GEOHERMAL SPACE AND WATER HEATING FACILITIES

Schooler Apartments
Klamath Falls, Oregon

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The following feasibility study is the result of a request to the Geo-Heat Utilization Center for Technical Assistance.

Introduction

Mr. Roger Schooler presently has under construction two buildings comprising a total of 16 apartments of about 1000 square feet each. The plan calls for the construction of eight buildings with a total of 50 apartments. The complex is located on the north side of Hilyard Avenue just west of Summers Lane. Mr. Schooler is considering heating the apartments with individual 10 KW electric furnaces, and providing domestic hot water with electric water heaters. As an alternative, he has requested a study to determine the feasibility of utilizing geothermal water for space and domestic water heating.

Summary and Conclusion

1. Utilizing geothermal water for space and water heating of the 50 apartment buildings is feasible and economically attractive. Estimated installed cost for the facilities is \$130,000. The net capital cost to the project is \$103,000, when a credit of \$27,000 is taken for electric furnaces and water heaters not installed. Table 1 presents a summary of the capital costs. Based on the \$103,000 a 31% rate of return, after taxes, has been calculated.
2. Savings in electrical power consumption for the first full year of operation is calculated to be \$39,333. To generate income a premium rental charge would be required. A charge of \$65 a month per apartment would be approximately equal to this energy savings. For the cost analysis an initial total income of \$37,366 was used. This is based on 95% occupancy. Table 2 summarizes how income was determined.
3. In determining the 31% rate of return on invested capital, the initial rental premium of \$65 per month was increased by 7% per year. Electrical energy costs are forecasted to escalate at 9.5% per year through 1986, and 8.58% per year thereafter. Based on these percentages, the allowable premium charge on the apartments could be greater in later years than those developed using the 7% figure. A satisfactory rate of return on capital could be projected by using a lower initial rental premium, and a rental premium escalation rate higher than 7%. Initial operating costs amount to \$6,036 per year for maintenance, electricity for pumping, taxes, and insurance. Depreciation amounts to \$4,635 per year. Table 3 summarizes operating costs.

Wells

An existing 500 foot well exists on the property. Temperature measurements taken on July 3, 1979 indicated the bottom temperature to be 98°F, at a depth of about 450 feet. Apparently there was a cave-in or blockage at that level. Earlier data (Water Resources Investigation 76-127, 1976) reported a temperature of 100°F at 500 feet, and a gradient of 5.5°C/100 feet. Based on this gradient and a temperature of 100°F at 500 feet a temperature of 145°F should be obtainable by reworking the well to a depth of 950 feet. This well is 1500 feet northwest of a well at Mazama School. The Mazama well has a bottom temperature of 142°F at 972 feet. The lava rock formation begins at 950 feet at Mazama and may be slightly shallower at the Schooler property. For design we have estimated a 950 foot well will yield 127 gpm of 140°F geothermal water. An injection well, also 950 feet deep, is thought to be required to return the used geothermal water to the same aquifer. The formation appears to lack the necessary permeability for injection at shallower levels. For both wells, a 10" base with 8" casing is proposed to a 500 foot depth. The remaining 450 feet is an 8" base with a 6" casing.

Facilities

A simplified diagram of the proposed facilities is shown on Figure 1. Geothermal water at 140°F is delivered by a turbine pump developing 325 feet of head at 127 gallons per minute. The geothermal water flows through an insulated pipe to a plate heat exchanger. Design duty for the exchanger is 1.85 MM BTU/HR, removing 30°F from the geothermal water. The water then flows through a network of uninsulated buried pipe that heats the walks and driveways. The cooled geothermal water arrives at the injection well with 30 psig of injection pressure. The injection well is located at the northwest corner of the property to provide the maximum separation between the wells.

