GEO-HEAT CENTER

OREGON INSTITUTE OF TECHNOLOGY
A Geothermally Heated Campus
KLAMATH FALLS, OREGON 97601

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GEOHERMAL FEASIBILITY STUDY
FOR HOTEL/APARTMENT COMPLEX:

Decker Land Development,
Tucson, Arizona

March 1982

GEOHERMAL FEASIBILITY STUDY

FOR

**DECKER LAND DEVELOPMENT
TUCSON, ARIZONA**

PREPARED FOR

**THE OREGON INSTITUTE OF TECHNOLOGY
CONTRACT NO. TA 1-82**

PREPARED BY

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MARCH 26, 1982

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**W. R. ACORN
ENGINEERING
ASSOCIATES**

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**GEOHERMAL FEASIBILITY STUDY
DECKER LAND DEVELOPMENT, TUCSON, ARIZONA**

MARCH 1982

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**W. R. ACORN
ENGINEERING
ASSOCIATES**

PART 1 EXECUTIVE SUMMARY

1.1 PURPOSE:

This report constitutes a study prepared by W.R. Acorn Engineering Associates to evaluate the technical and economic feasibility of utilizing a geothermal hot water resource for a commercial building project in Tucson, Az.

1.2 ORGANIZATION:

The report is organized in a manner which will outline the assumptions upon which the study is based and the techniques utilized to prepare the technical evaluation.

A summary of the results of the evaluations, our conclusions regarding feasibility and recommendations for a future course of action is included with the main body of the report.

Appendix "A" provides the calculations and analysis to substantiate the results and conclusions.

Appendix "B" provides copies of some correspondence relevant to the project and substantiating the assumptions upon which the study was based.

1.3 RESULTS AND CONCLUSIONS:

The study predicts a net energy savings of 9.9×10^9 BTU/YR for a net energy cost savings in the first year of system operation of \$ 43,000/YR. The net annual savings in water is predicted to be 1,100,000 cubic feet for a cost savings of \$ 10,600/YR in the first year of operation. These values do not include the positive impact of tax benefits which would be the result of a geothermal depletion allowance.

Based on an assumed increase in fuel and water costs of 15% per year, the net operating cost savings for the geothermal system escalates to approximately \$ 765,00/YR in the 20th year of the study, with the assumption of a 10% per year average rate of inflation.

The estimated incremental cost of the geothermal utilization project including contingencies, escalation to midpoint of construction and engineering fees is \$ 433,000. This cost does not recognize the rather substantial investment and energy investment tax credits which are available to this project.

Based on a simplified economic analysis, the project shows positive cash flow in the second year of operation (with an investment tax credit) or the fourth year of operation without the investment tax credit.

Further detailed analysis is being conducted by the project developer to address all of the potential economic nuances.

Based on the results of the study to-date, the technical and economic feasibility analysis indicates that this project is an excellent candidate for further consideration of direct utilization of geothermal energy. In addition to the tangible benefits which have been evaluated, the developer believes that there would be some rather significant intangible benefit associated with the publicity of a geothermal project.

1.4 ACKNOWLEDGEMENT:

The author wishes to thank Mr. Gene Culver of the Geo-Heat Center of the Oregon Institute of Technology and Mr. Larry Goldstone of the Arizona Geothermal Communication Team for their support and assistance in the preparation of this study.

PART 2 INTRODUCTION

2.1 PURPOSE OF REPORT:

This report represents the results of an engineering feasibility study performed by W.R. Acorn Engineering Associates of Tucson, Arizona, for the Geo-Heat Center of the Oregon Institute of Technology. The study was commissioned on behalf of Decker Land Development, Inc. (DLD) to determine the technical and economic feasibility of utilizing a geothermal resource as an alternative energy source for a commercial development in Tucson, Arizona.

2.2 SCOPE OF PROJECT:

The feasibility study was tasked with examining the potential energy savings available through utilization of geothermal hot water, determining the potential incremental costs of a geothermal utilization system and providing preliminary system design sketches. The report goes somewhat beyond the strict scope of work in providing preliminary life cycle and cash flow analysis for the project. Decker Land Development is in the process of preparing more detailed economic analyses, which will address the tax credits available to this type of project and other specific accounting techniques applicable to their company.

The commercial project identified for this study consists of a 200-unit Hotel and a 300-unit Apartment Complex, to be served by a common geothermal system. The project is assumed to begin construction one year from now and to be operational two years from now. An additional 200-unit hotel is assumed to be operational within seven years of now.

