the greater the chemical difference the greater the argument for definition as a mineral. Likewise the more distinct the sources of water i.e., groundwater at 100' vs. geothermal water at 1,500'.

Low Temperature Geothermal Well: The California Public Resource Code Section 3703.1 defines a low temperature geothermal well as follows: "Low temperature geothermal well means a well drilled in a geothermal resource area for the purpose of producing geothermal resources, as defined in section 6903, from which fluid can be produced which have value by virtue of the heat contained therein and have a temperature that is no more than the boiling point of water at the altitude of occurrence."

PROJECT COORDINATION:

As indicated in the attached Progress Report #2, a number of State Agencies and Federal Programs have been focused on helping San Bernardino determine the extent of its geothermal resource and the technical, financial and legal aspects of its use.

Coulter Stewart & Associates, Inc. has coordinated much of this effort including the onsite visits to San Bernardino of the California Dvision of Mines & Geology and the Geoheat Center of the Oregon Institute of Technology.

FINANCING THE PROJECT

INTRODUCTION

There are potentially a number of public and private options available to finance the San Bernardino Water Departments Wastewater Treatment Plant Geothermal Project. Which option or combination of options proves viable for this project depends upon a number of factors including: project size and cost; availability of money; resource risk; technical risk; value of natural gas displaced; payback ability of the participating party or parties; and project management.

Public funding can come in the form of grants or loans from either the federal or state government. Private funding can come via tax exempt municipal revenue bonds, bank loans or equity investors. This report discusses twelve federal, state and local financing options and their varying levels of viability and applicability to the San Bernardino project. No attempt is made here to anticipate the possibility of funding from any program not now in existance.

The first step taken in identifying viable funding approaches considers an analysis of existing direct heat geothermal projects around the country. In November 1980 the U.S. Department of Energy sponsored a semi annual review in Las Vegas, Nevada of the twenty direct heat projects in progress throughout the United States. A great deal of useful information was presented by each project team concerning their respective projects such as resource information, lessons learned and certain fiscal data. This information was summarized and presented in full to the San Bernardino Water Department by Coulter Stewart & Associates, Inc. in a report on December 1, 1980. The financial information is summarized on the following page. (See chart)

The financial problems surrounding the Boise District Heating Project are very instructional. Their position is therefore presented verbatum from the DOE November 1980 proceedings as follows: "Problem: Our original project was proposed to be about $9.5 million but DOE offered to provide only $4.9 million. This necessitated that the project be cut back and at the same time some additional funds were raised from EDA and the City. The end result was about $5.5 million available to the project. The problem is when preliminary engineering estimates were completed we needed at total of $8.3 million, or $2.8 million more than we had, and the City did not have that kind of funds nor was the City Council, because of the 1% initiative, willing to try raising that amount through bonds or other conventional financial mechanisms available to cities. This problem was further complicated by DOE wishing to cut about $700,000 more out of their original committment."

"Resolution: The Boise Warm Springs Water District committed $625,000 toward the $2.7 million of which they have obligated and spent about $265,000 on new piping. The balance was raised through an LID to serve the CBD mall area ($300,000) and a drilling fund of about $2 million to develop production wells. This resolution has raised the spectre of another problem, i.e. the drilling fund

EXISTING DIRECT HEAT PROJECTS

Location	Total	DOE	%
1. Madison County, Idaho	$3,422,500	$1,677,025	49%
2. Elko	NA	NA	
3. Pagosa Springs, Colo	$1,364,280	$1,111,000	81%
4. Brawley, California	$3,783,895	$3,546,897	94%
5. Warm Springs, Montana	$1,166,755	$ 995,108	85%
6. Sandy, Utah	$ 856,200	$ 478,312	56%
7. Draper, Utah	$ 637,326	$ 458,704	72%
8. Susanville, California*	$2,039,499	$2,011,187	99%
9. Boise City, Idaho	$7,608,300	$4,226,000	55%
10. Reno, Nevada	$ 982,667	NA	
11. El Centro, California	NA	NA	
12. Kelly Hot Springs, Ca.*	$ 514,729	$ 473,303	92%
13. Corsicana, Texas	$1,074,860	$ 861,650	80%
14. Klamath Falls, Oregon	$2,331,769	$1,547,183	66%
15. Marlin, Texas	$ 593,550	$ 466,820	79%
16. Philips, South Dakota	$1,205,804	$ 936,199	78%
17. Haskou County, South D.	$ 403,098	$ 250,925	62%
18. Pierre, South Dakota	$ 718,000	$ 538,500	75%
19. Klamath Falls, Oregon	$ 267,254	$ 209,000	78%
20. Dos Palmas, California	$ 575,266	$ 363,000	63%

* Both of these projects are in the California 1st Congressional District which until January 1981, was represented by the Chairman of the House Public Works Committee.

being private capital will increase the price per therm of delivered energy even though it enjoys the benefit of assuming total risk of failure in drilling for water of the right temperature and quantity. The proposed cut of $700,000 in DOE funds is not yet resolved."

It is interesting to note that of the twenty existing projects, seventeen of which provide useful financial information, the average Department of Energy committed share of that funding is 75%. Six projects are below 70% and six projects are above 80% in DOE share. This would indicate a high reliance by the project sponsors be they private or public entities upon direct financial support from the U.S. Department of Energy. The critical question raised by this point centers around the issue of continued availability of federal Department of Energy funds to support direct heat geothermal energy projects.

Uncertainty over existing DOE funding comes at a time when the State of California has taken steps to increase the availability of public and private funds for alternative energy, including geothermal direct heat. Two Revenue Bond Authority Acts, and two special energy lease revenue distribution funds provide possible sources of funds for the San Bernardino Wastewater Treatment Project. The various programs, including local financing, are discussed below.

DEPARTMENT OF ENERGY PROGRAMS

INTRODUCTION

The United States Department of Energy has been actively supporting the development of geothermal energy for several years. During that time a number of programs have been developed for use by a project sponsor at every phase of a project.

There are technical assistance programs for resource identification and prefeasibility, loan programs for detailed feasibility, resource confirmation and construction, and the geothermal loan guarantee program.

San Bernardino is taking advantage of the technical assistance programs and the detailed feasibility program. They are not in a position to yet utilize the GLGP and the Office of Management and Budget has withdrawn funding from the resource and construction loan programs.

<u>Drilling Loan Program</u>: The Energy Security Act of 1980 authorized $5 million for this program which would have been used for 90% loans to reservoir confirmation drilling projects. With these funds removed in fall 1980, it is now up to the Reagan Administration or Congress to put them back.

<u>User Coupled Confirmation Drilling Program</u>: This program is competitive and involves a sliding % of cost sharing by the Department of Energy and the applicant depending upon project success. The minimum reimbursement is 20% and the maximum (in the event of total project failure) is 90%. The proponent pays all costs and

is reimbursed by the DOE for the appropriate %. This program attempts to "share the risk" of reservoir confirmation and development well siting. One solicitation has already been held under this program and a second solicitation has been tabled. This program seems designed for private sector applicants who can accept some risk of project failure.

Feasibility Study Loans (Construction Loans): The Energy Security Act, 1980 also authorized and appropriated $5 million for feasibility study loans for geothermal direct heat projects. These loans could have been for 90% of the total cost of studying the feasibility of a direct heat project. These funds have also been withdrawn by the Office of Management and Budget. The Department of Energy is appealing the decision.

The Energy Security Act also authorized a Construction Loan Program for direct heat projects but no money has been authorized for this program.

DOE/HUD: The Department of Energy has transfered some money to the Department of Housing and Urban Development to enable local governments to perform prefeasibility studies for district heating systems regardless of heat source. A second solicitation, due in February 1981, will allow design work on similar district heating systems.

It is anticipated that these two programs would work into either the HUD Innovative Grant Program or the Urban Development Action Grant Program described below.

Urban Development Action Grants: The U.S. Department of Housing and Urban Development gives an alternative energy priority to qualifying cities in applying for certain grants under the Urban Development Action Grant Program.

This program enables a qualifying local government to apply for a grant which will then be used to cover up to 25% of the total irrevocably committed capital dollars of a project. A project is defined as one undertaken by the private sector which will positively affect the economic base, tax base and employment base of the given impacted community.

Assuming the application is successful the City then loans the money to the private entity at a flexible rate of interest and payback period. These two items are varied to achieve project profitability.

The total application process takes about 6 months.

Innovative Grant Program: This HUD grant program involves a cost share on the part of the local government and is intended for use where innovative concepts and methods are being implemented on a demonstration project basis. Such a project should be unique and untried or involved with special circumstances. The results of the project should be transferable to other impacted communities and able to meet common Community Development needs.

Both the UDAG and Innovative Grant Programs are applied for through the local government entity.

STATE OF CALIFORNIA OPTIONS

ASSEMBLY BILL 2973 (Tideland Oil Revenues): In 1980 the legislature enacted this measure which allocates the States Tideland Oil Revenues among certain programs. One new program, the Energy and Resources Fund, is authorized to receive $120,000,000.

