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DISTRICT-HEATING SYSTEM,
LA GRANDE, OREGON

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DISTRICT HEATING SYSTEM LA GRANDE, OREGON

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

INTRODUCTION

During a meeting with Union County officials on September 11, 1981 the Geo-Heat Center was asked to participate in a HUD-DOE district heating feasibility study. The area suggested for investigation encompassed slightly over 400 acres extending north and south from the geographic center of the city. This district was subdivided into 8 areas, which include the Grande Ronde Hospital, Eastern Oregon State College, La Grande school district, one institutional area, one commercial area and three residential areas. Subsequent to the meeting, basic space heating loads were developed for the various areas after a survey by County personnel and computation using a computer program developed by Argonne National Laboratory. This information, together with previous work done by Eliot Allen and Associates, Inc., forms the basis for this economic feasibility study.

SUMMARY OF CONCLUSIONS

A geothermal district heating system for the City of La Grande is economically feasible. This assumes that a 150°F geothermal source capable of delivering a peak water quantity of approximately 5,000 gallons per minute from a depth of 2,500 feet can be located within, or adjacent to, the district boundary. Total volume needed from the geothermal reservoir during the 25 year project life is approximately

33,000 acre feet.

The district's north boundary was established along Jefferson Avenue. After heat load evaluation, the residential area (Area 7) north of Jefferson Avenue was excluded from the proposed district because of a low heat density, and distance from the assumed site of the production wells. This site is north of 'H' Avenue and west of Second Avenue.

Total project cost, including all retrofit, is \$12,000,000. Based on 10% financing of \$9,723,000, which includes the retrofit cost of the public buildings, a present worth of about \$14,565,298 is generated over the 25 year project life.

Total energy saved during the 25 year life of the project is about 56 million therms of natural gas, 1.9 million gallons of fuel oil, and 1,600 tons of coal.

SYSTEM HEATING REQUIREMENTS

Figure 1, Heating District Boundary, shows the eight areas that were investigated. Union County personnel surveyed Areas 4, 5, 6, 7 and 8 and determined pertinent information related to the existing buildings. This information included number and size of buildings, type of construction, amount of insulation, and number of stories. Using a program provided by the Argonne National Laboratory and a HP 41 programmable calculator, the design loads on a heating degree day basis were calculated. This was done on a block-by-block basis using a design inside temperature of 65°F, and an outside design temperature of 10°F. Heat load requirements for Areas 1, 2 and 3 were based on information in a study entitled Preliminary Design & Economic Analyses for Three Conceptual Geothermal Demonstrations in Union County, Oregon by Eliot Allen and Associates, Inc. The Allen study is based

HEATING DISTRICT BOUNDARY
LA GRANDE, OREGON
 FIGURE 1

on 65°F inside temperature and 1°F outside temperature. Heat load calculations for Areas 4, 5, 6, 7 and 8 were converted to a peak heating requirement and adjusted to the 1°F outside temperature so that all areas were on a consistent basis. Table 1, Heating Summary and Flow Rates, tabulates the peak heating loads that form a basis for this study. Domestic hot water requirements were calculated and are also shown on Table 1. Summation of peak heat and peak hot water gives the maximum total heating load that the geothermal system must provide, which amounts to 126.38 million Btu per hour, for all areas except Area 7. About 16% of this peak requirement is needed to provide domestic hot water.

Area 7, the residential area north of Jefferson Avenue, was excluded from the proposed district because of a low heat density, and distance from the assumed site of the production wells. Area 7 has a peak heating requirement of 44.85 million Btu per hour, spread over a very large area of approximately 170 acres. This results in a low heat density of about 0.35 billion Btu per year per acre located about one mile and a half from the wells.