2.3 GEOTHERMAL APPLICATIONS:

This project investigates the economic feasibility of utilizing geothermal source water for the following applications:

- a) Space heating
- b) Domestic water heating
- c) Swimming pool heating
- d) Space cooling
- e) Byproduct landscape irrigation

PART 3 GEOTHERMAL APPLICATIONS:

3.1 GENERAL:

The project site, southwest of the intersection of Palo Verde Road and Interstate Highway 10, is adjacent to a known geothermal resource area (KGRA) discovered by Tucson Electric Power Company.

The TEPCO resource is located approximately two miles east of the site proposed by DLD and produces wellhead temperatures of approximately 52 C (125.6 F), from a depth of approximately 1,850 feet. It is important to note that the TEPCO well was not designed as a geo-thermal source and, as a result, the geothermal aquifer is known to mix with the cooler, shallow, drinking water aquifer, therefore, the geothermal water is believed to be considerably hotter than the wellhead temperature suggests. Furthermore, the TEPCO well is known to produce flow rates in the 1,000 to 2,000 GPM range, indicating a substantial resource.

3.2 PREDICTED PERFORMANCE:

It is estimated that a geothermal source will be encountered on the proposed commercial site at a depth of 1,600 to 2,400 feet and that such source will deliver wellhead temperatures of 50 C to 57 C (122 F to 135 F). The geothermal aquifer is believed to be totally separate from the shallow groundwater aquifer and of high quality. Utilization of the geothermal aquifer will not deplete the drinking water aquifer, in fact, the proposed use of some of the water for landscape irrigation will have a positive effect on the groundwater table. (Refer to Appendix "B," correspondence from Geologist James C. Witcher.)

3.3 FURTHER DATA:

Discussions with an independent geologist (Mr. Leonard Halpenny; see memorandum, Appendix "B") confirm the above conclusions. Mr. Halpenny has provided further information regarding the potential existence of a geologic fault between the TEPCO well and the proposed site. In the event that such a fault does exist, the geothermal source may be offset to a depth of approximately 3,000 feet.

It is estimated that hydraulic pressure will raise the geo-thermal water to within approximately 300 feet of the surface and that the "draw down" level while pumping will be to about 400 feet.

3.4 RESOURCE ASSUMPTION:

For the purpose of this feasibility study, we have assumed that a 135 F source can be developed at a depth of 2,500 feet. There is the potential for the source at that depth to be as high as 165 F with a properly designed well. We have further assumed a conservative "draw down" level of 500 feet with the pump to be set at an approximate depth of 600 feet.

PART 4 PROJECT ASSUMPTIONS

4.1 HOTEL:

The hotel is assumed be be a two-story, middle price range establishment with 200 guestrooms, a public restaurant, banquet/meeting facilities and a swimming pool. Guest rooms are assumed to have an average area of 450 sq. feet and the public areas, including office, restaurant and meeting facilities, are assumed to total approximately 30,000 sq. feet. A 75' x 30' swimming pool is assumed. Further assumptions regarding the thermal performance of the facility are outlined in the calculations of Appendix "A". The future hotel is assumed to be identical to the first in terms of energy performance.

4.2 APARTMENT COMPLEX:

The apartment complex is assumed to consist of 300 units, half of which have an area of 450 sq. feet and half at 750 sq. feet in area. The units are assumed to be clustered in 25 free-standing buildings of 12 units per building, two stories in height. A 75' x 30' swimming pool is assumed. Further thermal performance assumptions are outlined in the Appendix "A" calculations.

4.3 SYSTEM COSTS:

The incremental costs of the geothermal utilization system for the site are the only construction costs considered in the evaluation of economic feasibility. The incremental costs are defined as those costs above the cost of standard, fossil fuel-fired central plant systems for each facility. It is assumed that the hotel and the apartment complex would each have a central natural gas-fired boiler to distribute heating and domestic hot water to the end users. The incremental cost of the geothermal systems, therefore, has been limited to the cost of source and disposal wells, site distribution piping system from the wells to the building sites and related pumping and control equipment. It is assumed that a conventional boiler would still be provided at the hotel and the apartment complex as a back-up source, therefore, no credit for the potential deletion of such equipment is taken.

System costs have been estimated based on current prices for labor and material (Means Estimating Guide, and Leonard Halpenny, Geologist, for well costs) and include 10% contingency, 15% escalation for midpoint of construction 18 months hence and 10% engineering fees. The total incremental system cost estimated in this manner is \$ 433,000.