The monies from this fund are to be allocated each year in the annual budget bill. Monies can be spent on certain energy projects from an Energy Account which will terminate December 31, 1981 unless an Energy Department is created or the State Energy Commission has been reorganized by the legislature or governor (PRC Sec 6217 (g)). In any event the money reverts to the General Fund in 1984 unless the Energy Fund is extended by specific action in the Budget Act and by statute.

Both the Energy Account and the Resources Account of the Energy Resources Fund are applicable to geothermal energy projects. The statutory criteria which guides allocations from the Energy Account for energy projects are (PRC Sec 26401 (e)(1)(2)(3)):

"(1) Have the greatest potential for reducing the use of oil and natural gas to produce energy.
(2) Have the greatest potential for transferability and widespread use throughout the state by the year 1990.
(3) Have the highest degree of feasibility"

From the Resources Account (PRC Sec. 26403 (17)):

"(17) Programs for geothermal resources assessment".

It is further the intent of the legislature that "the funds from the Energy and Resources Fund be used only for short term projects and not for any ongoing programs". (PRC Sec 26401 (b).

If in any given year there are funds unallocated in this account they can be accessed with special urgency legislation if such action is taken prior to their reverting back to the General Fund or rolling forward to the next fiscal year. As the State budget crisis worsens, however, such special requests will face stiff competition.

ASSEMBLY BILL 1905 (BLM Lease Revenues): This piece of legislation was signed by Governor Brown as an urgency measure on May 30,1980. This law provides for the distribution of certain state revenues received by the State Controller from the State's share of royalty and bonus payments derived from BLM leases of geothermal rights to private operators at the Geysers, California. The legislation sets forth a formula and establishes general criteria for allocating these revenues among counties of origin and two state agencies- The Energy Commission and the Resources Agency.

The amount of money involved has been estimated at $9 million but as yet the State Controller and the BLM have not been able to separate the Geothermal Lease revenues from other mineral rights revenues involving BLM leases. The money if and when it is allocated will be distributed 40% to counties of origin (eg Sonoma,Lake and Mendocino Counties) and 30% each to the Resources Agency and Energy Commission. The Resources Agency will allocate the money from a special fund in the annual budget. The Energy Commission is required to distribute the money in the form of "grants to local jurisdictions having geothermal resources." (Sec. 3822, PRC Div 3 Chapt. 6).

These monies are to be allocated over a 5 year period or roughly $2 million each year through 1985/86. On this basis the Energy Commission would have about $700,000 available each year for 5 years.

The following criteria govern the distribution of grant funds by the Energy Commission: (Sec. 3823, PRC):

"(a) With respect to any local jurisdiction in which development of geothermal resources is contemplated, the revenues shall be expended for the following planning activities:

(1) Resources assessment and exploration technology.
(2) Local and regional planning and policy development and implementation necessary for compliance with programs required by local, state or federal laws and regulations.
(3) Identification of feasible measures that will mitigate the adverse impacts of the development of geothermal resources and the adoption of ordinances, regulations and guidelines to implement such measures.
(4) Collecting baseline data and conducting environmental monitoring.
(5) Preparation or revision of geothermal resource elements, or geothermal components of energy elements, for inclusion in the local general plan, zoning and other ordinances and related planning and environmental documents.

(b) With respect to any local jurisdiction in which geothermal resources are being developed or are in production, the revenues shall be expended for the following activities:

(1) Administrative costs incurred by the local jurisdiction that are attributable to the development or production of geothermal resources.
(2) Monitoring and inspecting geothermal facilities and related activities to assure compliance with applicable laws, regulations and ordinances.
(3) Identifying, researching and implementing feasible measures that will mitigate the adverse impacts of such development or production.
(4) Planning, constructing, providing, operating, and maintaining those public services and facilities that are necessitated by and result from such development or production.
(5) Undertaking projects demonstrating the technical and economic feasibility of geothermal direct heat and electrical generation applications.
(6) Undertaking projects for the enhancement, restoration, or preservation of natural resources, includ-

ing, but not limited to, water development, water quality improvement, fisheries enhancement, and park and recreation facilities and areas."

Presumable the grant monies available to the Energy Commission will be awarded on a competitive basis for proposals submitted in response to requests for proposals under criteria to be developed in the Spring of 1981.

<u>ASSEMBLY BILL 2324</u> (California Alternative Energy Source Financing Authority Act): The California Alternative Energy Source Financing Authority was created in 1980 to provide the state with an alternative method of financing projects which utilize certain alternative sources of energy as defined. Geothermal energy projects are eligible to utilize the Authority.

The California Alternative Energy Financing Authority is authorized by the legislature to issue up to $200,000,000 in bonds, notes and bond anticipation notes to finance alternative energy projects. The bonds are tax exempt revenue bonds not backed by the full faith and credit or taxing power of the state, but rather by the general revenues of the Authority unless otherwise specified in the bond resolution.

The typical participating entity (project sponsor) would approach the Authority with a project and funding request. The Authority would obtain a ruling from Bond Counsel and/or the IRS on the tax exempt status. The Authority would then sell the bonds, which are backed ultimately by the project revenues and project sponsor (participating party). The Authority then typically will loan the proceeds from the bond sale to the participating party to carry out the project. The Authority can also contract with the participating party to construct or develop a project which the Authority would own until such time as the bonds are redeemed.

A participating party is defined as "any person, company, corporation, partnership, firm or other entity or group of entities engaged in operations within this state which requires financing pursuant to the terms of this division to aid and assist in the promotion of alternative energy sources in the state" (PRC Sec 26003 (c).

Both the State Treasures Office and Bond Counsel have indicated that a question exists as to whether the San Bernardino Water Department could qualify as a participating party and could use energy cost savings as project revenues to make the necessary payments to principal and interest and other charges. See PRC Sec 26003(c) & Sec 26022(d)(1). A ruling from the State Attorney General on this point, has been requested.

Special provisions allow for small projects (those under $1 million) to be aggregated into one larger issue, say $10 million. If this approach were used additional time would be spent waiting for other projects to develop.

The Authority itself is composed of the State Treasurer (Chairman), State Finance Director, State Controller, Chairman of the Energy Commission and Chairman of the Public Utilities Commission. The Authority is required to "take final action to approve or disapprove of the issuance of bonds or notes to lend financial assistance to participating parties within 60 days of the receipt by the Authority of a request from such participating party for such action." It would seem that if everything goes smoothly, assuming three months to sell the bonds, project finance money should be available about six months after application is made to the Authority.

A cursory review of tax status rulings to date would indicate that a geothermal project which distributes hot water to customers, at least 75% of which are public entities, would qualify for the tax exempt bond status. An independent ruling would be required to assure such a finding. In addition, the small size of the project may assure eligibility.

LOCAL OPTIONS

BANKS: If the project were small enough it is conceivable that the above ground equipment could be financed in cooperation with a bank through a lease back of the equipment, to the Water Board until such time as the equipment is paid off by the Sewer Fund at which point it would revert to the Water Board. This method could finance the pumps and heat exchangers.

The remainder of the equipment could then be financed directly from the sewer fund as a standard capital improvement project. Thus expenditures for the wells and piping (subsurface activities) would be carried as an asset of the department and would be set up on the books as a separate line item.

This course of action would be advisable if all the variables were fixed, each risk,both technical and institutional, were eliminated and financial requirements were thus minimized.

GEOTHERMAL LOAN GUARANTEE PROGRAM (GLGP): If a bank becomes involved in the project and the bank wishes to make use of the Federal Geothermal Loan Guarantee Program, this should be explored. The GLGP is part of the U.S. Department of Energy and can guarantee private loans made for geothermal projects. They can guarantee up to 90% of a loan made to a municipality. There may be a way to prop up a lease back with this program. Usually however, the GLGP only gets involved in large (over $10 million) projects involving private parties. Like the user coupled confirmation drilling program the GLGP is more suited to privately sponsored projects.

AB74 (California Industrial Development Financing Act): Certain cities and counties in California can now issued their own local tax exempt industrial development revenue bonds to assist local industry and energy projects pursuant to legislation passed in 1980. One study A Blueprint for Financing Geothermal District Heating in California. . . . . A Discussion Draft says "Only Charter cities can issue revenue bonds for direct heat geothermal development."

A bond counsel memorandum entitled "Summary of Industrial Development Financing in California Under AB74" states the local "industrial development authorities are expected to function purely as conduit financing vehicles with no management or other responsibilities with respect to the projects financed." The governing body may declare itself or appoint the board of directors of the Authority..." Such an Authority would function like other limited purpose local agencies created by state law such as parking authorities, housing authorities and redevelopment authorities but without the additional responsibilities of such agencies.

In passing the California Industrial Development Act of 1980 the legislature "finds that the alternative method of financing provided in this title will benefit economically distressed areas of the state and localities which are making diligent efforts to maintain and provide services to existing companies and to prevent the loss of existing jobs." "This method of financing..... will benefit those projects which are partially funded by a job creation grant from the U.S. Department of Labor, Housing and Urban Development or Economic Development Administration..." (Govt. Code Title 10, Sec. 91501).