HOT WATER CIRCULATING RATE

Design hot water circulating rates were calculated on a block-by-block basis, with the exception of Area 1 and Area 3 where they were calculated on a per building basis. The results are summarized in Table 1. Water rates were calculated based on 145°F inlet water, and outlet water temperatures that varied from 115°F to 75°F. The 115°F results from space heating conversion to natural convection heaters, such as base board convectors. The 75°F results from conversion to

HEATING SUMMARY & FLOW RATES

LA GRANDE HEATING DISTRICT

Table 1

AREA NO. & TITLE	MAJOR CONSUMERS	LAND AREA (ACRES)	BLDG AREA (Ft ²)	PEAK (10 ⁶ Btu/Hr)			FLOW RATES (GPM at 145°F)					
				HEAT	HOT WATER	TOTAL	115	107	95	91	75	TOTAL
2 GRANDE RONDE HOSPITAL	Total Area 2	7.08	81,000	5.14	1.55	6.69			272			272
1 LA GRANDE SCHOOL DISTRICT	Central School High School & H.S. Addition Middle School Administration Building Total Area 1	41.73	34,320 176,740 74,900 42,750 328,710	1.37 4.65 2.00 0.85 8.87	.20 .47 .23 .08 0.98	1.57 5.12 2.23 0.93 9.85			64 208 91 38			401
6 RESIDENTIAL	Block 108 & 109 Block 110 & 111 Block 112, 113 & 114 Total Area 6	14.24	16,449 25,624 36,761 78,834	0.61 0.83 1.47 2.91	.37 .57 .82 1.76	0.98 1.40 2.29 4.67		53 75 123				251
4 INSTITUTIONS	Block 104 Block 105 Block 106 Block 107 Total Area 4	10.33	123,171 28,241 45,907 24,220 221,539	5.44 1.43 1.72 0.90 9.49	.19 .04 .07 .03 0.33	5.63 1.47 1.79 0.93 9.82				212 55 67 35		369
3 EASTERN OREGON STATE COLLEGE	Administration Building Plant Services Library Ackerman Hall Hunt Hall Dormitory Hoke Center Classroom Building Dorian Hall Dorm Quinn Coliseum Science Building Central Heating Plant Total Area 3	55.64	46,644 8,000 14,050 56,616 68,622 50,245 36,833 51,327 56,300 47,000 - 435,637	1.54 0.41 0.46 1.86 2.21 1.66 1.41 1.69 2.87 1.55 - 15.66	.33 .06 .10 .41 .49 .36 .27 .37 .41 .34 - 3.14	1.87 0.47 0.56 2.27 2.70 2.02 1.68 2.06 3.28 1.89 - 18.80	32		76 23 92		59 49	804
8 RESIDENTIAL	Block 71 through 76 Block 83 through 87 Block 88 through 94 Block 95 through 102 Total Area 8	66.83	168,658 70,127 136,093 104,945 479,823	10.58 2.47 5.10 3.76 21.91	3.76 1.56 3.03 2.34 10.69	14.34 4.03 8.13 6.10 32.60			583 164 331 248			1326
5 COMMERCIAL	Block 61, 62, 80, 81, 82 Block 60, 65, 66, 67, 68 Block 63, 64, 69, 70, 77, 78, 79 Total Area 5	41.32	139,175 352,795 446,599 938,569	5.97 16.88 19.69 42.54	.21 .53 .67 1.41	6.18 17.41 20.36 43.95				233 656 767		1656
TOTAL DISTRICT	Area 1 through Area 8 (Excluding Area 7)		2,564,112	106.52	19.86	126.38	355	251	2190	2025	258	5079

forced air convectors, including finned tube coil inside ducting. The various areas and buildings have a mix of space heating equipment and the outlet temperatures were estimated using the following:

<u>Water Out (°F)</u>	<u>Forced Air Systems (%)</u>	<u>Natural Flow Convectors (%)</u>
115	0	100
107	20	80
95	50	50
91	60	40
75	100	0

From Table 1, the total peak circulation water rate for the seven areas is 5,079 gpm, and the overall return temperature is calculated to be 94.4°F.

DESCRIPTION OF SYSTEM

Figure 2, Flow Diagram, District Heating System, is the conceptual design for the system. Six production wells are anticipated as being required to produce the necessary total of 5,047 gpm of 150°F geothermal water. The wells are 2,500 feet, with a static level of 200 feet and a pumping level of 300 feet. Each well requires turbine pumps set at 350 feet. The wells are fully cased with a 16 inch bore with 14 inch casing to a depth of 400 feet, a 12 inch bore with 10 inch casing for the next 1,000 feet, and finally a 10 inch bore with 8 inch casing for the next 1,100 feet to the bottom. Each turbine pump uses a 125 HP electric motor with variable speed hydraulic driver to deliver 841 gpm at the 370 foot total head. The variable speed driver minimizes electric power usage, and reduces wear and tear on the pump. Pump surface discharge pressure is about 28 psig, which is sufficient to move the water through the piping, the heat exchanger, and into the injection well.