W.R. ACORN ENGINEERING
ASSOCIATES

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SHEET NO. 1 OF 1

project DECKER GEOTHERMAL STUDY no. 16081
client O.I.T. design WRA date 3-19-82
subject COST ESTIMATE checked _____ date _____

☒ HVAC SYSTEM, ☐ PLUMBING, ☐ FIRE PROTECTION

☒ CODE "A" (SCHEM.DESIGN), ☐ CODE "B" (DESIGN DEV.), ☐ CODE "C" (FINAL)

ITEM NO.	DESCRIPTION	EST. QUANTITY	UNIT	UNIT COST	TOTAL COST
1.	Source well - 12" diameter	2,500	FT	\$ 36	\$ 90,000
	Pump test	1	EA		20,000
	Move-in cost	1	EA		10,000
	Pump	1	EA		20,000
2.	Disposal Well - 8" diameter	2,500	FT	\$ 26	65,000
3.	Site Circulation pump, 30 HP motor, double suction	1	EA		7,000
4.	Pump house	250	SF	\$ 50	12,500
5.	Site piping				
	6" epoxy-lined cement asbestos	850	LF	\$. 8	6,800
	4" " " " "	2,200	LF	\$ 6	13,200
	Pipe insulation	2,650	CF	\$ 11	29,150
	Trench excavations	600	CY	\$ 4	2,400
	Trench backfill	500	CY	\$ 4	2,000
	Valves, Fittings, Specialties	1	LS		5,000
6.	Irrigation Pond				
	Fill valve and controls	1	LS		2,000
	Pump, 3 HP, end suction	1	LS		3,000
	Pipe & Misc.	1	LS		2,000
7.	Controls and interlocks	1	LS		10,000
8.	Electric power	1	LS		15,000
9.	SUBTOTAL				315,050
10.	Contingency @ 10%				31,000
11.	Escalation @ 15% to midpoint of construction (18 months)				47,000
12.	SUBTOTAL				393,050
13.	Engineering @ 10%				40,000
Subtotal This Sheet					433,050
Subtotal Forward

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project DECKER GEOTHERMAL STUDY no. 16081
client O.T.I. design WRA date 3-18-82
subject COST ESTIMATE ASSUMPTIONS checked _____ date _____

COST ESTIMATE ASSUMPTIONS

1. Only incremental costs of geothermal system beyond conventional heating system will be considered.
2. Geothermal system will have a back-up boiler, therefore, do not credit for deletion of conventional heat source.
3. Source well depth = 2,500 ft. and source well size = 12" with 10" pump.
4. Disposal well depth = 2,500 ft. and size = 8" with blank casing down to aquifer level.
5. Disposal well will not require pumping - Will gravity flow back.
6. Site circulation pump will supply water to secondary pumps at apartment and hotel (see schematic). Site circulation pump cost and energy consumption to be charged against geothermal project, secondary pumps are assumed common to a conventional system.
7. Geothermal water quality is assumed suitable for use in fan coils directly, therefore, no additional heat exchanger is required. Geothermal water to heat domestic hot water via storage tank heat exchanger as per conventional system design (see schematic).
8. Storage pond for landscape irrigation system to be charged against landscape cost as this provides aesthetic enhancement. Landscape irrigation pump and controls and pump energy charged to geothermal system against water cost savings.

It should be recognized that tax credits are available for this type of project. An investment tax credit of 10% is available as in other standard projects, in addition, a geothermal energy tax credit of 15% is available for the project. This study has not considered the economic ramifications of these credits, which are being evaluated by DLD, Inc.

4.4 FUEL COSTS:

The primary fuels in the Tucson area are natural gas for heating and electricity for motors, fans, etc. There are two energy cost considerations for this project:

- 1) Natural gas fuel savings as the result of utilization of the geothermal source.
- 2) Electrical energy costs above that associated with a conventional system for pumping the geothermal water from the well and around the site.

This study has evaluated the potential natural gas savings and offsetting electrical energy costs to arrive at a "net" annual energy savings for the geothermal system. The rate of increase in fuel costs will have a significant impact on the economic evaluation of the project. Based on our best estimates and discussions with utility companies, we offer the following data:

- 1) 1981 Electrical Cost = \$0.06/KWH
- 2) 1981 Natural Gas Cost = \$0.43/Therm*
- 3) Projected annual increase in electrical unit cost = 15%/YR basis 10% annual inflation rate.
- 4) Projected annual increase in natural gas cost = 25%/YR through 1985, then 15%/YR basis 10% annual inflation rate.
- 5) Water Cost = \$0.70/CCF (approximately annual average)
- 6) Projected annual increase in water cost = 15%/YR basis 10% annual inflation rate.