The Legislature sets forth the criteria to be utilized in determining whether this financing method can be utilized in sections 91502.1 and 91503 of the Government Code.

In short projects must offer employment benefits, energy or other resources utilization benefits and consumer benefits. Eligible activities are industrial uses including assemblying, fabricating, manufacturing or processing activities with respect to any products of agriculture, forestry, mining or manufacture. Energy activities are development, production, collection, conversion, storage, conservation, transmission, transportation or conveyance but <u>not</u> distribution. Many activities are specifically excluded except sewage or solid waste disposal activities "if the property acquired is suitable for one or more of the activities described" above. (Calif. Govt. Code Sec. 91503(a)(b).

Therefore it would appear that if the City of San Bernardino created an Industrial Development Authority which meets the guidelines of AB74 as far as energy projects are concerned, a private company working with the Water Department could carry out the entire project with tax exempt bond financing as long as distribution were not involved. It should be noted that the City has the capability to issue industrial development bonds now but may need to amend its ordinance to incorporate the energy elements of AB74.

Some question may arise on just where transmission stops and distribution begins. Another question would be whether energy conversion includes heat exchangers. A company is defined as "a person, partnership, corporation whether for profit or not, trust, or other private enterprise of whatever legal form for which a project is undertaken or proposal to be undertaken pursuant to this title or which is in possession of property owned by an authority, and may include more than a single enterprise." (Calif. Government Code Sec. 91503(g).

However if Industrial Development Bonds are used for wells and transmission pipelines and a bank lease purchase is used for the heat exchanger retrofit that leaves only the distribution line (if any) for internal sewer fund financing. It should be noted the project must be located wholly within the political boundaries of the Industrial Development Authority , be it City, City-County or County. In addition there are company liquidity, company size and project size specifications.

Unfortunately as the California Industrial Development Financing Act (AB74) is now written public agencies such as municipal utilities cannot apply directly to the local Industrial Development Authority. The act could be amended to allow special districts and municipal utilities to take direct advantage but the original proponents of the bill are not yet receptive to such an idea.

PRIVATE PARTIES: If a private party becomes involved in certain phases of project development one or more federal tax incentives may be available to the private party. Geothermal projects are eligible for the 25% combined business (10%) and alternative energy (15%) tax credit; the current expensing of intangible drilling costs such as site preparation, drilling overhead, construction, etc.; and depletion allowances. These incentives can substantially affect the desireability of private participation in a geothermal project. If a public entity owns the resources and develops the entire project, these benefits are unutilized.

ADDITIONAL CONSIDERATIONS

PROJECT SIZE: Project size can affect the choice of financing options significantly,assuming that all other factors are controlled. If, for example, the total cost is $200,000 and $40,000 per year in natural gas costs are avoided, the payback on capital (not including interest and O&M) would be five years. Keeping the initial project small could well improve the overall chances for a successful demonstration of direct heat applications of geothermal energy at the San Bernardino Wastewater Treatment Plant.

GAS PRICE ANALYSIS AND PROJECTION TO 1985: A key factor in the financing decision is the prospective price of natural gas, which is now used to heat the digesters at the Wastewater Treatment Plant. This special Gas Price Analysis and Projection to 1985 has been prepared by Coulter H. Stewart specifically for the San Bernardino Wastewater Treatment Plant Geothermal Feasibility Study Project.

The following charts and discussion present an assessment of current and future natural gas prices under various assumptions and their anticipated impact on the San Bernardino Wastewater Treatment Plant Geothermal Project.

(See chart on following page)

PRESENT DELIVERED PRICES FEBRUARY 1, 1981

Priority	PG&E	Socal
1 - Lifeline	$3.07	$3.11
Average	3.88	3.43
2 -	4.46	3.57
3 & 4 Residual oil	4.29	3.50
Middle distillates	4.58	3.80
5	4.04	3.50

PRESENT SOURCE AND WELL HEAD PRICE OF CALIFORNIA GAS

Sources		Percentage	Price
California		15%	$2.50
Canada		20%	4.94(April 1, 1981)
Southwest	102	10%	2.67
	103	2%	6.00-7.00
	Old	53%	1.00

At the present time all natural gas consummed in California, except the 103 gas and the Canadian gas, is still under some form of price control subject to annual price adjustments for inflation plus an additional inflator. This ranges from 8-9% per year to 12-13% per year depending on the category.

Natural Gas prices are scheduled to be completely decontrolled in January 1985. The current decontrolled price is roughly $6.00 per million BTU or slightly less than the average equivalent price of oil to the refinery. Thus if natural gas prices are decontrolled before 1985 one would expect the price to rise toward the world price of oil.

In 1985, 40% of California's gas supply will still be under contracts signed before April 1977 and unless specifically decontolled, will remain low priced (i.e. $1.00 1980 plus 9%/year). All prices are figured on a basis of per million BTU.

Assuming 1985 decontrol,Southern California Gas Company will thus be faced with 50% of its gas still price controlled at about $1.70 and 50% of its gas uncontrolled at or close to the then world oil price. Assuming a modest 15% price rise per year above the existing average $36/barrel world oil price, the 1985 price should be $63/barrel in 1985 dollars or just over $10 million BTU.

Thus the average price paid for natural gas on the Socal system for a commercial user should be .5 x $10.00 + .5 x $1.70 = $5.85/million BTU plus $1.00/million BTU for distribution for a total rolled in retail price of $6.85 per million BTU or 68¢ per therm. The sooner the price of natural gas is decontrolled, the faster this price will be achieved. If old gas is also decontrolled, the price will track that of world oil immediately upon removal. By 1990 the gas price will have increased 400% to over $14/million BTU as old contracts are depleted.

If the Socal gas mix is 40% old gas and 60% decontrolled in 1985, the rolled in retail price would be .6 x $10 + .4 x $1.70 = $6.68 plus $1.00 for transmission and distribution or $7.68/million BTU's or 76¢ per therm. One therm - 1x10^5BTU's.

The San Bernardino Wastewater Treatment plant boilers will use 5.5 billion BTU's of natural gas per year. At today's price of 38¢ per therm, the cost for that gas is $20,900. At 68¢ or 76¢ per therm, the cost will be between $37,400 and $42,240 in 1985. If the entire amount of natural gas used to heat the boilers can be backed out, the cost savings to the Water Department in 1985 dollars will be $37,400-$42,240 per year. This cost savings could be used to finance any debt requirements incurred by the project.

The foregoing analysis does not take into account such external price factors as sudden cut off in a major portion of domestic oil supplies from OPEC countries or a dramatic break in the world oil price. Since U.S. oil imports from OPEC nations are on the decline, vulnerability to this threat should lessen.

SUMMARY

At the present time, the only federal programs with money already authorized and appropriated are the Department of Energy Geothermal Loan Guarantee Program, the Department of Housing and Urban Development (HUD) Innovative Grant Program and the HUD Urban Development Action Grant Program. The loan guarantee program is relevant if private participation is involved. If not, the two HUD programs should be explored. The Water Department can ask the City Department of Community Development to submit an unsolicited proposal to HUD under the Innovative Grant Program to see if HUD will issue such a grant. The UDAG program can be applied for quarterly beginning January 31st. Each such application is treated separately and can be prepared and presented through the City Department of Community Development.

If the City uses a UDAG grant in conjunction with an Industrial Development Authority pursuant to the California Industrial Development Authority Act, 1980, the total project bonding limit can rise to $20 million and maintain the tax exempt status.

The only fully operational state funds at the moment are the Energy Account and Resources Account of the Energy and Resources Fund. If time is of the essence to the San Bernardino Water Department a budget change proposal or special legislation should be introduced now to access this years unencumbered balance. Failing that an amendment should be proposed to the budget bill to incorporate the project in the coming fiscal year.

The Energy Commission and the Resources Agency should have annually about $700,000 a piece under the Bosco Bill to allocate sometime after the Spring of 1981. This assumes the State Controller releases the BLM lease revenues, the date for which at this writing is uncertain. In any case, given the limited funds available and the multitude of potential uses this source is questionable.

If the project were funded from a variety of sources combining UDAG (25%) and City Sewer Fund (25%) then the Bosco Bill Energy Fund could be competitively bid for the remaining 50% for project administration, permitting, public works and exploration activities. However the more complicated and numerous the funding sources, the harder it is to keep any project on a consistant and coherent schedule and hence the greater the likelihood of delays and cost overuns.

The California Alternative Energy Source Financing Authority which was authorized on January 1, 1981, should be operational by April or May of 1981. This Authority should be approached for answers to any questions concerning the eligibility of the San Bernardino Project to benefit from Revenue bond financing through the Authority.

This project is a good one from the standpoint of risk and ability to pay and hence this option should be pursued if the Energy and Resources Fund dries up.