TURBINE PUMPS
W/VARIABLE SPEED
DRIVERS (6 REQ'D)
 125 HP, 841 GPM, 370'

FLOW DIAGRAM
DISTRICT HEATING SYSTEM
 LA GRANDE, OREGON
 FIGURE 2

Two large plate heat exchangers are needed to transfer the 126.38 million Btu per hour from the geothermal water to the circulating clean water stream. The geothermal water is expected to be of insufficient quality to permit direct use in the space heating and domestic water heating equipment within the buildings. The plate heat exchanger isolates corrosion and scaling problems to the geothermal side of the system.

Water entering the injection well will be 99°F, or slightly less. No injection pressure is needed if the production and injection aquifers prove to be similar, and the static and pumping levels are as shown on Figure 2. The water level in each of the four injection wells will rise about 180 feet when the total flow is being accepted. The injection wells are 2,500 feet deep using a 10 inch bore, and fully cased with 8 inch pipe.

On the circulating side of the system, water returns to the plate heat exchanger at 94.4°F and leaves at 145°F. The design circulation rate is 5,079 gpm at the 145°F temperature. Circulation is accomplished by a large 200 hp centrifugal pump that develops a total head of 124 feet and a discharge pressure of about 53 psig. There is an identical non-operating pump that acts as a spare pump. The 53 psig discharge pressure is sufficient to pump the circulating water to and from the furthest building with an allowance of 6 psig pressure drop for control and piping pressure loss within the building. No booster pumps are required.

PIPING SYSTEM

Figure 3 shows the pipeline routing in Areas 1, 2, 3, 4 and 6,

Figure 4 shows the routing in Areas 5 and 8. Looking at Figure 3, the six production wells are located in Area 1 north of 'H' Avenue, west of Second Avenue, and south of the schools. The wells are spaced 500 feet apart. The heat exchanger/pump building is located about 100 feet west of the intersection of Second and 'I' Avenues. The injection wells are located in Area 3 south of 'G' Avenue, and west of the eastern boundary of the area. The main pipeline serving Areas 3, 4, 5, 6 and 8 runs from the pump/exchanger building east on 'I' Avenue, north on Seventh Avenue, east on 'K' Avenue, north on Eighth Avenue, and northeast on Greenwood Street ending at Jefferson Avenue. Area 2 piping runs south on Second Avenue, west on 'H' Avenue, and north on Sunset Drive. Area 1 mainline runs north on Second Avenue to 'K' Avenue, where branch lines run both east and west. Wherever possible, branch lines are located in alleys.

The circulating and hot geothermal system is based on using quick connect fiberglass reinforced piping (FRP) for all piping 2 inches and larger. 1 1/2 inch piping and smaller is black steel pipe. All pipe is insulated with two inches of urethane and protected by a polyvinyl chloride (PVC) jacket. The cold geothermal water disposal line from the pump/exchanger building to the injection wells is uninsulated asbestos cement pipe. All pipe is buried three feet. With the exception of very short runs, mainline pipe velocities are in the range of 2 to 7 feet per second, with the higher velocities occurring in the larger pipe sizes. With these velocities, mainline pressure drop is not high and pumping costs are not excessive. The piping required to do the total district, excluding piping within the building is:

PIPELINE ROUTING
AREAS 1, 2, 3, 4 & 6
LA GRANDE, OREGON
FIGURE 2

PIPELINE ROUTING

AREAS 5 & 8

LA GRANDE, OREGON

FIGURE 4

INSULATED FRP

<u>Size (inch)</u>	<u>Length (feet)</u>	<u>Size (inch)</u>	<u>Length (feet)</u>
18	4,650	6	6,680
16	4,240	4	13,000
12	1,100	3	11,020
10	4,600	2	6,600
8	15,640		