* therm = 100,000 BTU

PART 5 GEOTHERMAL UTILIZATION TECHNIQUES

5.1 GENERAL:

This section of the report will briefly define the types of systems considered with regard to utilization of the geothermal resource. The calculations and sketches included in Appendix "A" will provide further information regarding system design.

5.2 SPACE HEATING:

Based on the assumption of a 135 F source, direct utilization of the geo-water in fan coil units is proposed. The anticipated quality of the water is such that there will not be a need to utilize heat exchangers, filters or other water treatment devices. Each apartment and each hotel unit is assumed to have an individual fan coil with geo-water supplied from the facility central plant pump.

The entire heating system for each facility (apartment complex and hotel) is assumed to be the same as would be provided under a conventional central plant system with fan coils. The incremental heating system cost is limited, therefore, to the cost of source and disposal well, well pump, site circulation pump and site piping distribution system up to the individual facility. (Refer to the following system and layout sketches.)

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project DECKER GEOTHERMAL STUDY no. 16081
client O.I.T. design WRA date 3-21-82
subject SYSTEM SCHEMATIC checked _____ date _____

NOTES:

- ①. Domestic hot water storage tank with heat exchanger
- ②. Landscape water pond level control valve
- ③. Landscape water supply pump
- ④. To site irrigation system
- ⑤. To other fan coil units and heat exchanger for swimming pool heat
- ⑥. Piping and equipment beyond this point assumed equal to conventional system

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project DECKER GEOTHERMAL STUDY no. 16081
client O.I.T. design WRA date 3-18-82
subject SCHEMATIC SITE PLAN checked _____ date _____

5.3 DOMESTIC WATER HEATING:

Heating of domestic water for the apartments and the hotel via the geothermal source represents a significant energy savings. This study assumes that a conventional domestic hot water storage tank with integral heat exchanger would be "fired" via the geo-water. An in-depth analysis of this process might uncover the need to utilize a "plate and frame" type of heat exchanger to insure minimal approach to the geo-water supply temperature, and thus, achieve maximum energy savings. The study assumes that approximately 80% of the required hot water load can be satisfied by the geothermal system. The balance of the hot water energy requirement could be met via an instantaneous type gas-fired conventional water heater in series with the water storage tank outlet.

5.4 SPACE COOLING:

In that the Tucson area has a high demand for cooling, the study examined several potential techniques for utilization of the geothermal resource. (Refer to Appendix "A" for a detailed analysis).

A two-stage evaporative cooling process was investigated. The first stage of the cooling process would utilize a dessicant dehumidifier to adsorb water vapor from the outside air, thereby lowering the wet bulb temperature. The dessicant would be regenerated with the geo-water. The second stage of the two-stage cooling process would utilize an adiabatic (air washer) process to lower the supply air dry bulb temperature. A detailed thermodynamic and psychrometric analysis of this process proved it not to be technically feasible.

An extension of the above two-stage evaporative cooling system to a three-stage system was analyzed. In this scheme, a first stage air to air heat exchanger was utilized to precool the outside air intake into the system, using air relieved from the building as the cooling medium. The second stage of this system utilized a geothermal regenerated dessicant wheel with an air washer adiabatic third stage. For reasons similar to those encountered in the two-stage analysis, this process was abandoned as not feasible.

A heat pump was considered as a means for producing high temperature hot water to power an absorption process water chiller. In this scheme, the geo-water was utilized as the heat source in the evaporator of a water to water, high temperature heat pump. The heat pump was utilized to generate water at 200 F to "fire" an absorption chiller. As the Appendix "A" calculations indicate, this process was extremely costly and resulted in greater energy expenditure than a conventional electrically driven compression cycle chiller, therefore, the process was abandoned.

A last attempt to consider a geothermal assisted cooling cycle was based on the hypothesis that a deep well (on the order of 6,000 feet) might be found to produce water temperatures in the neighborhood of 250 F. (This assumption based on data gathered during the drilling of an oil exploration well approximately 10 miles from the project site.) With a 250 F source, direct utilization of the geo-water in an absorption chiller is feasible and would result in a "net" electrical energy savings of approximately 310,000 KWH/year (\$ 23,000/year based on unit cost of \$0.07/KWH). The hypothetical nature of this analysis and the obvious extreme cost of such a well (with rather low anticipated net energy savings) dictated that further analysis of the option not be considered.

5.5 LANDSCAPE IRRIGATION:

In the arid climate of Tucson, water for irrigation of landscaping is generally considered an unacceptable extravagance. The theme of the proposed commercial project under study requires a liberal quantity of water-intensive landscaping such as grass and trees. The high quality anticipated for the geo-water, coupled with the belief that it is geologically isolated from the drinking water table, present a unique opportunity for the project to utilize a portion of the geo-water for landscape irrigation.