Serious thought should also be given locally to the establishment of an Industrial Development Authority which could be further restricted to alternative energy projects. In this case either the Act should be amended to allow certain public agencies to be project sponsors or the Water Department should consider working with a private company to develop and lease back the project. In this way a whole range of tax incentives can be realized. Company size limitations may prove excessive however and therefore should be investigated thoroughly.

Both the California Authority and the Local Authority would simplify the funding source dilemma and provide greater local controls as would the availability of State Energy Resource Fund monies.

SOCIAL ISSUES

The Wastewater Treatment Plant Geothermal Project poses only one major social issue - Public Awareness and Acceptance. Therefore this section will concentrate on a Public Awareness Program that can be implemented in San Bernardino.

The project itself is small enough so as to not have any significant impact upon employment, taxes, public services or the need for social service support programs. Rates for sewer service, however, could be affected if anticipated energy cost savings are realized and passed through to the consumer.

PUBLIC AWARENESS PROGRAM: The San Bernardino Water Department has an opportunity to greatly impact the public awareness of geothermal energy. Since most residents of the Inland Empire probably think geothermal energy is something remote from their sphere of reference both geographically and functionally, a properly designed program can go a long way towards demystifying geothermal energy and making it relevant to the local citizenry.

By citing it's historical use in San Bernardino at Urbita, Harlem and Arrowhead Hot Springs, Baseline Laundry and the Colton Plunge, San Bernardino can lay the foundation for a full discussion of possible end uses for commercial, industrial and residential purposes.

Such a program should include a multi-media approach, be operated by local Water Department or city staff, where ever possible, and be implemented through as many public forums as possible to achieve maximum citizen coverage.

A listing of primary goals and objectives can include the following:

Public Awareness Program

A - Program Goals:
- 1 - Educate the greatest number of local residents about the availability and usefulness of geothermal energy
- 2 - Educate the project area residents and business operators about the importance of the specific wastewater treatment plant geothermal project

B - Program Objectives:
- 1 - Utilize multi-media approach to present educational material
- 2 - Utilize local staff to present briefings, talks, displays etc. concerning geothermal energy and the wastewater treatment plant project
- 3 - Utilize diverse public and media forums to present the educational material

PROGRAM DESCRIPTION: There is a great deal of geothermal information available in a variety of forms which can be made available to San Bernardino. A number of private companies and public agencies have produced films on the application of geothermal energy for both electric and direct heat purposes. While San Bernardino is unique in the country in proposing to use geothermal energy to heat the digesters at the Wastewater Treatment Plant, films which present the ways in which geothermal energy is being used for either direct heat or electric purposes elsewhere in California, Nevada, Oregon, Idaho, Mexico, Japan, Iceland, the Phillipines and New Zealand exist and would be very educational.

Such films could be presented as special energy programs in meetings of local civic groups like the League of Women Voters, Kiwanis, Rotary, Inland Action, Chamber of Commerce and others. Perhaps the Water Board would like to sponsor a special meeting for local elected and appointed officials and other interested parties.

The local cable television stations should be encouraged to run special educational shows including a film with a brief discussion of the San Bernardino Project afterward.

Such efforts could be enhanced by both pre and post publicity in the form of newsletter items, meeting announcements, press releases or general news stories in all the local daily and weekly newspapers and radio stations.

Talk shows and special interviews can be held on the local radio stations in both Spanish and English to emphasize the project and the geothermal energy source available to San Bernardino.

Local staff from city departments, including the Water Department, and any existing public relations personnel should be trained to handle the presentation of information under this program. Five city and Water Department employees can be provided with an orientation and background material on geothermal energy and the San Bernardino project. These persons could then rotate the responsibility for presenting the Geothermal Awareness Program to the groups and through the forums described herein.

Individual films are available from the Argonne National Labs (direct heat), the State Department of Water Resources, the Natomas Company (Geysers, world wide and direct heat), Union Oil Company (technical), JETRO (the Japanese Trade Organization), Mitsubishi International Corp, Pacific Gas and Electric Company, Phillips Petroleum Co., Lawrence Livermore Laboratory (Imperial Valley), and the Geothermal Resources Council (direct heat).

Other information materials in the form of slides, charts, graphs, reports and booklets are available from the Idaho National Energy Laboratories & EGG in Idaho, the Geoheat Center at the Oregon Institute of Technology and Union Oil Company.

PROGRAM CONTENT: Any Geothermal Public Awareness Program should at a minimum contain information on the historical use of geothermal energy locally in the San Bernardino area; the nature of the geothermal resource, including system controls either fault or magma; the technology for developing and utilizing the resource; the various ways in which the resource is being used and can provide useful heat or electric energy; the various places around the world that are currently using geothermal energy; the environmental and other technical issues involved in large vs. small scale use of geothermal resources; and the specifics of energy cost tradeoffs between fossil fuels and geothermal energy.

PROGRAM TIMING*:

Task	Duration	Month
1 - Final Design and Buy Off	1 month	February
2 - Training Personnel	1 month	March
3 - Arrange Calendar	2 weeks	April
4 - Make Presentation	3 months	April-June
Totals	5.5 months	Feb.-July

*Conceiveably items 1 and 2 could be shortened to two weeks each thereby dropping the project duration to 4.5 months which would enable it to be implemented before summer vacation. Likewise the program could be run in the fall of 1981 with tasks 1 & 2 & 3 completed in the Spring and Summer. Thus only 3.0 months for Presentations would be required. Press related activities could go forward at any point.

<u>SUMMARY</u>: In the event that public funding is not made available to cover the capital costs of developing geothermal energy in San Bernardino such a public awareness program would be crucial in building support for local remedies such as the use of General Obligation Bonds, the Industrial Development Authority Revenue Bonds or department funds.

REFERENCES

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3- Pariani vs. The State of California-Final Decision in the California Court of Appeals, May 20, 1980.

4- The United States vs. Union Oil Company of California-Final Decision in the 9th Circut Court of Appeals, 1977.

5- Geothermal Kinetics, Inc. vs. Union Oil Company of California Final Decision of the 3rd District Appellate Court.

6- Memorandum June 4,1980-United States Department of the Interior-Office of the Solicitor, Robert D. Conover.

7- California Laws for Conservation of Geothermal Resources, State of California, Resources Agency.

8- Drilling and Operating Geothermal Wells in California. California Division of Oil & Gas

9- The California Public Utilities Code.

10-Geothermal Direct Heat Applications Program Summary, November 1980, U.S. Department of Energy.

11-United States Department of Energy-SAN Office. December 1980., January 1981.

12-City of San Bernardino Department of Community Development. December, 1980.

13-Fundamentals of Municipal Bonds, Investment Bankers Association of America, January 1969.

14-Chapter 908, Statutes of California, 1980. The California Alternative Energy Source Financing Authority Act-AB2324.

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16-Summary of Industrial Development Financing in California Under AB74, Orrick, Herrington & Sutcliffe, 1980.

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18-Chapter 899, California Statutes of 1980, Energy & Resources Fund.

19-Report on AB 1905-Distribution of BLM Geothermal Revenues, Van Horn, Robert F., July 30, 1980.

20-Chapter 139, Statutes of California 1980, AB 1905

21-"A Blueprint for Financing Geothermal District Heating in California....A Division Draft, Hansen, Derek and Associates, Inc., October, 1980.

22-Staff Members of: The San Bernardino Water Department
Department of Community Development
The Planning Department
California Legislature
California Public Utilities Commission
California Energy Commission
Members of the California Legislature
California Pollution Control Financing Authority
State Treasurers Office
Division of Oil & Gas
Division of Mines and Geology
San Bernardino County Environmental Health Services Department
The Santa Ana Regional Water Quality Control Board

ATTACHMENTS

15101. Class 1: Existing Facilities.

Class 1 consists of the operation, repair, maintenance or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of use beyond that previously existing: including but not limited to:

(a) Interior or exterior alterations involving such things as interior partitions, plumbing, and electrical conveyances;

(b) Existing facilities of both investor and publicly owned utilities used to provide electric power, natural gas, sewerage, or other public utility services;

15102. Class 2: Replacement or Reconstruction.

Class 2 consists of replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced, including but not limited to:

(c) Replacement or reconstruction of existing utility systems and/or facilities involving negligible or no expansion of capacity.

15103. Class 3: New Construction or Conversion of Small Structures.

Class 3 consists of construction and location of limited numbers of new, small facilities or structures; installation of small new equipment and facilities in small structures; and the conversion of existing small structures from one use to another where only minor modifications are made in the exterior of the structure. The numbers of structures described in this section are the maximum allowable within a two year period. Examples of this exemption include but are not limited to:

(d) Water main, sewage, electrical, gas and other utility extensions of reasonable length to serve such construction.

Figure 3.5

ENVIRONMENTAL REVIEW COMMITTEE
OF THE
CITY OF SAN BERNARDINO, CALIFORNIA

300 North "D" Street, City Hall
San Bernardino, California

NEGATIVE DECLARATION

_______________ 19 _____

Clerk of the Board of Supervisors
175 West 5th Street
San Bernardino, CA 92415

The Environmental Review Committee of the City of San Bernardino, California, reviewed the hereinafter described development at its meeting of ____________ ________________ and found that on the basis of the initial study the project will not have a significant effect on the environment.