INSULATED STEEL

1 1/2	2,620	1	760
1 1/4	15,300	3/4	31,100

ASBESTOS CEMENT

18	2,850
16	600
10	1,040

CAPITAL COST

Table 2 summarizes estimated capital and operating cost for the district heating system as described in the previous pages. These costs are in 1982 dollars, and no escalation is included. Total cost for the district is \$12,000,000 including \$3,000,000 to retrofit the buildings. Retrofit costs are very difficult to estimate since they are dependent on what exists in the buildings, as well as the new equipment that is to be installed. This estimate, which is more correctly an allowance, is based on the type of retrofit that is expected and a cost per million Btu per hour for that particular type retrofit. The costs used are as follows:

	<u>\$/Million Btu/hr</u>
Natural flow convectors	23,000
Forced air convectors	8,000
Finned coils in existing ducting	6,000
Building piping	8,000
Domestic hot water	12,000

Obviously, the ease or difficulty of installing piping (and wiring for forced air convectors) will cause a wide variation of retrofit costs on a building-to-building basis. The type of retrofit can be interpreted

from Table 1, since they were used to calculate the return temperatures of the circulating water. As an example, the water return temperature from Area 5 is 91°F, which is 60% forced air systems and 40% natural flow convectors. In each case, forced air systems assume a 50/50 utilization of forced air convectors and finned coils in existing ducting. Therefore, Area 5 retrofit cost is calculated to be:

Heat	42.54	X	.6	X	.5	X	8,000	=	102,096
Heat	42.54	X	.6	X	.5	X	6,000	=	76,572
Heat	42.54	X	.4	X	23,000			=	391,368
Hot Water	1.41	X	12,000					=	16,920
Piping	43.95	X	8,000					=	<u>351,600</u>
TOTAL									938,556

Calculated retrofit costs were rounded upward, and totaled as shown:

Area 1	\$250,000
Area 2	150,000
Area 3	450,000
Area 4	250,000
Area 5	950,000
Area 6	150,000
Area 8	<u>800,000</u>
Total Retrofit Cost	\$3,000,000

Small buildings, about 10 foot by 10 foot, are needed at each of the six production wells. A 20 foot by 25 foot building is needed to house the plate heat exchangers, circulating pump and spare, and the control room. These buildings were estimated to cost \$80,000.

Miscellaneous mechanical and electrical subcontract work amounting to \$200,000 is estimated. This includes some modification work on existing facilities to accommodate the geothermal system.

The subtotal for the work is estimated to be \$10,600,000. To this, a contingency of \$1,400,000 has been added which includes the engineer's fee. The engineer's fee is negotiable, and therefore has not been shown as a separate item. Total job cost is estimated to be \$12,000,000 in 1982 dollars. There is no escalation in this dollar figure.

SUMMARY OF CAPITAL AND OPERATING COSTS

LA GRANDE HEATING DISTRICT

1982 Dollars

Table 2

CAPITAL

Piping	\$5,000,000
Production wells (6) & injection wells (4)	1,500,000
Turbine pumps w/variable speed drivers (6)	500,000
Circulating pump & spare	70,000
Plate heat exchangers (2)	250,000
Well head bldgs (6) & pump/exchanger bldg.	80,000
Building retrofit	3,000,000
Miscellaneous mechanical & electrical	200,000
	<hr/>
SUBTOTAL	10,600,000
Contingency & engineering fee	1,400,000
	<hr/>
TOTAL CAPITAL COST	\$12,000,000

OPERATING COST (1st 100% year)

Maintenance	
Piping, retrofit & exchangers	90,000
Pumps & buildings	28,364
	<hr/>
TOTAL MAINTENANCE	\$118,364
Insurance	\$51,818
Electrical Power	
Convactor fans 150.0 kw	
Turbine pumps (6) 506.4	
Circulating pump (1) 152.6	
	<hr/>
	809.0 kw
TOTAL POWER COST @ \$0.03/kwh & 1710 hrs/year	\$41,502
	<hr/>
TOTAL OPERATING COST (1st 100% year)	\$211,684

It is estimated that expenditures for construction of the system will occur over a two year period, and over a five year period for the retrofit. Figure 5 is a plot of the schedule of capital expenditures in 1982 dollars.

OPERATING COSTS

A summary of operating costs are shown on Table 2. Total operating cost is \$211,684 per year in 1982 dollars. However, this rate will not be reached until the end of the 5th year, when all retrofit is completed and the system is operating at design capacity. Figure 6 is a plot of the rate of operating expenditures at years end.

