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BASIN VIEW GEOTHERMAL HEATING DISTRICT

Klamath Falls, Oregon

Housing Unit Development

July 1, 1981

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BASIN VIEW GEOTHERMAL HEATING DISTRICT
KLAMATH FALLS, OREGON

CONCEPTUAL DESIGN AND ECONOMIC-
FEASIBILITY STUDY REPORT

CONTRACT #TA20-80

JULY 1, 1981

Prepared for:

OREGON INSTITUTE OF TECHNOLOGY
GEO-HEAT CENTER

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1.0 INTRODUCTION AND SUMMARY OF RESULTS

1.1 Scope

The content of this document reports the findings of a feasibility study performed by Center 4 Engineering for Basin View Heating District in Klamath Falls, Oregon. The purpose of the study is to determine the physical, economic, and political feasibility of establishing a geothermal heating district to provide space heat to housing units in the Basin View Development of Klamath Falls.

This report is not intended to provide final designs or construction documents and it is not intended to optimize final parameters and decisions. Sufficient details are provided to allow the owner to understand the major options and likely results of his decisions about possible development of the project facilities.

1.2 Organization of Report

The report is divided into five sections; 1) this introduction and summary of results; 2) scope of work; 3) physical feasibility; 4) economic feasibility; and 5) political feasibility. Sections 3, 4, and 5 contain information provided to or developed by Center 4 Engineering and comprise the basis for the following summary of results.

1.3 Summary of Results

Of the several systems considered in this report, all are physically feasible. The system as described in this text is effective with respect to both the maximum number of units served and the cost effectiveness of the system.

The project is politically feasible if the owner complies with governmental requirements as stated in section 5.0.

Economic feasibility is based on considerations of money value rates, tax rates and expected rates of return, which are dependent on government and money markets. For analysis a money value rate of 21% and an owner's marginal tax rate of 35% were adopted.

With these, and other rates, several computer printouts were generated of the present worth of net cash at the end of each year for 20 years. The figure in section 4.4 (Figure 16) shows what is considered to be the most likely result, in which the owner's rate of return on total investment is approximately 16%. This return on investment is in surplus of the 21% money market rate used for the value of money borrowed or invested.

It will be the responsibility of the owner to determine if the rate of return on investment is large enough to proceed with the project. But it is the conclusion of this report that the project as stated is economically feasible.

2.0 SCOPE OF WORK

2.1 Definition of the Project

Mel Stewart owns a large tract of land on the eastern outskirts of Klamath Falls, Oregon. He seeks to develop his resources in two ways: 1) by subdivision of the land which has already been approved, 2) by serving structures on the land development through a small, privately owned, geothermal heating district (for which he has an existing agreement with the City of Klamath Falls). A geothermal well has been drilled on the property.

Mr. Stewart is therefore raising these questions about the feasibility of his plans:

1. Is it feasible to use the well to serve the next segment of development, consisting of 32 housing units?
2. Is it feasible to use the well to serve 24 existing housing units (consisting of six four-plex structures)?
3. Is it feasible to use the well to serve a larger number of housing units within the development; and if so, how many units?
4. Is it feasible to use the well to serve some combination of the above?

2.2 Assumptions and Supportive Information

1. For purposes of this evaluation, "feasibility" is presumed to mean physical, economic, and political feasibility. Political feasibility is attainable if it appears the project will be allowed by governing agencies. Our determination is of the physical and economic feasibility. We also present findings and suggestions about political feasibility, but the ultimate conclusions and possible action are the responsibility of the owner.

Physical feasibility is attainable if there is sufficient capacity and a way to serve the desired units. Economic feasibility is attainable if expected revenues exceed expected expenses; the owner will need to decide for himself what return on investment is desired.

2. Attainable revenues are based on comparative cost tradeoffs with electric heat.
3. Each existing and planned future housing unit is approximately 1100 square feet in size. Each unit is assumed to be part of a two-story, four-plex structure constructed to current building codes (Oregon UCB Chapter 53, etc.), except that the 24 existing units have R19 ceiling, R11 walls, and double glazing.

4. The land development area of interest is platted to consist of 185 lots, each intended to contain one 4-unit structure, except there are two large lots which together should be able to support 60 units. This represents a maximum total of 792 units.
5. Delivery of geothermal water to dwelling units can be flow restricted to provide equitable and balanced delivery. But rather than individual metering, billings can be made by flat periodic charges.
6. Surface moisture and ground water levels are sufficiently high so that any buried piping will be wetted on the surface.
7. Piping runs will need to be specified for optimum distribution benefit/cost tradeoffs. Under-street runs were once suggested, but most streets have since been paved.
8. The owner has suggested surface disposal of spent geothermal water, using a natural water flow way (to which the owner controls access) consisting of a valley to the west and a little north of that portion of the development of interest to the analysis.