PROJECT NAME:
LOCATION AND NAME OF DEVELOPER AND/OR DEVELOPMENT:
PROJECT DESCRIPTION:
MITIGATION MEASURES, IF ANY, TO AVOID POTENTIALLY SIGNIFICANT EFFECTS:

A copy of the initial study for this project is attached hereto and by reference made a part thereof.

ENVIRONMENTAL REVIEW COMMITTEE OF THE
CITY OF SAN BERNARDINO, CALIFORNIA

____
Secretary

Form OGG105 (1/80)

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS

Figure 4.1

Notice of Intention to Drill a Geothermal Resources Well

(SUBMIT IN DUPLICATE)

Operator	Well Designation				
Field	County	Sec.	T.	R.	B.&M
Name *(Person submitting report – print or type)*	Street Address				
Title *(Agent or officer of company)*	City	State	Zip Code		

Signature ______________________ Date __________ Telephone Number __________

The appropriate drilling fee, an indemnity or cash bond, a complete drilling program, and a parcel map showing the operator's surface rights, mineral rights, and the location of the proposed well must accompany this notice.

Location of well: ________ meters ________ *(Direction)* along section/property line, and ________ meters ________ *(Direction)* at right angles to said line from the ________ corner of section/property *(Cross out one)* ________ or ______________.

Elevation of prepared site above/below sea level: ________ meters. *(Cross out one)*

Is the surface location or intended productive interval within 100 feet of property boundary? yes [ ] no [ ]

If well is to be directionally drilled, show proposed coordinates (from surface location) at total depth:

________ meters ________ *(Direction)* and ________ meters ________ *(Direction)*.

PROPOSED CASING PROGRAM

All depth measurements taken from top of ______________ *(Derrick Floor, Rotary Table, or Kelly Bushing)* that is ________ meters above ground.

SIZE OF CASING CM API	WEIGHT (Kg)	GRADE AND TYPE	NEW OR USED	TOP OF CASING (m)	SIZE OF HOLE (cm)	VOLUME OF CEMENT (m³)	CEMENTING DEPTHS	CALCULATED FILL BEHIND CASING

Intended zone(s) of completion: ______________ *(Name, depth, and expected pressure)*. Estimated total depth: ________ meters.

ENVIRONMENTAL INFORMATION

(SEE REVERSE SIDE)

If a governmental agency has prepared an environmental document, please submit a copy of the document with this notice *or* supply the following information:

Government Agency: ______________ Contact Person: ______________

Address: ______________ Phone: ( ) ______________

Document title: ______________ S.C.H. No.: ______________

Submitted in compliance with Section 3724, Division 3, Chapter 4, Public Resources Code.

ENVIRONMENTAL INFORMATION

The California Environmental Quality Act (CEQA) applies to the project described in the information on the front of the notice if the project could have a significant impact on the environment. To approve a project subject to CEQA, the Division of Oil and Gas must consider the need for either a Notice of Exemption, a negative declaration, or a final environmental impact report If none of these documents exists or if an operator is seeking approval for a project involving six (6) or fewer exploratory wells (including temperature observation wells), the operator shall contact the Division of Oil and Gas CEQA Unit as soon as possible The phone number is (916) 445-9686. The address is 1416 Ninth Street, Room 1316-35, Sacramento, California 98514.

FOR DIVISION USE ONLY

API WELL NO. ____________________

MAP	MAP BOOK	CARDS	FEE	BOND	FORMS		GEP #	EXEMPT ☐ NEG. DEC. ☐ E.I.R. ☐
					OGG114	OGG121	(14 SP)	CLASS____ SCH. NO.____

Figure 4.2

STATE OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS
1416 NINTH STREET, ROOM 1316, SACRAMENTO 95814

DESIGNATION OF AGENT FOR INDIVIDUAL OR PARTNERSHIP

In compliance with Section 3721, Division 3, Public Resources Code, notice is hereby given and.................. (I, we)

hereby certify that........................ (I, we) ____

of.., State of.., have appointed, authorized and

empowered ____

whose address is.. (Postal Address) (City) (Zip Code),

State of California, as...................... (my, our) agent for the State of California* ______________________

upon whom all orders, notices and processes under the provisions of said act may be served.

This notice revokes all former appointments made for said purpose.

In Witness Whereof...................... (I, we) have signed this certificate this..............day of..............................19......

____
(Name and Title)

____
(Signature)

Witness:

____
(Signature)

Agents acceptance:

Accepted ______________________________
(Signature)

Sec. 3721. Every owner or operator of any well shall designate an agent, giving his post office address, who resides in this State, upon whom may be served all orders, notices, and processes of the supervisor, a board, or any court of law. Every person so appointing an agent shall, within five days after the termination of any such agency, notify the supervisor, in writing, of such termination, and unless operations are discontinued, shall appoint a new agent.

Note: An operator may appoint himself as agent.

* Should the owner or operator filing this form choose to appoint more than one agent, the phrase, "the State of California," should be deleted and the exact area for which the agent is to be appointed should be inserted. A separate form must be filed for each agent.

Figure 4.3 A

STATE OF CALIFORNIA BOND NO. ....

INDIVIDUAL GEOTHERMAL RESOURCES WELL INDEMNITY BOND

(SEE INSTRUCTIONS ON REVERSE SIDE FOR APPLICABLE AMOUNT)

Know All Men by These Presents:

WE

That I,

as principal, and a corporation

organized and existing under and by virtue of the laws of the STATE OF
and authorized to transact surety business in the STATE OF CALIFORNIA, as surety, are held and firmly bound unto the STATE OF CALIFORNIA in the sum of .... THOUSAND AND NO/100 DOLLARS ($......000.00) lawful money of the United States of America, to be paid to the said State of California, for which payment, well and truly to be made, we bind ourselves, our heirs, executors and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH THAT,

WHEREAS, said principal is about to acquire ownership or operation, drill, redrill, deepen, maintain, or abandon a

.... - temperature geothermal resources well designated as .... , Sec. .... ,
(high or low)

T. .... R. .... B. & M., and is required to file this bond in connection therewith in accordance with Sections 3723.5 and 3725 to 3729, inclusive, of Chapter 4 of Division 3 of the Public Resources Code of the State of California

NOW, THEREFORE, if said ....

the above bounden principal, shall well and truly comply with all the provisions of Chapter 4 (commencing with Section 3700) of Division 3 of the Public Resources Code and shall obey all lawful orders of the State Oil and Gas Supervisor, or his district deputy or deputies, if not appealed as provided in that chapter, or upon affirmance thereof by the Geothermal Resources Board, if appealed thereto, and shall pay all charges, costs, and expenses incurred by the supervisor or his district deputy or deputies in respect of such well or the property of said principal, or assessed against such well or the property of such principal, in pursuance of the provisions of said chapter, then this obligation shall be void; otherwise, it shall remain in full force and effect.

IN WITNESS WHEREOF, the seal and signature of the said principal is hereto affixed and the corporate seal and name of the said surety is hereto affixed and attested by its duly authorized at

California, this day of 19

(SEAL OF PRINCIPAL)

(Principal) ....

By ....

(SEAL OF SURETY)

(Surety) ....

By ....

Office of surety to which correspondence relating to this bond should be addressed:

....

....

The premium charged for this bond is $ .... annum.

NOTARIZATION OF THE SURETY:

STATE OF CALIFORNIA } ss.
COUNTY OF

On this .... day of ...., in the year 19 ....

before me, ...
A Notary Public in and for said County and State, personally appeared

....
known to me to be the person whose name is subscribed to the within instrument

as the of

, and acknowledged to me that he subscribed the name

of thereto and his own name as ....

....

....
Notary Public in and for said County and State

INSTRUCTIONS

1. *The surety on the bond may be any surety company licensed in California.*
2. *The signature of the surety must be notarized.*
3. *If the principal is a corporation, the corporate seal must be affixed.*
4. *If the principals are partners, their individual names shall appear in the body of the bond, with the recital that they are partners composing a firm, and naming said firm.*
5. *The name of the principal as well as the designation and number of the well on the bond must agree exactly with that shown on the notice of intention to acquire ownership or operation, drill, redrill, deepen, permanently alter the casing, or abandon.*
6. *A bond containing a cancellation clause at the option of the surety is not acceptable.*
7. *Low-temperature well is a well from which fluid produced has a temperature that is no more than the boiling point at the altitude of occurrence.*
8. *Applicable amount:*
   Coverage for high-temperature well..$25,000
   Coverage for low-temperature well:
   - *less than 2,000 feet total depth...$ 2,000*
   - *at least 2,000 feet but less than 5,000 feet total depth $10,000*
   - *at least 5,000 feet but less than 10,000 feet total depth...........................$15,000*
   - *at least 10,000 feet or greater total depth...$25,000*

If a well is deepened to a depth requiring higher bond coverage, either a rider specifying supplemental coverage or a new bond is required.