ANNUAL FUEL SAVINGS

Annual fuel savings are summarized in Table 3. The annual requirements for space heating are projected from the peak heating requirements tabulated in Table 1 on the basis of 1710 hours per year. Annual hours based on 6374 degree days, a 1°F outside design temperature, 65°F inside design temperature yield 2390 hours per year. This is corrected by a factor of .716 (ASHRAE) to give 1710 hours per year. Conversion from peak hot water to annual hot water varied from about 685 hours per year to 1703 hours per year depending on the particular facility using the hot water.

Total annual energy replaced by geothermal is 182.887 billion Btu per year for space heating and 19.223 billion Btu per year for hot water. Total energy replaced is 202.110 billion Btu per year.

Annual heat densities were calculated by dividing the total annual

SCHEDULE OF CAPITAL EXPENDITURES
HEATING DISTRICT
LA GRANDE, OREGON
1982 DOLLARS
FIGURE 5

ANNUAL OPERATING COST

HEATING DISTRICT
LA GRANDE, OREGON
(1982 \$)

FIGURE 6

ANNUAL FUEL SAVINGS
LA GRANDE HEATING DISTRICT

Table 3

AREA NO. & TITLE	MAJOR CONSUMERS	ANNUAL (10 ⁹ Btu/Yr)			ANNUAL HEAT DENSITY = Btu X 10 ⁹	EXISTING FUEL USAGE Btu/Yr X 10 ⁹				
		HEAT	HOT WATER	TOTAL		NATURAL GAS	FUEL OIL	COAL	ELECT.	TOTAL
LA GRANDE RONDE HOSPITAL	Total Area 2	8.800	2.640	11.440	1.62	17.487				17.487
LA GRANDE SCHOOL DISTRICT	Central School	2.494	.191	2.685		.287				.287
	High School & H.S. Addition	8.303	.452	8.755		20.681	1.583			22.264
	Middle School	3.593	.220	3.813		.331				.331
	Administration Building	1.514	.080	1.594		.968		1.640		2.608
	Total Area 1	15.904	0.943	16.847	0.40	22.267	1.583	1.640		25.490
RESIDENTIAL	Block 108 & 109	1.038	.252	1.290		.688			.744	1.432
	Block 110 & 111	1.416	.392	1.808		.964			1.085	2.049
	Block 112, 113 & 114	2.512	.562	3.074		1.639			1.844	3.483
	Total Area 6	4.966	1.206	6.172	0.13	3.291			3.673	6.964
INSTITUTIONS	Block 104	9.306	.179	9.485		12.014	.730			12.744
	Block 105	2.440	.041	2.481		3.143	.191			3.334
	Block 106	2.945	.067	3.012		3.815	.232			4.047
	Block 107	1.532	.035	1.567		1.985	.121			2.106
	Total Area 4	16.223	0.322	16.545	1.60	20.957	1.274			22.231
EASTERN OREGON STATE COLLEGE	Administration Building	2.633	.533	3.166						
	Plant Services	.701	.142	.843						
	Library	.787	.159	.946						
	Ackerman Hall	3.181	.644	3.825						
	Hunt Hall Dormitory	3.779	.765	4.544						
	Hoke Center	2.839	.575	3.414						
	Classroom Building	2.411	.488	2.899						
	Dorian Hall Dorm	2.890	.585	3.475						
	Quinn Coliseum	4.908	.993	5.901						
	Science Building	2.651	.536	3.187						
	Central Heating Plant	-	-	-		55.650				55.650
	Total Area 3	26.780	5.420	32.200	0.58	55.650				55.650
RESIDENTIAL	Block 71 through 76	18.097	2.580	20.677		26.191	1.591			27.782
	Block 83 through 87	4.227	1.073	5.300		6.713	.408			7.121
	Block 88 through 94	8.716	2.082	10.798		13.677	.831			14.508
	Block 95 through 102	6.430	1.606	8.036		10.179	.618			10.797
	Total Area 8	37.470	7.341	44.811	0.67	56.760	3.448			60.208
COMMERCIAL	Block 61, 62, 80, 81, 82	10.209	.200	10.409		13.185	.801			13.986
	Block 60, 65, 66, 67, 68	28.865	.508	29.373		37.206	2.259			39.465
	Block 63, 64, 69, 70, 77, 78, 79	33.670	.643	34.313		43.463	2.639			46.102
	Total Area 5	72.744	1.351	74.095	1.79	93.854	5.699			99.553
TOTAL DISTRICT	Area 1 through Area 8 (Excluding Area 7)	182.887	19.223	202.110		270.266	12.004	1.640	3.673	287.583