2.3 Statement of Work

Center 4 Engineering has conducted a feasibility study of the proposed heating district, consisting of the following Tasks:

Task 1. Estimate typical dwelling unit heating loads

Calculate probable heat losses and heating requirements for structures of the type, size, construction and location defined in the description. Identify probable average yearly energy requirements, and probable peak loads. Evaluate the approximate range of applicability of this model to the development project.

Task 2. Select appropriate technologies

Investigate and select from among major alternative technologies, systems, components and materials needed for heating district facilities. Consider the significance of resource depletion, water injection mode to the system, heat transfer interfaces and efficiencies, spent water discharge, corrosive and high temperature effects of the geothermal waters, dwelling unit taps to the main distribution trunk, control modes, maintenance requirements and emergency operations.

Task 3. Estimate geothermal water flow requirements

Calculate probable flow requirements for each option of the number of housing units, and compare them to the available geothermal resource. Determine rough sizing of piping, piping runs, heat exchangers and pumps. Estimate electrical energy consumption for well pump, circulating pump(s) and fan-coil radiators.

Task 4. Estimate construction/amortization and operating costs

Provide approximate estimates of all costs required for construction and operation of district facilities and services. Estimate probable lifetimes of facilities and necessary amortization rates. Distinguish between facilities within and exterior to individual dwelling units.

Task 5. Estimate expected revenues

Estimate unit revenue rates based on competitive energy prices, and apply them to the heating district.

Task 6. Compare benefits and costs

Compare economic and non-economic benefits and costs. Determine estimated total investment and funding availability, simple payback, life cycle benefits and costs and benefit/cost ratio. Provide comparative analysis for system alternatives.

3.0 PHYSICAL FEASIBILITY

3.1 Well and Water Considerations

The geothermal water well for the Basin View Utility District project has been drilled and found to produce usable water. Requirements and sizing of the project are dependent on the well. The following information about the well and water quality was provided for the feasibility study.

The Water Well Report filed with the State of Oregon Water Resources Department is reproduced in Appendix A. The log shows that the well was drilled to a depth of 1650 feet and completed to 1391 feet, of which 341 feet are sealed with 12-3/4" welded casing. Water was first encountered during drilling at 1108 feet, after which a static level of 71 feet was maintained. The well was tested by pumping 275 gpm for 4 hours. The water level drew down 200 feet. The temperature of the water was 152°F.

Out of concern for the well's ability to sustain this yield for longer periods, Center 4 Engineering contacted both the well driller and the company which conducted the test pumping.

The well was drilled by E. E. Storey & Son Well Drilling, Inc. of Klamath Falls. Several telephone conversations were held with Dave Storey. Mr. Storey was understood to state that a series of pumping tests were conducted, and at 350 feet/275 gpm, after 2 hours, the pump sucked dry. He also stated that the water quality was good, not likely to be corrosive, and probably potable. He suggested that the pump should be placed at 400 feet with a pumping rate of 275 gpm.

The test pumping was conducted by Valley Pump & Equipment Co. of Klamath Falls. Several telephone conversations were held with Art Farr. Mr. Farr sent a copy of further drilling/pumping data, also reproduced in Appendix A. The report shows that hot water encountered during drilling was in two strata: 148°F at 1046 feet, and 180°F at 1400 feet.

The Valley Pump report details several test runs. Pumping was accomplished at various depths and at rates ranging from 150 to 275 gpm. For these conditions, water temperatures ranged from 126°F to 152°F. The final series of tests included approximately 45 minutes at 275 gpm with the water level drawn down to the 320 foot mark (i.e., a drawdown of approximately 250 feet from the static level), followed by approximately 30 minutes at 200 gpm with the water drawn down to the 270 foot level. Mr. Farr stated that the water appeared to hold its own under continuous pumping under each of these conditions. He also expressed opinions that: 1) a 275 gpm pump could best be placed at 350 feet, and 2) the well capacity would increase below the 320' level at the rate of 1.25 gpm per foot of drawdown.

Our own interpretation of the drawdown information from the field appears on Graph 1. The 275 gpm/250-foot drawdown condition appears to be a reasonable design point, provided that allowance is made for 1) further drawdown with increased pumping time, and 2) possible fluctuations in the natural water table. The recommendation from E. E. Storey & Sons is therefore adopted: to design for 275 gpm maximum flow from a pump placed at 400 feet.

GRAPH 1
 DRAWDOWN INFORMATION

The above data contains the information used for this feasibility study. Additional information would be constructive, of course, and is recommended prior to final design. Emphasis is placed on the quality of the water in respect to both its corrosive properties and the conditions under which surface disposal will be allowed.