NOTE: In lieu of an individual indemnity bond, a person may, with the written approval of the Supervisor, file a cash bond or securities in the appropriate amount as prescribed in Section 3728.5, Division 3 of the Public Resources Code.

A supply of this form may be obtained from the Division of Oil and Gas.

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS

Figure 4.4 A

ENVIRONMENTAL CHECKLIST FORM

DATE FILED

I. PROJECT DESCRIPTION:

PROJECT TITLE:		☐ OBSERVATION ☐ EXPLORATORY	WELL NAME(S) AND NUMBER(S)
FIELD	COUNTY/CITY		
NAME OF OPERATOR		OPERATOR REPRESENTATIVE	
OPERATOR ADDRESS			OPERATOR PHONE NUMBER

II. ENVIRONMENTAL IMPACTS

(Explanations of all "yes" and "maybe" answers are required on attached sheets.)

	YES	MAYBE	NO
1. **Earth.** Will the proposal result in:			
a. Unstable earth conditions or in changes in geologic substructures?	___	___	___
b. Disruptions, displacements, compaction or overcovering of the soil?	___	___	___
c. Change in topography or ground surface relief features?	___	___	___
d. The destruction, covering or modification of any unique geologic or physical features?	___	___	___
e. Any increase in wind or water erosion of soils, either on or off the site?	___	___	___
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?	___	___	___
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?	___	___	___
2 **Air.** Will the proposal result in:			
a. Substantial air emissions or deterioration of ambient air quality?	___	___	___
b. The creation of objectionable odors?	___	___	___
c. Alteration of air movement, moisture or temperature, or any change in climate, either locally or regionally?	___	___	___
3. **Water.** Will the proposal result in:			
a. Changes in currents, or the course or direction of water movements, in either marine or fresh waters?	___	___	___
b. Changes in absorption rates, drainage patterns or the rate and amount of surface water runoff?	___	___	___
c. Alterations to the course or flow of flood waters?	___	___	___
d. Change in the amount of surface water in any water body?	___	___	___
e. Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen or turbidity?	___	___	___
f. Alteration of the direction or rate of flow of ground waters?	___	___	___
g. Change in the quantity of ground waters, either through direct additions or withdrawals or through interception of an aquifer by cuts or excavations?	___	___	___
h. Substantial reduction in the amount of water otherwise available for public water supplies?	___	___	___
i. Exposure of people or property to water related hazards such as flooding or tidal waves?	___	___	___
4. **Plant Life.** Will the proposal result in:			
a. Change in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops, and aquatic plants)?	___	___	___
b. Reduction of the numbers of any unique, rare or endangered species of plants?	___	___	___
c. Introduction of new species of plants into an area, or in a barrier to the normal replenishment of existing species?	___	___	___

	YES	MAYBE	NO
d. Reduction in acreage of any agricultural crop?			
5. **Animal Life.** Will the proposal result in:			
a. Change in the diversity of species, or numbers of any species of animals (birds, land animals including reptiles, fish and shellfish, benthic organisms or insects)?			
b. Reduction of the numbers of any unique, rare or endangered species of animals?			
c. Introduction of new species of animals into an area, or result in a barrier to the migration or movement of animals?			
d. Deterioration to existing fish or wildlife habitat?			
6. **Noise.** Will the proposal result in:			
a. Increases in existing noise levels?			
b. Exposure of people to severe noise levels?			
7. **Light and Glare.** Will the proposal produce new light or glare ?			
8 **Land Use.** Will the proposal result in a substantial alteration of the present or planned land use of an area?			
9. **Natural Resources.** Will the proposal result in:			
a. Increase in the rate of use of any natural resources?			
b. Substantial depletion of any nonrenewable natural resource?			
10. **Risk of Upset.** Does the proposal involve a risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?			
11 **Population.** Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?			
12 **Housing.** Will the proposal affect existing housing, or create a demand for additional housing?			
13. **Transportation/Circulation.** Will the proposal result in:			
a. Generation of substantial additional vehicular movement?			
b Effects on existing parking facilities, or demand for new parking?			
c. Substantial impact upon existing transportation systems?			
d. Alterations to present patterns of circulation or movement of people and/or goods?			
e. Alterations to waterborne, rail or air traffic?			
f Increase in traffic hazards to motor vehicles, bicyclists or pedestrians?			
14. **Public Services.** Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:			
a. Fire protection?			
b. Police protection?			
c. Schools?			
d. Parks or other recreational facilities?			
e. Maintenance of public facilities, including roads?			
f. Other governmental services?			
15. **Energy.** Will the proposal result in:			
a. Use of substantial amounts of fuel or energy?			
b. Substantial increase in demand upon existing sources of energy, or require the development of new sources of energy?			
16. **Utilities.** Will the proposal result in a need for new systems, or substantial alterations to the following utilities:			
a. Power or natural gas?			
b. Communications systems?			
c. Water?			
d. Sewer or septic tanks?			

C

	YES	MAYBE	NO
e. Storm water drainage?	___	___	___
f. Solid waste and disposal?	___	___	___
17. **Human Health.** Will the proposal result in:			
a. Creation of any health hazard or potential health hazard (excluding mental health)?	___	___	___
b. Exposure of people to potential health hazards?	___	___	___
18. **Aesthetics.** Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?	___	___	___
19. **Recreation.** Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	___	___	___
20. **Archeological/Historical.** Will the proposal result in an alteration of a significant archeological or historical site, structure, object or building?	___	___	___
21. **Mandatory Findings of Significance.**			
a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	___	___	___
b. Does the project have the potential to achieve short–term, to the disadvantage of long–term, environmental goals? (A short–term impact on the environment is one which occurs in a relatively brief, definitive period of time while long–term impacts will endure well into the future.)	___	___	___
c. Does the project have impacts which are individually limited, but cumulatively considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect of the total of those impacts on the environment is significant.)	___	___	___
d. Does the project have environmental effects which will cause substantial adverse effects on human beings either directly or indirectly?	___	___	___

III. DISCUSSION OF ENVIRONMENTAL EVALUATION

Checklist Prepared By: ______________________________ **Date** ____________

IV. DETERMINATION

On the basis of this initial evaluation:

___ I find the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

___ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because the mitigation measures described on an attached sheet have been added to the project. A NEGATIVE DECLARATION WILL BE PREPARED.

___ I find the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

Date ____________________ ______________________________

GEOTHERMAL C.E.Q.A. UNIT SUPERVISOR

Figure 4.5

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS

NOTICE OF DETERMINATION

TO: SECRETARY FOR RESOURCES
1416 NINTH STREET, ROOM 1311
SACRAMENTO, CALIFORNIA 95814

PROJECT DESCRIPTION:

PROJECT TITLE:		WELL NAME(S) AND NUMBER(S)
FIELD	COUNTY/CITY	
SECTION(S), TOWNSHIP(S), AND RANGE(S); B & M		
NAME OF OPERATOR	OPERATOR REPRESENTATIVE	
OPERATOR ADDRESS		OPERATOR PHONE NUMBER

PROJECT ABSTRACT:

DIVISION CONTACT:	PHONE NUMBER

The Division of Oil and Gas, Department of Conservation, has approved the above-described project and has made the following determinations:

The project ☐ will, ☐ will not, have a significant effect on the environment.

☐ An Environmental Impact Report was prepared for the project pursuant to the provisions of CEQA.

☐ A Negative Declaration was prepared for the project pursuant to the provisions of CEQA. A copy of the Negative Declaration is attached.

A Statement of Overriding Considerations ☐ was, ☐ was not, adopted for this project. A copy of the Statement is attached.

STATE CLEARING HOUSE NUMBER ____________

OGG/OG PROJECT NUMBER ____________

____
State Oil and Gas Supervisor

DATE: ____________________

OGS150(3-79-DWRR-5C)

Form OGG107 (1/80)

RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS

Figure 4.6

API No.________________

REWORK/SUPPLEMENTARY NOTICE GEOTHERMAL WELL

Submitted in compliance with Section 3724, Division 3, Chapter 4, Public Resources Code

Operator			Well Designation				
Field or GRA			County	Sec.	T.	R.	B.&M.
Name *(Person submitting report – print or type)*			Street Address				
Title *(Agent or officer of company)*	City		State			Zip Code	

Signature____________________________________Date________________Telephone Number______________

The present condition of the well is as follows:

1. Total depth: __________ meters.

2. Complete casing record, including plugs:

3. Last produced:____________________, 19____ ______________________________
(Production in kg/hr.or gal. /min.)

The proposed work is as follows:

File this report in duplicate with the appropriate geothermal district office.