energy replaced for each of the seven areas by the number of acres within the boundaries of the area. This density varies from a low of 0.13 billion Btu per year per acre for Area 6 to a high of 1.79 for Area 5. Area 7, the residential area north of Jefferson Avenue was excluded from the proposed district because of a low heat density (.035 billion Btu per year per acre) and distance from the assumed site of the production wells. On the other hand, Area 6 (also a residential area) was included since it is close to the wells and the main circulating pipeline passes through Area 6.

The annual existing fuel savings in Table 3 were assembled from actual utility usages in Areas 1, 2, 3 and a portion of 4 which were covered by the Eliot Allen report previously mentioned. In the remaining areas, annual existing energy usages were prorated to the appropriate fuels and increased according to the following conversion units and efficiencies:

<u>Fuel</u>	<u>Conversion</u>	<u>Efficiency</u>
Natural Gas	100,000 Btu/therm	75
Fuel Oil	138,690 Btu/gal	65
Coal	23.07 X 10 ⁶ Btu/ton	53
Electricity	3,413 Btu/kwh	100

Total annual existing fuel usage which will be saved with the heating district in full operation are:

Natural Gas	2.528 million therms/year
Fuel Oil	86,533 gallons/year
Coal	71.1 tons/year
Electricity	1.076 million kw hours

A two year construction period is assumed, and a five year period prior to the system reaching 100% capacity. Thus, energy savings begin at system start-up, and increase each year until the end of the fifth year.

The gross annual savings for the first 100% operating year in 1982 dollars is:

Natural Gas @ \$.534/therm	\$1,349,840
Fuel Oil @ 1.119/gallon	96,853
Coal @ \$83.50/ton	5,936
Electricity @ \$.03/kw hour	<u>32,285</u>
Total	\$1,484,914

Total energy saved during the 25 year life of the project is about 56 million therms of natural gas, 1.9 million gallons of fuel oil, and 1,600 tons of coal. However, electricity for pumping the system will exceed that saved by the geothermal electrical heating by about 6.8 megawatt hours over the 25 year period. This is not significant, but is considered in the economic calculations.

Figure 7 is a plot annual gross fuel savings in 1982 dollars.

LIFE CYCLE COST ANALYSIS

Life cycle cost analysis for the geothermal heating district appears in Table 4.

It was assumed that the system would come on line in 1984. The 25 year forecasts assume a 7% economic inflation rate over the project life and additional inflation rates for conventional fuels as forecast by the Oregon Department of Energy "Fifth Annual Report" as follows:

Natural Gas

9.0% through 1984
9.2% 1985 through 1989
10.0% 1990 through 1994
10.2% 1995 through 2006

Heating Oil & Propane

15.0% through 1982
8.9% 1983 through 1994
8.8% 1995 through 2006

ANNUAL FUEL SAVINGS
HEATING DISTRICT
LA GRANDE, OREGON
(1982 \$)
FIGURE 7

Electrical Power

7.86% through 1987

9.10% 1988 through 2006

Coal

9.0% through 2006

In Table 4:

Column one provides the 25 year forecast cost of natural gas based on current costs for the district;

Column two provides the 25 year forecast cost of fuel oil currently being used;

Column three forecasts the 25 year cost of electricity based on current consumption;

Column four projects the 25 year cost of coal based on current consumption;

Column five projects the electrical pumping costs for the geothermal system;

Column six forecasts the maintenance costs for the geothermal system inflating at 7% per annum;

Column seven projects the insurance costs for the geothermal system.

Column eight assumes that debt financing would be required for \$9.723 million and shows the loan payment that would be required as capital is borrowed over the first five years of the project. Interest on the loan is assumed to be 10% per annum for 25 years;

Column nine shows the 25 year savings in energy costs that result from the conversion to geothermal energy;

Column ten is a discounted cash flow at 10% per annum to arrive at a net present value of the geothermal system over the projected con-

ventional fuel costs;

Column eleven accumulates the cash flows from column nine and indicates that the project would accumulate losses of over two million dollars in the first three years of the project. This indicates that additional working capital would be required to support the project through the third year.