This study assumes that the water will only be mildly corrosive, and standard pumps, piping and fittings can be used. Therefore eliminating the need or cost of higher quality metals or other corrosion inhibiting approaches. Justification for this assumption is found in part in the relatively low temperature of the geothermal water and partly from Mr. Storey's representation of the well conditions. It is also assumed that the mildly corrosive condition warrants the use of a wellhead heat exchanger, rather than placing the well brine directly into the heating loop, which would subject individual fan coil units to corrosion. In the housing units the fan coils typically have soldered joints which are subject to leaks in the event of corrosion, and since leakage could lead to consequential damage of the buildings, it is considered prudent to use the heat exchanger design approach despite the reductions in system efficiency, performance and cost effectiveness.

Although water temperatures varied with pumping conditions, possibly reflecting the two different hot water layers encountered, the 142°-152°F variation is relatively small with the exception of one test at 126°F. The one lower test temperature shows that there is no assurance of a consistent water temperature, especially when the withdrawal rate is reduced. It is tempting to speculate that sealing the well at the cooler of the two hot water levels would allow production at a higher temperature, but an oral report from the field showed the 180°F stratum appeared to be a poor producer. A withdrawal temperature of 150°F is therefore assumed in this report.

It is possible, and indeed likely, that the well yield will improve with use. If so, the owner should be alert to the possibility of expanding its use beyond what is presented here. However, preliminary system concepts, are premised on the more conservative possibility that the well will continue to yield what has already been observed.

The maximum number of housing units which the heating district can serve is set primarily by the temperature and volume of geothermal water produced by the well. If the time arrives when added production is desired, another well will be needed. Personnel at the Geo-Heat Center in Klamath Falls suggest that a well to the east and further up the slope (relative to the present well) should be attempted in the expectation of striking hotter water.

A second well could also become a requirement at a later date for another reason. This study is premised on a single well with surface discharge of the spent water, which is compatible with present regulations. Depending on current State and local initiatives, however, surface discharge may have to be abandoned in favor of a reinjection process. Under the local initiative, water would have to be returned to the same well. Under the Oregon State proposal, water would have to be reinjected at a second well.

The primary disadvantage of a second well is the added drilling cost. Otherwise, reinjection in a second well has sufficient history behind it to be confident of its feasibility. The one limitation which could be encountered is in how large a flow can be accommodated. The rule of thumb is that wells require as much pressure to return a flow as the head needed to withdraw it. The present well at 275 gpm has a dynamic drawdown of approximately 250 feet from a static level at about 70 feet. To reinject 275 gpm from another well into this one therefore presumes 180 feet of water pressure (about 80 psi) above the ground surface. Any pressure of this magnitude would require a good seal to avoid blowout; but even with a good seal there is doubt that the full 80 psi can be achieved in practice without complications from surface leakage or subsurface transport.

On the other hand, reinjection of water to the same well from which it is pumped has unknown consequences. The approach, to our knowledge, has never been tried. There is, however, reason to believe it could prove to be a successful mode of operation. In some respects, this type of reinjection would be similar to downhole heat exchange: pumping heads (and therefore costs) for a given flow could be minimized, but localized depletion of the resource is possible, partially because there would only be a slight subsurface gradient to drive return water into the well and force a fresh supply of water from the resource. As with downhole exchange wells, it should be

possible to establish and promote thermal convective currents in the well by directing the cooler returning water into an annulus around the main (hot) pump string. This would encourage good mixing to the depth of the pipe annulus, suggesting that if pipe in this configuration were extended to the vicinity of the hot water stratum (about 1000 feet), it might be possible to obtain the hot water with minimum temperature reduction from mixing of the return water. Still better, a two-pipe (supply, return) system would allow the cooler water to be returned to a level below the production zone. Mixing, however, is less significant in this mode than might be expected because recirculation of the primary waters becomes feasible as a means of increasing heat transfer to the secondary heating loop. That is, water returned to the well and mixed with the hotter supply there can be reused at a relatively low pumping cost.

Despite the several possibilities for reinjection, the current feasibility study has been prepared based on thermal water extraction from the existing well, together with surface disposal of the water after it has been used for heating.

3.2 General Designs

3.2.1 Estimate Typical Dwelling Unit Heating Loads

A second factor in project feasibility is the heating loads of the housing units being served. While some differences will exist between units already in place and those to be constructed in the future, there are many more similarities than differences, and an "average" unit has been defined for purposes of the feasibility analysis.