A portion of the cooled geo-water would be directed to a pond which is also part of the landscaping design and retained and further cooled if necessary via spray jets. The stored water is then pumped to a site irrigation piping and control system much the same as a conventional irrigation system.

PART 6 ENERGY ANALYSIS TECHNIQUES

6.1 GENERAL:

In that the viability of a geothermal utilization project is dependent on the existence of a substantial heating energy requirement, this study devoted considerable effort to the estimation of such potential energy demand. Several techniques were utilized to increase the level of confidence in the final results. (All calculations are presented in Appendix "A").

6.2 MODIFIED DEGREE DAY METHOD:

This method of calculating heating energy requirements on an annual basis is documented in the 1980 edition of the ASHRAE "Systems Handbook". The method is based on the historically determined annual heating "degree days", (which referenced to 65 F for Tucson =1,800) and the calculated design heating load and temperature differential.

Design heat loss calculations for the various buildings were prepared in accordance with the 1981 ASHRAE "Handbook of Fundamentals".

Heating energy required for the swimming pools was calculated by the degree day method with the design heating load calculated in accordance with the method indicated in the 1979/1980 edition of the ASPE "Data Book", Volume I.

Annual heating energy requirements of the hotel public spaces were reduced from that predicted by the degree day method by taking credit for interior lighting during the occupied times of the day.

Annual cooling energy requirements were calculated on the basis of the modified degree day method using a value of 2,985 annual cooling degree days as obtained from Weather Data Manual AFM 88-8, published by the Department of Defense.

6.3 DOMESTIC HOT WATER ENERGY:

Hot water annual consumption energy was predicted based on the recommendations of the 1980 ASHRAE "Systems Handbook" and "Practical Plumbing Design Guide", 1979 by James Church, P.E. The recommended water consumption quantities for the various facilities were assumed to be heated from an average groundwater temperature of 60 F to a useage temperature of 115 F. A "standby" loss factor of 120% was included to account for heating requirements of the stored volume during periods of light useage, and a "geothermal heat factor" of 80% was applied to account for times when natural gas energy might be required as a back-up source.

It should be noted that because of the annual nature of the hot water demand, this useage represents a large portion of the annual energy savings of the project.

6.4 COMPUTER SIMULATED ENERGY CONSUMPTION:

A microcomputer was utilized to simulate each building in terms of heating and cooling loads and annual energy for heating, cooling and domestic hot water. The microcomputer is programmed with a modified "bin method" energy analysis routine which uses historic weather data and information regarding the construction of the building and the operation of the proposed HVAC systems.

The computer generated annual heating energy consumption data proved to be in excess of the values calculated via the "degree day" method (Appendix "A" indicates a discrepancy of approximately 20%). Heating energy savings assumptions for the study, utilize the average of the degree day and bin method values in order to be conservative. (See discussion of historical data below).

Computer generated annual cooling energy consumption data showed considerably lower energy than the degree day estimates. As previously stated, cooling systems utilizing the geothermal resource were not feasible, therefore, this data is provided for reference only.

Computer generated data for domestic hot water energy consumption correlated very well with the manual calculations.

6.5 HISTORICAL DATA:

As a final check, we obtained data generated by a nationwide survey of the American Hotel and Motel Association of 323 complexes (Refer to Appendix "B"). The data was specified by geographic location and fuel type. We compared the average data from the survey for the three adjacent geographic regions, with the average heating and water heating energy consumption as calculated above for this project. The AHMA data indicated an average fossil fuel consumption of 59,575 BTU/sq. ft./yr. which compares very favorably to the study value of 52,400 BTU/sq. ft./yr. for the hotel.

Data obtained from the local gas company for typical apartment complex gas consumption indicates a unit fuel consumption of approximately 46,00 BTU/sq. ft./yr. which is considerably higher than the 36,700 BTU/sq. ft./yr. projected by this study for the apartments. The historical data cited above lends considerable confidence to the energy savings predicted by this study. Use of the historical data would result in energy savings considerably greater than that predicted by the study:

HISTORICAL DATA PREDICTION:

BTU/YR

$$\begin{aligned}\text{Hotel} &= 59,575 \text{ BTU/SF/YR} \times 90,000 \text{ SF} = 5.4 \times 10^9 \\ \text{Apts.} &= 46,000 \text{ BTU/SF/YR} \times 180,000 \text{ SF} = \underline{8.3 \times 10^9}\end{aligned}$$

$$\begin{aligned}\text{Total BTU/YR} &= 13.7 \times 10^9 \\ \text{Total Savings Natural Gas} &= \underline{\$ 91,000/\text{YR}}\end{aligned}$$