It should also be noted that these figures assume that the district would charge conventional fuel rates for the life of the project. However, one can easily see that charges could be significantly reduced after the sixth year to provide a considerable savings to the consumer. An additional consideration would be to accelerate the time period to bring the system to 100% capacity. This would improve the economics.

TABLE 4

LIFE CYCLE COST ANALYSIS
FOR
THE DISTRICT HEATING SYSTEM, LA GRANDE, OREGON

DATE JAN. 13, 1982

EQUITY FINANCING	2277000
DEBT FINANCING	9723000
COST OF CAPITAL	10%
TOTAL CAPITAL COST	12000000
NET PRESENT VALUE	14564298

	1	2	3	4	5	6	7	8	9	10	11
	NATURAL GAS CURRENT SYSTEM	FUEL OIL CURRENT SYSTEM	ELECTRICITY CURRENT SYSTEM	COAL CURRENT SYSTEM	ELECTRICITY GEOTHERMAL SYSTEM	MAINTENANCE GEOTHERMAL SYSTEM	INSURANCE GEOTHERMAL SYSTEM	DEBT SERVICE GEOTHERMAL SYSTEM	NET ENERGY SAVINGS	DISCOUNTED CASH FLOW 10%	CUMULATIVE CASH FLOW
PRESENT COST	1349840	96853	32285	5956	4693						
YEAR											
1982	0	0	0	0	0	36839	14899	591272	-643010	-584555	-643010
1983	0	0	0	0	0	109677	42284	1115125	-1267086	-1047178	-1910096
1984	961445	68795	22282	4242	3239	126974	47168	1142706	-271807	-204213	-2181903
1985	1439574	102161	32699	6306	4764	144435	51650	1172593	194687	132974	-1987216
1986	1991219	140921	44650	8706	6508	163718	56294	1204378	737186	457734	-1250031
1987	2499429	161540	50666	9989	7389	177632	58355	1204378	1253890	707788	3859
1988	2729376	175917	55276	10888	8062	190067	59523	1204378	1487653	763401	1491512
1989	2980479	191574	60306	11868	8796	203371	60713	1204378	1743233	813231	3234745
1990	3069893	208624	65794	12936	9596	217607	61927	1204378	1837867	779435	5072612
1991	3161990	227191	71781	14100	10469	232840	63166	1204378	1936010	746416	7008622
1992	3256850	247411	78314	15369	11422	249139	64429	1204378	2037838	714250	9046460
1993	3354555	269431	85440	16752	12461	266578	65718	1204378	2143539	682997	11189999
1994	3455192	293410	93215	18260	13595	285239	67032	1204378	2253313	652705	13443312
1995	3807621	319231	101698	19903	14832	305206	68373	1204378	2615858	688837	16059169
1996	4195999	347323	110952	21695	16182	326570	69740	1204378	3015709	721937	19074878
1997	4623991	377887	121049	23647	17655	349430	71135	1204378	3456682	752275	22531560
1998	5095638	411141	132064	25775	19261	373890	72558	1204378	3942981	780098	26474541
1999	5615393	447322	144082	28095	21014	400062	74009	1204378	4479238	805630	30953779
2000	6188163	486686	157194	30624	22926	428067	75489	1204378	5070559	829077	36024338
2001	6819355	529514	171498	33380	25013	458031	76999	1204378	5722567	850623	41746906
2002	7514930	576112	187105	36384	27289	490094	78539	1204378	6441463	870439	48188368
2003	8281452	626810	204131	39659	29772	524400	80110	1204378	7234075	888677	55422443
2004	9126161	681969	222707	43228	32481	561108	81712	1204378	8107929	905479	63530373
2005	10057029	741982	242973	47118	35437	600386	83346	1204378	9071319	920971	72601692
2006	11082846	807276	265084	51359	38662	642413	85013	1204378	10133382	935271	82735074
TOTAL	111308579	8440229	2720961	530282	396826	7863774	1630180	29313634	82735074	14564298	