It is assumed that all units are grouped in four-plex structures. Each four-plex is assumed to be a two-story structure 32 feet wide by 70 feet long. Thermal conductivity factors for the building are taken at the limits allowed by the building code: for the walls, $U = 0.19$ (average); for ceiling/roofs, $U = 0.05$. Ground floors are perimeter insulated, with an average heat loss of 1 Btu/hr/ft². Allow one air change per hour for infiltration and ventilation. The design heating condition for Klamath Falls is 9°F outside air temperature. Inside air temperature is assumed to be 75°F. The reason for the relatively high inside temperature is that there are no plans to meter the heat, and occupants therefore will be less careful about energy conservation. The annual heating degree days, are 6516.

Peak heating load per four-plex

	Btu/hr
Floor: $(32 \times 70)\text{ft}^2 \times 1 \text{ Btu/ft}^2$	= 2,240
Walls: $2[(32+70) \times 15]\text{ft}^2 \times 66\text{F} \times 0.19 \text{ Btu/ft}^2/\text{hr}$	= 38,370
Ceiling/roof: $(32 \times 70)\text{ft}^2 \times 66\text{F} \times 0.05 \text{ Btu/ft}^2/\text{hr}$	= 7,390
Air -change: $(32 \times 70 \times 15) = 33,600\text{ft}^3$ volume	
-heat: $33,600 \times 0.075 \times (18.02 + 30\%RH \times 20.59 - 3.49)$	= 52,180
Total heat loss	100,180

Peak heating load per dwelling unit

$$= 100,180 \text{ Btu/hr} / 4 = (\text{rounded}) \quad 26,000$$

Annual heating load per dwelling unit (geothermal)

$$= \frac{26,000 \text{ Btu/hr} \times 24 \text{ hr}}{66\text{F}} \times 6516 \text{ F-days} = 61.6 \times 10^6 \text{ Btu/yr}$$

Annual heating load per dwelling unit (electric)

$$= 14,000 \text{ kWh/yr (assuming lower indoor temperature for metered consumption)}$$

Comment: The 24 existing units are each served by 10kW (34,100 Btu/hr electric furnaces. They are reported to be more than adequate. New units yet to be constructed will conform to more stringent energy standards, and will therefore need less heat.

3.2.2 Select Appropriate Technologies

3.2.2.1 Alternative Systems

Preliminary analysis were made of several alternative systems which could be used for the geothermal heating district. It has subsequently been determined that the wellhead heat exchanger is to be used in the final design. The various options are presented in the paragraphs that follow.

The Downhole Heat Exchanger System

In this system a tubular heat exchanger is placed in the well below the static water level. Domestic water is then pumped through the heat exchanger and circulated through a piping loop to each 4-plex (see Figure 1).

FIGURE 1
DOWNHOLE HEAT EXCHANGER SYSTEM

The advantage of this system is the fluid (domestic water) used in transporting the heat would not be corrosive to the system piping. Thus, the system piping would have a longer life. However, according to a report by John W. Lund, Associate Director of Geo-Heat Utilization Center at O.I.T. in Klamath Falls, (1) the desired temperature of the well water should be in excess of 80°C (175°F). Because the temperature of this well is 66°C (150°F) the downhole exchanger system will not be covered in this report.

(1) Report on "Geothermal Space Heating", pg. 2 (not dated).

Direct Use Continuous Discharge System

This system would employ a main pump to bring the geothermal water to the surface and cause it to flow through a pipe line to each 4-plex. The water would then be discharged from the system by means of a temperature controlled discharge valve (see Figure 2). Control of the flow through each 4-plex will be discussed in Section 3.2.2.3.

FIGURE 2

DIRECT USE CONTINUOUS DISCHARGE SYSTEM

Direct Use ReInjection System

This system also uses geothermal water pumped from the well into the main line but then it is circulated through the main line by a second pump. The water is discharged by use of a temperature regulated discharge valve (see Figure 3).

FIGURE 3
DIRECT USE REINJECTION SYSTEM

The advantages of this system over the prior system is that the main pump would be a smaller pump in regard to horse power and head required. Also the main pump would not have to operate as often because water will be recirculated by the circulating pump.

Two Pipe Direct Use Continuous Discharge System

A combination of the continuous discharge and reinjection system would allow for discharge of "cold" water and yet allow re-use of "hot" water. This system would use a main pump for drawing water from the well and a circulating pump for providing pressure in the main line (see Figure 4).

FIGURE 4

TWO PIPE DIRECT USE CONTINUOUS DISCHARGE SYSTEM

This system would allow maximum flow during peak demands and yet during less than peak demands the main pump would not have to operate as often.

Wellhead Heat Exchanger System

The wellhead heat exchanger system involves a primary and a secondary piping system. The primary side would involve the main well pump, the exchanger and a discharge system. The secondary side would incorporate an inline circulating pump, a distribution line and a recovery line (see Figure 5).