Flow through the closed secondary loop is provided by a circulating pump that delivers 118 gpm at 355 feet of head. Loop water arrives at the plate heat exchanger at 98.5°F and leaves at 130°F. Outside lines are buried with supply lines insulated and return lines uninsulated. Domestic hot water is provided by a 130°F slip stream off the heated loop water. Average demand is 3.65 gallons per minute. Peak demand has not been determined. The apartments are heated by individual hot water fan coil units. Requirements for the units are:

Basis:	Water in	130°F
	Water out	100°F
	Air in	65°F
	Air out	100°F
	Air flow	895 SCFM
Coil:	Fin height	12"
	Fin length	15"
	Face area	1.25 square feet
	Tubes per row	7
	Number of rows	3
	12 Fins per inch	
	Duty	34,130 BTU/HR
	Number feeds	1
	Number passes	21
	5/8" Copper tubes, aluminum fins	

Water leaving the fin coils is returned to a suction drum for the circulating pump. Makeup domestic water also enters the drum. Though not detailed a system for controlling flow and temperature is provided for in the estimate. Piping costs were based on steel pipe in sizes from 2 1/2" to 3/4". Insulation is 2" urethane foam, a PVC jacket on buried pipe, and a wrapped cover over insulated pipe in the building. Final design should consider the potential problem of exterior corrosion on buried steel pipe if unprotected.

Cost Analysis

The cost analysis used a savings of electrical costs assuming 95% occupancy and inflated these savings at 7% which is assumed to be the economic inflation rate.

Percentage depletion allowances were assessed, these savings are as follows:

1980	22%
1981	20%
1982	18%
1983	16%
1984 through 1998	15%

Depreciation was based on straight-line depreciation, a 20 year life, and a 10% salvage value.

Electrical pumping costs were assumed to inflate at 9.5% annually through 1986 and 8.58% thereafter.

Operation and maintenance costs inflate at 7% annually and the property taxes and insurance are projected to increase at 1% per year.

The company is assumed to be in a 48% effective tax bracket for federal income tax purposes.

Table 4 details the cost analysis.

CAPITAL COST SUMMARY

Schooler Apartments
Klamath Falls, Oregon

50 Apartments

TABLE 1

Geothermal well, rework existing well to 950' 10" Bore x 8" case x 500', 8" bore x 6" case x 450'	\$ 21,000
Injection well, new well 950' deep 10" Bore x 8" case x 500', 8" bore x 6" case x 450'	23,000
Geothermal and secondary piping system	32,000
Turbine pump 127 gpm @ 325' head	8,000
Secondary circulating pump 125 GPM @ 355'	8,000
Plate heat exchanger (geothermal/secondary)	5,000
Pump/exchanger building 12' x 15'	6,000
Fan coil heaters 50 - 34,130 BTU/HR units	10,000
Miscellaneous electrical & mechanical	<u>5,000</u>
Subtotal -	118,000
Contingency	<u>12,000</u>
Installed cost	\$130,000
Credit for electric furnaces not installed 50 - 10 KW units	18,000
Credit for electric water heaters not installed 50-52 gallon units	<u>9,000</u>
(1) Net capital cost	\$103,000

(1) Excludes any engineering or contractors fees, building permits
or licenses, or cost escalation

INCOME SUMMARY

Schooler Apartments
Klamath Falls, Oregon

50 Apartments

TABLE 2

Annual power savings (100% occupancy)

Elimination of electric furnaces

Basis: 50 - 10 KW units, 2295 heating
hours per year

$$50 \times 10 \times 2295$$

$$1,148,000 \frac{\text{KWH}}{\text{Year}}$$

Elimination of elimination of electric water heaters

Basis: 50 - 52 gallon water heaters
2 changes per day, 80°F rise
in water temperature

$$\frac{52 \times 80 \times 8.31 \times 2 \times 30}{3413} = \frac{608 \text{ KWH}}{\text{Apartment} \times \text{Month}}$$

$$608 \times 50 \times 12 =$$

$$364,800$$

Total Power Saving

$$1,512,800 \frac{\text{KWH}}{\text{Year}}$$

Value of power savings @ \$.0260/KWH

$$1,512,800 \times .0260 =$$

$$\$39,333/\text{year}$$

Monthly premium rental to generate income
equivalent to value of power savings
@ 100% occupancy

$$\frac{39,333}{50 \times 12 \times 1.0} = \$65 \text{ per month}$$

Initial total income for economic calculations
@ 95% occupancy

$$39,333 \times .95 = \$37,366.35$$

OPERATING COST SUMMARY

Schooler Apartments
Klamath Falls, Oregon

50 Apartments

TABLE 3

Operating Cost:

Maintenance -

Piping @ 1/2% of installed cost	\$/YR
32,000 x .005 =	160

Pumps, exchangers, fan coils, exchanger, building @ 3%	
54,000 x .03 =	1,620

Wells - Negligible	<u>0</u>
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Total maintenance	1,780
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Taxes and insurance @ 2 1/2% of installed cost (except wells) (130,000 - 44,000) x .025)	2,150
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Electrical pumping costs @ \$.0260/KWH

Turbine pump	36,000 KWH/YR
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Circulating pump	<u>45,000</u>
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Total	81,000 KWH/YR
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81,000 x .0260 =	<u>2,106</u>
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Initial annual operating cost	\$ 6,036/year
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Depreciation - 20 year straight-line
with 10% salvage value

$\frac{103,000 \times .9}{20}$	= \$ 4,635/year
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TABLE 4
COST ANALYSIS

Year	Cost of Elec.	Depletion	Depreciation	Electrical Costs for Geothermal System	Operation & Maintenance Costs for Geothermal System	Insurance & Property Taxes for Geothermal	Net Income Before Taxes	Federal Income Tax	Net Income After Taxes	Plus Depre. & Depletion	After Tax Cash Flow	31% Net Present Value
1	39,982	8,796	4,635	2,306	1,905	2,172	13,308	0	13,308	13,431	26,739	20,41
2	42,781	8,556	4,635	2,525	2,038	2,193	22,833	0	22,833	13,191	36,024	20,99
3	45,775	8,240	4,635	2,765	2,181	2,215	25,740	9,103	16,637	12,875	29,511	13,12
4	48,980	7,837	4,635	3,028	2,333	2,237	28,910	13,877	15,033	12,472	27,505	9,33
5	52,408	7,861	4,635	3,315	2,497	2,260	31,840	15,283	16,557	12,496	29,053	7,53
6	56,077	8,412	4,635	3,630	2,671	2,282	34,446	16,534	17,912	13,047	30,959	6,12
7	60,002	9,000	4,635	3,975	2,858	2,305	37,228	17,870	19,359	13,635	32,994	4,98
8	64,202	9,630	4,635	4,316	3,058	2,328	40,234	19,312	20,922	14,265	35,187	4,05
9	68,697	10,304	4,635	4,687	3,272	2,351	43,447	20,854	22,592	14,939	37,532	3,30
10	73,505	11,026	4,635	5,089	3,502	2,375	46,879	22,502	24,377	15,661	40,038	2,69
11	78,651	11,798	4,635	5,525	3,747	2,399	50,547	24,263	26,285	16,433	42,717	2,19
12	84,156	12,623	4,635	5,999	4,009	2,423	54,467	26,144	28,323	17,258	45,581	1,78
13	90,047	13,507	4,635	6,514	4,290	2,447	58,654	28,154	30,500	18,142	48,652	1,45
14	96,350	14,453	4,635	7,073	4,590	2,471	63,129	30,302	32,827	19,088	51,914	1,18
15	103,095	15,464	4,635	7,680	4,911	2,496	67,909	32,596	35,312	20,099	55,412	96
16	110,312	16,547	4,635	8,339	5,255	2,521	73,015	35,047	37,968	21,182	59,150	78
17	118,033	17,705	4,635	9,054	5,623	2,546	78,470	37,666	40,804	22,340	63,144	64
18	126,296	18,944	4,635	9,831	6,016	2,572	84,297	40,463	43,835	23,579	67,414	52
19	135,136	20,270	4,635	10,675	6,437	2,597	90,521	43,450	47,071	24,905	71,944	42
20	144,596	21,689	4,635	11,591	6,888	2,623	97,170	46,641	50,528	26,324	76,853	34

TOTAL 102,86

PROPOSED GEOTHERMAL SPACE HEATING & WATER HEATING SYSTEM
SCHOOLER APARTMENTS
KLAMATH FALLS, OREGON
 FIGURE 1

GPR 7/12/79