STUDY PREDICTION:

$$\begin{aligned}\text{Total BTU/YR} &= 11 \times 10^9 \\ \text{Total Savings Natural Gas} &= \underline{\$ 75,900/\text{YR}}\end{aligned}$$

$$\begin{aligned}\text{DIFFERENCE:} &= 2.4 \times 10^9 \\ &= \underline{\$ 15,600/\text{YR}} = \underline{20.5\%}\end{aligned}$$

THEREFORE, IT IS BELIEVED THAT THE VALUES OF ENERGY SAVINGS STATED IN THIS STUDY ARE CONSERVATIVE AND REASONABLE.

PART 7 STUDY RESULTS

7.1 The following table is a summary of the predicted annual energy savings with the proposed 300-unit apartment complex and 200-unit hotel. The values indicated as future, represent values for energy consumption when a second 200-unit hotel is added to the geothermal system. All values are indicated as savings in equivalent therms of (100,000 BTU) of natural gas.

STUDY ITEM	COMPUTER CALCULATION	MANUAL CALCULATION	AVERAGE VALUE
300-unit apts. HTG.	29,375TH.	23,846TH.	26,610TH
300-unit apts. DHW.	27,850TH.	25,964TH.	26,907TH
*200-unit hotel HTG.	28,677TH.	18,000TH.	23,339TH
*200-unit hotel DHW.	4,654TH.	4,945TH.	4,800TH
*Hotel Public HTG.	2,724TH.	2,154TH.	2,439TH
*Hotel Public DHW.	1,700TH.	1,780TH.	1,750TH
*Kitchen Make-up Air	not calc.	2,308TH.	2,308TH
(2) Swimming Pools heating)	not calc.	25,100TH.	25,100TH
(3) Swimming Pools (with future hotel)	not calc.	37,700TH.	37,700TH
TOTAL PRESENT THERM:			122,388TH. 104,097TH. <u>113,243TH**</u>

* These values will double with future hotel

** This value is used in economic analysis

7.2 The following represents a summary of the estimated annual energy and water cost savings for the proposed geothermal project. It should be noted that there has been no attempt to quantify the available depletion allowance tax credits, which would have a further cost savings impact on the project.

ITEM	QUANTITY	UNIT COST*	ACTUAL \$ ANNUAL SAVINGS
Present Natural	113,250	\$0.67/CCF	\$ 76,000
Gas Savings	CCF		
Present Addit.	414,000	\$0.079/KWH	\$-32,850
Elec. Consump.	KWH		
Present Landscp.	1,100,000	\$0.93/CCF	\$ 10,600
Water Savings	CCF		
**Total Net Present			
Project Savings: (Two Years Hence):			<u>\$ 53,750/YR</u>
Future Natural	160,480	\$1.47/CCF	\$235,900
Gas Savings	CCF		
Future Addit.	457,000	\$0.16/KWH	\$-73,000
Elec. Consump.	KWH		
Future Landscp.	1,100,000	\$1.86/CCF	\$ 20,500
Water Savings			
Total Net Future			
Project Savings: (Seven Years Hence):			<u>\$183,400/YR</u>

*Unit Cost Data:

"Present" values basis two years hence and are computed as follows:

$$\begin{aligned}\text{Natural Gas} &= (\$0.429/\text{CCF}) \times (1.25)^2 = \$0.67/\text{CCF} \\ \text{Electricity} &= (\$0.06/\text{KWH}) \times (1.15)^2 = \$0.079/\text{KWH} \\ \text{Water} &= (\$0.70/\text{CCF}) \times (1.15)^2 = \$0.93/\text{CCF}\end{aligned}$$

"Future" values basis seven years hence when second hotel is projected to come on line, and are computed as follows:

$$\begin{aligned}\text{Natural Gas} &= (\$0.429/\text{CCF}) \times (1.25)^2 \times (1.15)^5 \\ &= \$1.47/\text{CCF} \\ \text{Electricity} &= (\$0.06/\text{KWH}) \times (1.15)^7 = \$0.16/\text{KWH} \\ \text{Water} &= (\$0.70/\text{CCF}) \times (1.15)^7 = \$1.86/\text{CCF}\end{aligned}$$

** Refer to previous discussion of predicted fuel savings vs. that which could be projected on the basis of historical data (see part 6).