FIGURE 5
WELLHEAD HEAT EXCHANGER SYSTEM

By using a two pipe system on the secondary side each housing unit coil will receive hot water that is relatively the same temperature at all units. The pipe sizing of the distribution line would be stepped down as the quantity of flow required is decreased. The recovery line would be stepped up in size as the quantity of flow increases. This would allow for a negative pressure differential between the distribution line and the recovery line, which would cause water to flow through the 4-plex. Regulation of this flow would be accomplished either by a thermostatically controlled motor operated valve or by a thermostatically controlled inline pump (see section 3.2.2.3).

3.2.2.2 Evaluation of Secondary Loop

For the purpose of evaluating the following systems it will be assumed that there are 100 units or (25) 4-plex buildings connected to each piping system. All units will require 26,000 BTU/HR and each system will require 130 GPM flow rate. Control of the flow within each 4-plex will be discussed in Section 3.2.2.3.

System A

The first system is a single pipe loop system consisting of the heat exchanger, a circulating pump and the distribution line. An orifice is placed in the main line to create a flow through the 4-plex (see Figure 6).

FIGURE 6
SYSTEM A

System B

System B is also a single pipe loop system similar to System A except that the flow to the 4-plex would be accomplished by a circulating pump (see Figure 7). In order to prevent a thermal siphon a one way valve must be placed in the main line.

FIGURE 7
SYSTEM B

System C

The third system is a two pipe loop system that consists of a heat exchanger, a circulating pump, a distribution line and a recovery line. Flow through the 4-plex would be caused by a pressure differential between the distribution line and the recovery line (see Figure 8). This pressure differential will be maintained by a set of valves that will be self-regulating.

FIGURE 8
SYSTEM C

System D

System D is similar to System C except the pressure regulating valves would be replaced by a bleeder line between the distribution line and the recovery line. The distribution line would be stopped at the last 4-plex (see Figure 9).

FIGURE 9

SYSTEM D

Evaluation

The advantage of systems C and D over Systems A and B is that the hot water temperature supplied to each 4-plex will be relatively the same temperature where as in systems A and B the last 4-plex will have a cooler water temperature than the first 4-plex.

To state this in terms of how many units could be heated with systems A and B would be to say if one 4-plex requires a flow of 5.20 GPM and the temperature drop across the fan coil units is 40°F then the delution of the 4-plex line to the main line would be $5.20 \text{ GPM} \div 130 \text{ GPM} \times 40^\circ\text{F}/4\text{-plex} = 1.6^\circ\text{F}/4\text{-plex}$. According to the fan coil heating unit manufacturer the lowest inlet temperature permitted is 130°F. This means that the limit of the heating would be $(140^\circ\text{F} - 130^\circ\text{F}) \div 1.6^\circ\text{F}/4\text{-plex} = 6.25$ (6) 4-plexes or 24 units.

In evaluating Systems C and D it is noted that there is no dilution of the distribution line which means that the maximum 4-plexes that can be heated is $130 \text{ GPM} \div 5.2 \text{ GPM/4-plex} = (25) \text{ 4-plexes}$. (These numbers do not take into account the losses due to line losses, and further refinement is warranted.) It is hereby concluded that because of the dilution of the distribution line temperature Systems A and B are not nearly as efficient as Systems C and D. However, the conclusion to choose a system should be based on the cost effectiveness and not just the effectiveness of the systems. An evaluation of the cost effectiveness follows.

Table 1 shows a comparison of the (4) systems based on equipment costs and operating costs. Table 2 uses the results of Table 1, calculates the present construction and operating costs of each system (see Appendix B for the computer printout of the present costs) with respect to each 4-plex. (Costs are without regard to piping and heater coils for each 4-plex.)

SYSTEM NUMBER	SIZE LENGTH OF PIPE	HL/ 100'	HL/ ORIFICE	+100' HEAD TOTAL HL/PSI	PIPE COST \$/FT	PIPE COST TOTAL	COST OF 20 GPM PUMP EA./TOTAL	OPERATING COST OF PUMP/YR EA./TOTAL	COST OF 130 GPM PUMP	OPERATING COST/YR	COST OF ORIFICE OR ONE WAY VALVE EA./TOTAL	COST OF PRESSURE ADJ. VALVE	TOTAL COST	TOTAL OPERATING COST/YR
A	3" / 900	3.85	30	165'	11.59	10,431	—	—	1330	1391	50 / 300	—	12,061	1391
	4" / 900	0.95	30	138'	14.81	13,329	—	—	1276	1249	50 / 300	—	14,905	1249
B	3" / 900	3.85	—	135'	11.59	10,431	250 / 1500	44.11 / 265	1270	1234	50 / 300	—	13,501	1499
	4" / 900	0.95	—	108'	14.81	13,329	250 / 1500	44.11 / 265	1216	1092	50 / 300	—	16,345	1357
C	3" / 5400	3.85	—	307' / 130'	11.59	62,586	—	—	1614	2140	—	1580	65,700	2140
	4" / 5400	0.95	—	151' / 64'	14.81	79,974	—	—	1302	1318	—	2000	83,276	1318
D	3" / 5200	3.85	—	300' / 128'	11.59	60,268	—	—	1600	2100	—	—	61,868	2100
	4" / 5200	0.95	—	141' / 60'	14.81	77,012	—	—	1298	1307	—	—	78,310	1307