A. Effluent Limitations

1. a. The discharge of wastes containing constituent concentrations in excess of the following limits is prohibited:

Constituent	Discharge Serial No.	Mass Emission Rate[1] 30-Day Average	Mass Emission Rate[1] 7-Day Average	Concentration Limit 30-Day Average	Concentration Limit 7-Day Average
Biochemical Oxygen Demand	001	7006 lbs/day (3178 kg/day)	10508 lbs/day (4766 kg/day)	30 mg/l	45 mg/l
Suspended Solids	001	7006 lbs/day (3178 kg/day)	10508 lbs/day (4766 kg/day)	30 mg/l	45 mg/l
Ammonia-Nitrogen	001	3269 lbs/day (1483 kg/day)	---	14 mg/l	---

1. b. The discharge of wastes containing constituent concentrations in excess of the following limits is prohibited:

Constituent	Discharge Serial No.	4-Month Average Mass Emission Rate	4-Month Average Concentration Limits
Filtrable Residue	001	124,933 lbs/day (56,668 kg/day)	535 mg/l
Total Hardness (as $CaCO_3$)	001	50,207 lbs/day (22,773 kg/day)	215 mg/l
Chloride	001	19,849 lbs/day (9,003 kg/day)	85 mg/l
Sodium	001	19,849 lbs/day (9,003 kg/day)	85 mg/l
Sulfate	001	19,849 lbs/day (9,003 kg/day)	85 mg/l
Boron	001	117 lbs/day (53 kg/day)	0.5 mg/l
Fluoride	001	234 lbs/day (106 kg/day)	1.0 mg/l
Total Nitrogen	001	6,550 lbs/day (2,970 kg/day)	28 mg/l

[1]Based on 28 MGD

1. c. The discharge of wastes containing a 4-month average filtrable residue concentration which exceeds the 4-month average concentration of filtrable residue in the water supply by more than 230 mg/l is prohibited.

1. d. The discharge of wastes containing constituent concentrations in excess of the following limits is prohibited:

Constituent	Discharge Serial No.	Maximum Mass Emission Rate		Maximum Daily Concentration Limit	
Arsenic	001	12 lbs/day	(5 kg/day)	0.05	mg/l
Barium	"	233 lbs/day	(106 kg/day)	1.0	"
Cadmium	"	2 lbs/day	(1 kg/day)	0.01	"
Chromium, Total	"	12 lbs/day	(5 kg/day)	0.05	"
Cobalt	"	47 lbs/day	(21 kg/day)	0.2	"
Copper	"	233 lbs/day	(106 kg/day)	1.0	"
Cyanide	"	47 lbs/day	(21 kg/day)	0.2	"
Iron	"	70 lbs/day	(32 kg/day)	0.3	"
Lead	"	12 lbs/day	(5 kg/day)	0.05	"
Manganese	"	12 lbs/day	(5 kg/day)	0.05	"
Mercury	"	0.5 lb/day	(0.2 kg/day)	0.002	"
Selenium	"	2 lbs/day	(1 kg/day)	0.01	"
Silver	"	12 lbs/day	(5 kg/day)	0.05	"
Zinc	"	1168 lbs/day	(530 kg/day)	5.0	"

2. The pH of the discharge shall at all times be within the range of 6.5 and 8.0 pH units.

3. There shall be no visible oil and grease in the discharge.

4. The waste discharge shall be, at all times, an adequately disinfected and oxidized wastewater. The wastewater shall be considered adequately disinfected if at some location in the treatment process the median number of coliform organisms does not exceed 23 per 100 milliliters. The median value shall be determined from the bacteriological results of the last 7 days for which analyses have been completed.

5. The 30-day flow-weighted average biochemical oxygen demand and suspended solids concentrations of the discharge shall not be greater than fifteen percent (15%) of the 30-day flow-weighted average influent concentrations.

B. Receiving Water Limitations

1. Whenever there is a non-storm induced flow in the Santa Ana River at Alabama Street, Redlands, the discharge shall not cause the dissolved oxygen to be depressed below 5.0 mg/l to be measured at Station B indicated in Monitoring and Reporting Program No. 79-83.

2. The discharge shall not alter the color of the receiving water.

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA

Figure 5.2

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

REPORT OF WASTE DISCHARGE
Pursuant to Division 7 of the State Water Code

FOR USE OF REGIONAL BOARD
WRCB Form 200 Rec'd: ________
Duty Fee: ________
Letter to Discharger: ________
Report Rec'd: ________
Effective Date: ________

(A) REPORT FROM:

Discharger ____________________
(Owner of Facility, Municipality, County, District, Firm or Individual)

Mailing Address ____________________
Zip Code

Telephone No. ____________

Name of Facility ____________________

(B) DESCRIPTION:

I. WASTE DISCHARGE: (check)
1. New discharge -------------------- ( )
2. Existing discharge -------------------- ( )
3. Increase in quantity of discharge -------------------- ( )
4. Change in character of waste -------------------- ( )
5. Change in place or method of disposal -------------------- ( )

II. LOCATION OF POINT OF DISPOSAL OR OPERATION (describe and attach map, sketch or locate on USGS Quadrangle map, 7.5 minute series.) List distances or bearing and distance from section corner or quarter corner, Section, Township, Range and Base and Meridian.)

____
____

III. WASTE TREATMENT OR DISPOSAL FACILITIES: (check)
1. Construction of entirely new facilities -------------------- ( )
2. Enlargement of existing facilities -------------------- ( )
3. Other (explain) ____________________

____

(C) TYPE OF WASTE DISCHARGE: (check)
1. Sewage only -------------------- ( )
2. Industrial wastes only -------------------- ( )
3. Mixed sewage and industrial wastes -------------------- ( )
4. Solid wastes -------------------- ( )
5. Cattle wastes -------------------- ( )
6. Soil, silt, clay, etc. -------------------- ( )
7. Other wastes -------------------- ( )

(D) QUANTITY OF WASTES:
1. Present or proposed flow (in mgd) ____________
2. Design flow (in mgd) ____________
3. Present population ____________
4. Design population ____________
5. Solid waste disposal site (in cubic yards) ____________
6. Area in which soil will be disturbed (in acres) ____________

(E) SOURCE OF WATER SUPPLY:
1. Municipal or utility service ( )
2. Individual wells ( )
3. Surface supply: (a) Name of Stream ____________
(b) Type of Water Rights: Riparian ( ) Appropriation ( )
(c) Water Rights Permit or License Number ____________

(F) ENVIRONMENTAL IMPACT REPORT (EIR):
1. Has an EIR been prepared for this project?
Yes ( ) No ( )
2. If yes, please enclose a copy
3. If no, will an EIR be prepared? Yes ( ) No ( )
4. If yes, who will prepare the EIR? ____________________

ALL OF THE STATEMENTS CONTAINED HEREIN ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF AND ARE SUBMITTED UNDER PENALTY OF PERJURY.

SIGNATURE OF AUTHORIZED PERSON ____________________

Title ____________________
(Manager, Clerk, Engineer, Consultant, etc.)

Date ____________________

You will be notified of the correctness of filing fee and submittal of any additional information deemed necessary to complete your Report of Waste Discharge pursuant to Division 7, Section 13260 of the State Water Code.

SWRCB FORM 200 APPENDIX

Provide information in categories checked only

I. Project Description

A. Location

1. Point(s) of discharge (includes points of application and uses of reclaimed water).

2. Facility or project location and description, including the following if applicable:

a. Any area to be dredged and any area to be filled
b. For mining operations, description of mineral commodity, operation, nature of operation.
c. For petroleum refineries, provide "process factor" information as required by E.P.A.
d. For reclaimed water use, indicate source of reclaimed water and party responsible for quality when delivered to point of use or application.
e. For subdivisions, submit subdivision map and vicinity map, and provide information on public entity if required.
f. For animal confinement facilities, indicate number, species, and gender of animals, design of facility and waste containment facilities or measures.

3. Wells, drainage courses, surface waters, and nearby structures.

B. Volume of Flow of Waste Discharge

1. Present volume (cubic yards) or flow in mgd.

2. Design volume (cubic yards) or flow in mgd.

3. Variations in flow or volume.

4. Total capacity of solid waste disposal site in cubic yards.

C. Quality of Waste Discharge

1. Provide laboratory analysis of the discharge.

2. Provide chemical analysis of any associated toxic materials or chemicals.

3. Describe physical properties.

4. List amounts and types of material discharged, including estimates of turbidity if project involves dredging or dredge soil disposal.

D. Water Supply

1. Source

2. Quality

3. Average quantity

E. Other Approvals

List all other public agency approvals and permits required, including any necessary Division of Oil and Gas approval.

F. Contacts

Provide names, addresses, phone numbers and titles of persons responsible for maintaining project and waste treatment facility, including landowners, lessees, agents or operators, and, if project is a mining operation, claim holders.

G. CEQA/NEPA

Provide a copy of final EIR/EIS or negative declaration if prepared. If not, state why exempt.

H. Filing Fee

Provide information to determine correct fee, in accordance with SWRCB Forms 201 and 202.

II. Treatment and Disposal

A. Treatment

1. Describe type or processes of treatment and capacity

2. For experimental treatment projects, describe test results, similar projects, evaluation of similar projects.

B. General Disposal Information

1. Describe method of disposal of treated wastes and other wastes from operation, including drilling muds and dredge spoil, if applicable, and including any storage and transmission facilities. For ocean discharges include depth and length of outfall and diffuser.