7.3 INCREMENTAL COST DATA:

The preliminary cost estimate presented indicates an incremental cost of approximately \$ 433,000 for the geothermal utilization system. (The assumptions upon which the estimate is based are also provided). This cost includes 10% contingency, 15% escalation to the projected midpoint of construction and 10% engineering fees.

7.4 SIMPLE PAYBACK FOR THE GEOTHERMAL PROJECT:

$$\begin{aligned} \text{SPP} &= \$ 433,000 \text{ First Cost} \\ &= \$ 53,750 \text{ Net Annual Savings} \\ &= \underline{8.06 \text{ years}} \end{aligned}$$

This value is misleading because it does not include investment and depletion tax credits, nor does it include an allowance for the escalation of fuel cost savings. The simple payback approach presents an unrealistically pessimistic view of the project.

7.5 LIFE CYCLE COST ANALYSIS:

The following represents simplified life cycle cost analyses of the project based on the assumptions stated in Part 4. The life cycle cost studies do not take into account depletion allowances or investment tax credits (except in a simplistic manner). The final economic evaluations for this project are to be prepared by Decker Land Development, Inc.

The life cycle cost data labeled Run #10 represents the analysis based on the ammmortization of the full cost of the project. Negative values actually represent positive cash flows, therefore, it can be seen that the project provides positive cash flows in the first year and a total positive cash flow of \$ 3,600,000 over the 20 year analysis period.

The life cycle cost data labeled Run #11, represents the project analyzed with a 25% tax credit on the initial investment, therefore, an amortized cost of \$ 320,000. The project shows positive cash flow beginning in the second year and a total positive cash flow of approximately \$ 4,000,000. The study does not take credit for depletion tax allowances.

RUN # 10

DECKER GEOTHERMAL STUDY - GEOTHERMAL FEASABILITY REVISED INPUT DATA

VALUES ARE EXPRESSED IN ACTUAL DOLLARS

YEAR	OWNING COST	OPT. COST	MAIN. COST	TOTAL COST
1	\$63,419.60	-\$53,750.00	\$8,000.00	\$17,669.60
2	\$63,419.60	-\$61,812.50	\$8,960.00	\$10,567.10
3	\$63,419.60	-\$71,084.40	\$10,035.20	\$2,370.47
4	\$63,419.60	-\$81,747.00	\$11,239.40	-\$7,087.97
5	\$63,419.60	-\$94,009.10	\$12,588.20	-\$18,001.30
6	\$63,419.60	-\$108,110.00	\$14,098.70	-\$30,592.10
7	\$63,419.60	-\$124,327.00	\$15,790.60	-\$45,116.80
8	\$63,419.60	-\$142,976.00	\$17,685.50	-\$61,871.00
9	\$63,419.60	-\$164,422.00	\$19,807.70	-\$81,195.10
10	\$63,419.60	-\$189,086.00	\$22,184.60	-\$103,482.00
11	\$63,419.60	-\$217,449.00	\$24,846.80	-\$129,182.00
12	\$63,419.60	-\$250,066.00	\$27,828.40	-\$158,818.00
13	\$63,419.60	-\$287,576.00	\$31,167.80	-\$192,989.00
14	\$63,419.60	-\$330,712.00	\$34,907.90	-\$232,385.00
15	\$63,419.60	-\$380,319.00	\$39,096.90	-\$277,803.00
16	\$63,419.60	-\$437,367.00	\$43,788.50	-\$330,159.00
17	\$63,419.60	-\$502,972.00	\$49,043.10	-\$390,509.00
18	\$63,419.60	-\$578,418.00	\$54,928.30	-\$460,070.00
19	\$63,419.60	-\$665,181.00	\$61,519.70	-\$540,241.00
20	\$63,419.60	-\$764,958.00	\$68,902.10	-\$632,636.00
TOTALS				
-	\$1,268,390.00	-\$5,506,340.00	\$576,420.00	-\$3,661,530.00

RUN # 10
INPUTS

TOTAL COST OF EQUIPMENT=	\$425,000.00	NUMBER OF YEARS FINANCED	20
OPERATING COST OF EQUIP=	-\$53,750.00	ANNUAL INTEREST RATE =	14
ANNUAL MAINTENANCE COST=	\$8,000.00	% INCREASE IN MAINT. COST	12
% INFLATION RATE / YEAR=	0.00	% INCREASE IN OPT. COST	15