NOTE: 1. ASSUME 5' HEAD LOSS EACH 4-PLEX FOR ORIFICE AND \$50 COST FOR ORIFICE.
2. PRESSURE ADJUSTING VALVE APPROXIMATE COST \$1500 & \$2000.
3. HEAD LOSS IN PIPE BASED ON C=150.

TABLE 1
SYSTEM COMPARISONS

In Table 2, the Present Value figures are for the operating and capital costs analyzed.

SYSTEM NUMBER	PIPE SIZE	TOTAL COST	OPERATING COST	PRESENT VALUE	÷ # OF 4-PLEXES	PRESENT VALUE PER 4-PLEX
A	3"	12,061	1391	22,217	6	3703
	4"	14,905	1249	24,024	6	4004
B	3"	13,501	1499	24,446	6	4074
	4"	16,345	1357	26,253	6	4376
C	3"	65,700	2140	61,325	25	3253
	4"	83,276	1316	92,899	25	3716
D	3"	61,868	2100	77,201	25	3088
	4"	76,310	1307	87,853	25	3514

TABLE 2
PRESENT COST FOR HEATING 4-PLEX

An inspection of the table reveals that Systems A and B have less total cost for initial construction, while Systems C and D are less expensive per unit when comparison is made of the present value of all such costs over the system's lifetime. It is pointed out that revenue generated is proportional to the number of units served, thus both expenses and revenues are more favorable for Systems C and D than for Systems A or B. Further discussion is therefore limited to Systems C and D. Likewise, System D appears to be less expensive than System C, with equal revenues. System D is therefore selected for the feasibility analysis.

3.2.2.3 Evaluation of 4-Plex Piping Systems

The evaluation of the 4-plex piping system is based on the use of System D of the preceeding section. It will be assumed that each 4-plex requires a flow rate of 5.20 GPM, and each housing unit is equipped with a fan coil type furnace and duct work. The intention of this section is to determine which of the following systems is to be used and not to determine the final design.

System #1

This system places all units in series by using a single inlet line and outlet line. There would be no control of the flow of hot water within each unit. The control of heat would be accomplished by a thermostatically controlled fan within each fan coil unit (see Figure 10).

FIGURE 10

SYSTEM #1

System #2

System #2 places each fan coil unit directly feeding off of the distribution line. Control of the flow through the fan coil unit would be accomplished by a thermostatically controlled valve. Additional control of the heat would be accomplished by placing a thermostatically controlled fan in conjunction with the valve (see Figure 11).

FIGURE 11
SYSTEM #2

System #3

The third system places a secondary distribution line within the 4-plex and each fan coil draws off of this line. Control of the flow through the fan coil unit would be achieved in two manners: a) by placing an orifice in the secondary distribution line and using a thermostatically controlled valve at the fan coil unit; or b) by using a thermostatically controlled pump at the fan coil unit. In addition heat would be controlled by a thermostatically controlled fan (see Figure 12).

FIGURE 12
SYSTEM #3

System #4

This system requires both a secondary distribution line and a secondary recovery line. A small bleeder line must be employed to insure continuous flow. Control of flow through the fan coil unit would be achieved by using a thermostatically controlled valve. A fan operating in conjunction with this thermostat would control the heat flow (see Figure 13).

FIGURE 13

SYSTEM #4

Evaluation

System #1 has the distinct disadvantage of a low inlet water temperature to the last housing unit within the 4-plex. The water temperature would be too low to be resused. Therefore, System #1 will not be discussed further.

System #2 has the advantage of being able to draw directly from the main distribution line and thus achieve maximum heat per housing unit. Another advantage of this system is minimal heating controls. However, this system has (four) inlet lines and (four) outlet lines which is (four) times as many lines as any other system. If the main distribution line is far from the 4-plex the cost of these laterals would be great.