2. Describe the means of disposal for wastes other than those in application.

C. Liquid Waste Discharge to Land Surface (Pond and Spray Disposal)

1. Describe area size.

2. Design criteria and details including loading rates, odor prevention, solids removal, and disposal capacity of land.

3. Depth to groundwater.

4. Groundwater quality.

5. Soil profile and permeability.

6. Annual rainfall and prevailing wind directions.

7. Evaporation or evapotranspiration rates.

8. For spray disposal only

   a. Institutional arrangements for control,
   b. State and local health department controls,
   c. Geologic and agricultural information.

D. <u>Subsurface Disposal</u>

1. Percolation tests.

2. Disposal design criteria and details.

E. <u>Solid Waste Disposal Sites</u>

Supply all information to comply with evaluation procedures in latest edition of SWRCB publication "Waste Discharge Requirements for Nonsewerable Waste Disposal to Land - Disposal Site Design and Operation Information."

III. <u>Receiving Water Information</u>

A. <u>Liquid Waste Discharge to Lakes or Water Courses</u>

1. Describe stream flow volume and variability.

2. Provide water quality analyses of receiving waters.

3. Determine downstream beneficial uses.

B. <u>Ocean Discharge</u>

1. Describe dilution ratio and how determined.

2. Pre-discharge monitoring.

C. <u>Industrial Process or Municipal Bay or Estuary Discharge</u>

Enhancement of beneficial uses over than in absence of discharge.

IV. Planning Information

A. Flood Protection

Provide information required to assess protection of facility from floods.

B. Erosion

Provide information required to assess erosion and siltation of project area during construction and operation.

C. Surface Water Control

Provide information concerning runoff protection and storm drainage control for project area.

D. Spill Plan

Prepare and submit a technical report on spill prevention and contingency measures.

E. Mining Operations

For mining operations, describe reclamation or rehabilitation program for project area after closure.

F. Proposed Developments

For developments containing more than thirty dwelling units and with lots containing less than 20,000 square feet net area, a report shall be submitted on the conditions in the area of the development including:

1. Quality of groundwater in the area (insofar as possible, wells within the development and within 600 feet of the boundary of the proposed development must be sampled and analyzed for "standard water chemistry"),

2. Existing or planned land use within 600 feet of the boundaries of the development, dwelling density (units/acre),

3. Distance to community sewer systems, and

4. Whether failures of the disposal systems have occurred and whether such failures are due to inadequate design, construction or maintenance.

Figure 6.1A

COULTER STEWART & ASSOCIATES, INC.
4409 VISTA WAY
DAVIS, CALIFORNIA 95616
916-758-0320

PROJECT STATUS REPORT

November 3, 1980
Report No. 1
Report Period:
1 October 80 -
31 October 80

CONTRACT TITLE:

San Bernardino Municipal Water Department
Geothermal Process Heating Feasibility Study-
Waste water Treatment Plant.

CONTRACTOR NAME:

Coulter Stewart & Associates, Inc.
4409 Vista Way, Davis, Ca. 95616

CONTRACT PERIOD:

1 October 1980-16 April 1981

1. Contract Objective: Assess social, financial, legal and regulatory institutional feasibility of the proposed process heating project. Prepare Geothermal Awareness Program. Assist Board in overall project coordination.

2. Technical Approach: Have gathered materials from and held meetings with persons from various state and local agencies which may exercise a discretionary or ministerial authority over the proposed project. Have prepared one press release for Water Department approval and gathered information on financial options.

Agencies thus far contacted include:

San Bernardino Water Department
San Bernardino Planning Department
California Division of Oil and Gas
California Energy Commission
California State Treasure
California State Legislature
San Bernardino Department of Public Works

U.S. Department of Energy
U.S. Department of Housing and Urban Development

3. Schedule/Tasks: Coulter Stewart & Associates Inc. is currently ahead of the original schedule and is expected to complete its work by 1 February 1981.

4. Problems: None

5. Plans: During the coming month work will continue on defining the optimum path through the regulatory maze and identifying financial options. An assessment of the legal framework will begin as will an outline for the Geothermal Awareness Program.

6. Hours/Days: The contractor has spent 11.5 days in the performance of the activities described in #2 above during this reporting period.

COULTER STEWART & ASSOCIATES, INC.
4409 VISTA WAY
DAVIS, CALIFORNIA 95616
916-758-0320

PROJECT STATUS REPORT

December 1, 1980
Report No. 2
Report Period:
1 November -
30 November

CONTRACT TITLE:

San Bernardino Municipal Water Department
Geothermal Process Heating Feasibility Study-
Waste Water Treatment Plant

CONTRACTOR NAME:

Coulter Stewart & Associates, Inc.
4409 Vista Way
Davis, Ca. 95616

CONTRACT PERIOD:

1 October 1980- 16 April 1981

1. Contract Objective: Assess social, financial, legal and regulatory institutional feasibility of the proposed process heating project. Prepare Geothermal Awareness Program. Assist Board in overall project coordination.

2.Technical Approach: Prepared first draft sections of the report. Items covered:

- a) Permit procedures
  - 1-Conditional Development Permit - City
  - 2-Well Drilling Permit - DOG
    - -Exploratory
    - -Development
  - 3-Waste Water Discharge Requirements
  - 4-Encroachment Permits
    - -County
    - -State
  - 5-Street Cut Permits - City
- b) Legal Issues:
  - 1-Pariani vs. State of California
  - 2-U.S. vs. Union Oil Company
  - 3-Geothermal Kinetics vs.UnionOil Company
  - 4-Conover Memo

The sections of the report dealing with the permit procedures were circulated and reviewed by the appropriate permitting agency. Comments will be incorporated in the final draft.

Additional interviews and meetings were held concerning the status of various financing options and legal issues.

Coulter Stewart & Associates, Inc. took the lead in coordinating the onsite San Bernardino visit of the four man Resource Assessment Team from the State Division of Mines and Geology operating under the DOE - State Coupled Program.

CS & A,Inc. also coordinated the onsite visit of the Oregon Institute of Technology Geoheat Center-Technical Assistance Team. This meeting was held in conjunction with the San Bernardino Geothermal Advisory Committee meeting of November 17th.

Prepared a summary of the DOE Geothermal Direct Heat Application Program Summary, November 1980 for Water Department management review.

Agencies contacted this time period include:

- Earl Warren Legal Institute
- Santa Ana Regional Water Quality Control Board
- California Division of Mines & Geology
- California Division of Oil & Gas
- San Bernardino Planning Department
- San Bernardino Water Department
- State Treasures Office
- California Municipal Utilities Association
- City of Santa Clara
- California Legislature
- Geothermal Resources Council
- U.S. Court of Appeals
- U.S. Department of Energy
- San Bernardino Economic Development Council
- California Energy Commission

3. Schedule/Tasks: Coulter Stewart & Associates Inc. is currently ahead of the original schedule and is expected to complete its work by 1 February 1981.

4. Problems: None

5. Plans: Permitting and legal sections of the report will be finalized. Financing section will be drafted for review. Geothermal Awareness Program will be held in abeyance. Coordination with appropriate Local, State and Federal agencies and Programs will continue.

6. Hours/Days: The Contractor spent 96 hours or 12 days performing the activities described in #2 above during this period.

Figure 6.3A

COULTER STEWART & ASSOCIATES, INC.
4409 VISTA WAY
DAVIS, CALIFORNIA 95616
916-758-0320

PROJECT STATUS REPORT

January 2, 1981
Report No. 3
Report Period:
1 December 1980-
30 December 1980

CONTRACT TITLE:

San Bernardino Municipal Water Department
Geothermal Process Heating Feasibility Study-
Waste water Treatment Plant.

CONTRACTOR NAME:

Coulter Stewart & Associates, Inc.
4409 Vista Way, Davis, Ca. 95616

CONTRACT PERIOD:

1 October 1980-16 April 1981

1. Contract Objective: Assess social, financial, legal and regulatory institutional feasibility of the proposed process heating project. Prepare Geothermal Awareness Program. Assist Board in overall project coordination.

2. Technical Approach: Have finalized the permitting and legal sections and forwarded them to the Water Department for submittal to USDOE. Have narrowed the financing options in conjunction with the Water Department and have gathered additional information from federal, state and private sources concerning the viability to the various options.

Agencies contacted this time period include:

- USDOE - Geothermal Loan Guarantee Program
- USDOE - Idaho Operators Office
- California Division of Mines & Geology
- California Division of Oil & Gas
- California Energy Commission
- California Municipal Utilities Association
- State Treasurers Office
- California Legislature
- Bank of America
- Bank of California
- San Bernardino Water Department

3. Schedule/Tasks: Coulter Stewart & Associates should complete its work by 1 February 1981.

4. Problems: None

5. Plans: During January work will be done on the financing options.

6. Hours/Days: The contractor has spent 10.5 days or 84 hours in this period.