RUN # 11

DECKER GEOTHERMAL STUDY - DECKER GEOTHERMAL STUDY REVISED

VALUES ARE EXPRESSED IN ACTUAL DOLLARS

YEAR	OWNING COST	OPT. COST	MAIN. COST	TOTAL COST
1	\$47,751.20	-\$53,750.00	\$8,000.00	\$2,001.24
2	\$47,751.20	-\$61,812.50	\$8,960.00	-\$5,101.26
3	\$47,751.20	-\$71,084.40	\$10,035.20	-\$13,297.90
4	\$47,751.20	-\$81,747.00	\$11,239.40	-\$22,756.40
5	\$47,751.20	-\$94,009.10	\$12,588.20	-\$33,669.70
6	\$47,751.20	-\$108,110.00	\$14,098.70	-\$46,260.50
7	\$47,751.20	-\$124,327.00	\$15,790.60	-\$60,785.20
8	\$47,751.20	-\$142,976.00	\$17,685.50	-\$77,539.40
9	\$47,751.20	-\$164,422.00	\$19,807.70	-\$96,863.50
10	\$47,751.20	-\$189,086.00	\$22,184.60	-\$119,150.00
11	\$47,751.20	-\$217,449.00	\$24,846.80	-\$144,851.00
12	\$47,751.20	-\$250,066.00	\$27,828.40	-\$174,486.00
13	\$47,751.20	-\$287,576.00	\$31,167.80	-\$208,657.00
14	\$47,751.20	-\$330,712.00	\$34,907.90	-\$248,053.00
15	\$47,751.20	-\$380,319.00	\$39,096.90	-\$293,471.00
16	\$47,751.20	-\$437,367.00	\$43,788.50	-\$345,827.00
17	\$47,751.20	-\$502,972.00	\$49,043.10	-\$406,178.00
18	\$47,751.20	-\$578,418.00	\$54,928.30	-\$475,738.00
19	\$47,751.20	-\$665,181.00	\$61,519.70	-\$555,910.00
20	\$47,751.20	-\$764,958.00	\$68,902.10	-\$648,304.00
TOTALS				
-	\$955,025.00	-\$5,506,340.00	\$576,420.00	-\$3,974,900.00

RUN # 11
INPUTS

TOTAL COST OF EQUIPMENT=	\$320,000.00	NUMBER OF YEARS FINANCED	20
OPERATING COST OF EQUIP=	-\$53,750.00	ANNUAL INTEREST RATE =	14
ANNUAL MAINTENANCE COST=	\$8,000.00	% INCREASE IN MAINT. COST	12
% INFLATION RATE / YEAR=	0.00	% INCREASE IN OPT. COST	15

PART 8 CONCLUSIONS:

8.1 Based on the assumption of a geothermal resource which is relatively shallow (2,500 feet) and relatively hot (135 F or greater), this study finds utilization for space heating, pool heating and domestic water heating to be both technically feasible and economically attractive.

8.2 The nature of this project (Apartments and Hotels) presents several factors which lend significantly to the favorable results:

- a) New construction can be designed to effectively utilize the resource more economically than in a retrofit of an existing facility.
- b) The source is believed to be relatively hot (135 F) allowing direct utilization for heating, rather than the need for an intermediate device, such as a heat pump.
- c) This type of project is relatively energy intensive from a heating requirement viewpoint due to the following:
 - 1. 24 hour per day operation
 - 2. Low internal heat generation (ie. lights, etc.) to offset the required heating.
 - 3. Swimming Pools require heating
 - 4. Large demands for domestic heat water on a year-round basis

8.3 Geothermally assisted cooling with a 135 F source is not technically feasible from the viewpoint of energy conservation.

8.4 Geothermally assisted cooling with a 250 F source is technically feasible, however, for this project it does not appear to be economically viable because of the assumed cost of the well and energy required to operate the pumps.

8.5 A useful by-product of geothermal energy utilization for this project is to capture some of the cooled water for use in irrigating the proposed extensive landscaping. This by-product provides both an economic advantage to the project and a benefit to the community by reducing the potential demand on the drinking water aquifer.

PART 9 RECOMMENDATIONS

9.1 A more detailed engineering analysis of the project should be commissioned when the planning has advanced to the point where fewer assumptions need be made and more accurate results could be provided.

9.2 Decker Land Development should proceed with their detailed economic analysis of the data presented herein. The DLD analysis must evaluate tax implications, short and long-term borrowing costs, the intangible benefit which might result from positive publicity and the financial risk of the venture.

9.3 In the event that the project type is changed from apartments and hotels to a less heating energy-intensive facility (ie. office space), an engineering evaluation of the energy impact of such a change must precede any decision to implement geothermal utilization.

9.4 The design of a geothermal well should be such that a relatively inexpensive test well could be constructed to determine the nature of the resource and if it proves viable, the test well could be expanded into a full production well with minimal expense.