System #3 has the advantage of a single inlet and a single outlet which results in less piping than System #2. System #3 has the disadvantages of a lower inlet temperature for the last housing unit fan coil, and added costs of controls and maintenance, therefore, this system will not be further discussed.

System #4 has the advantage of both a moderate amount of piping and a fewer amount of controls. This system seems to be the better of the four based on physical requirements. A comparison of the second and fourth systems based on economic consideration follows.

For the purpose of this economic discussion two distances have been used in an attempt to show a cost comparison that can be used as a guide for decision making. The distances shall be from the distribution line to the fan coil units and shall be taken as 20 feet and 70 feet. The amount of pipe (per single pipe) within the 4-plex shall be assumed to be 60 feet.

Table 3 computes an approximate total cost for each system, with respect to both the 20 foot and 70 foot distances. Table 3 does not take into consideration the cost of items such as the controls and valves because they are expected to be the same and therefore would not change the ratio of one system to the other.

SYSTEM	DISTANCE	PIPE SIZE	LENGTH OF PIPE	COST OF PIPE \$/L.F.	COST OF PIPE	COST OF CHECK VALVE \$/EA.	COST OF CHECK VALVE	TOTAL COST
2	20'	1"	160'	7.01	1122	50	200	1322
	70'	1"	560'	7.01	3926	50	200	4126
4	20'	1"	200'	7.01	1402	50	50	1450
	70'	1"	300'	7.01	2103	50	50	2303

NOTE: 1. THE COST OF PIPING IS BASED ON PRE-INSULATED PIPE.

TABLE 3
APPROXIMATE COST PER SYSTEM

Assuming the distance between the distribution line and the fan coil unit varies, an average cost can be computed to determine the least costly system. For System #2 the average cost is \$2,724. The average cost of System #4 is \$1,876. This shows the average cost for System #4 is the least expensive. However if the distribution coil unit was placed within 20 feet of the fan coil unit it would be less expensive to use System #2. For the purpose of this study System #4 will be the system used.

3.3 Specific Design

The specific design of the Basin View Utility District heating system will depend on variables that the owner must act on. The following heating system design is based on the preceding sections and economic considerations. The intent is to provide a design that will be cost effective without being the final design.

It is considered the owner's responsibility to develop or have developed the final design.

3.3.1 Design Basics

Available Total Heat Exchange

In conversations with suppliers of wellhead heat exchangers it was determined that the "plate" type heat exchanger would be the choice rather than the "shell and tube" type. The reason being the plate heat exchanger has the ability to approach the same temperature on the outlet to the secondary side as the inlet of the primary side. In addition a report by John W. Lund (2) of the Oregon Institute of Technology states that "the plate heat exchanger has an advantage in that it is more efficient, requires smaller space, and is more accessible and easier to expand to meet additional heating load."

The plate heat exchanger, as reported by the J. A. Courtney Co., Inc. of Portland, Oregon, would accept 275 GPM's of geothermal water, cooling it from 150°F to 127.7°F with a pressure drop of 19.2 PSI, and 200 GPM of recirculating water in the heating loop, heating it from 110°F to 147.5°F with a pressure drop of 10.5 PSI. Which is said to have a total heat exchange of 3,750,000 BTU/HR.

At this expected heat exchange the number of units that could be served is $3,750,000 \text{ BTU/HR} - (7,200 \text{ L.F.} \times 12 \text{ BTU/HR/FT line loss}) = 3,663,600 \text{ BTU/HR}$; $3,663,600 \text{ BTU/HR} \div 26,000 \text{ BTU/HR/UNIT} = 140.9 \text{ units}$ or (35) 4-plexes. The total heat exchange as directed by the A.J. Courtney Company will be adopted.

Definition of System

The heating loop design is based on the premise that a two loop system will be required. If a single loop system were implemented the heat loss through the piping would be so excessive that the last 4-plex on the loop would not be adequately heated. However, with a two loop system the length of pipe per each loop would be cut roughly in half, thus cutting the heat loss through each loop roughly in half and providing the last 4-plex on the loop with a higher inlet temperature.

(2) Report from "Geothermal Energy Utilization For The Homeowner", December, 1978.

Figure 14 is a schematic representation of the heating system. It shows the use of a single circulating pump in conjunction with two pressure regulating valves. In addition, the system utilizes a plate heat exchanger, a turbine pump and a pressure tank. For further information on the operation of this system, see Section 3.2.2.

FIGURE 14
HEATING SYSTEM SCHEMATIC

Figure 15 is a plot of the Basin View Utility District and a proposed layout of the heating loops. It gives a general indication of the location and length of piping for the district and is used as a basis for estimating the length of piping. Please note that the discharge line is not fully shown but is expected to discharge to the retention pond to the northwest of the Utility District.

FIGURE 15
PROPOSED LAYOUT OF HEATING LOOPS

4.0 ECONOMIC FEASIBILITY

The economic feasibility considers the approximate estimated costs required for construction and operation of the district facilities and services. Included is an estimate of expected revenues, expected life and amortization costs. The estimated unit revenue rates are based on competitive energy prices as applied to the heating district.

4.1 Construction Costs

4.1.1 Cost of Piping

Table 4 represents a comparison of costs and BTU/HR losses for insulated and noninsulated pipe systems. It is designed to show the relationships between the different systems and even though the costs are relative the table does not reflect discount prices a contractor might receive from his supplier.

SIZE	COST \$/FT				HEAT LOSS BTU/HR/FT			
	NOT INSULATED	FIELD INSULATED	PRE-INSULATED	DRY PACK INSULATED	NOT INSULATED	FIELD INSULATED	PRE-INSULATED	DRY PACK INSULATED
1"	3.05	7.12	7.01	7.08	74	5	5	5
1½"	3.55	8.09	7.96	8.54	107	7	7	15
2"	4.47	10.02	10.40	9.46	134	9	9	18
3"	6.56	13.45	11.59	12.60	197	12	12	20
4"	8.67	17.35	14.81	15.67	254	17	17	23

- NOTE: 1. DATA COSTS ARE BASED ON AVERAGES OF PRICES SUPPLIED BY DIFFERENT MANUFACTURERS. PRICES INCLUDE EXCAVATION AND BACKFILL.
2. FIELD INSULATION COSTS ARE FROM THE 1981 DODGE GUIDE.
3. INSULATION COSTS AND HEAT LOSSES ARE BASED ON 1" THICK INSULATION AND T=100 F.
4. DRY PACK INSULATION COSTS AND HEAT LOSSES ARE BASED ON GILLSULATE 500 AT \$8.75/CU.FT. AND RECOMMENDED MANUFACTURE THICKNESSES.

TABLE 4
PIPING COSTS AND HEATING LOSSES

Based on the preceding table, that the dry pack material, even though competitive in price, is not a recommended means of insulation because the heat loss is almost twice that of insulated pipe. It is also concluded that the field insulation method is not recommended due to the higher cost per lineal foot. This leaves the uninsulated and pre-insulated methods for further study.

In regard to System D (section 3.2.2.2) a comparison of uninsulated pipe to pre-insulated pipe was made and is presented in Tables 5 and 6.

PIPE SIZE	HEAT LOSS BTU/HR/FT		PIPE LENGTH FT	HEAT LOSS BTU/HR	
	NOT INSULATED	PRE-INSULATED		NOT INSULATED	PRE-INSULATED
3"	197	12	5200	1,024,400	62,400
4"	254	17	5200	1,320,800	88,400

TABLE 5
PIPE HEAT LOSS

PIPE SIZE	EQUIVALENT KW/HR		ASSUMED ELECTRICAL COSTS \$/KW/HR	EQUIVALENT ELECTRICAL COSTS \$/FT		Δ COST	COST OF PIPE \$/FT		COST OF PIPE		Δ COST
	NOT INSULATED	PRE-INSULATED		NOT INSULATED	PRE-INSULATED		NOT INSULATED	PRE-INSULATED	NOT INSULATED	PRE-INSULATED	
3"	300.2	18.3	0.04	105,192	6408	98,784	6.56	11.59	34,112	60,268	26,156
4"	387.0	25.9	0.04	135,600	9075	126,525	8.67	14.81	45,084	77,612	31,928

TABLE 6
EQUIVALENT ELECTRICAL AND PIPE COST

From Table 6 it is easy to see that the extra price of the pre-insulated pipe will be recovered by the heat saved within the first year of operation. Therefore, the pre-insulated pipe will be the type used in the cost estimate of the system.

4.1.2 Total Construction Costs

The following is the cost of equipment and it's installation for the Basin View Utility District. The prices are given for budget only and do not reflect any discount that a contractor may be entitled to.

	<u>Quantity</u>	<u>Unit Costs</u>	<u>Cost Total</u>
<u>Production Well Equipment</u>			
Turbine Pump	1	\$21,700	\$21,700
Circulating Pump	1	1,620	1,620
Pressure Tank	1	5,200	5,200
Regulated Discharge Valve	1	250	250
Heat Exchanger	1	11,200	11,200
Well House	1	9,000	9,000
Power Service	1	1,000	1,000
Control System	1	9,000	9,000
Installation			<u>11,000</u>
Total Equipment Installed			\$69,970
<u>Distribution & Recovery</u>			
3" Preinsulated Pipe	5900 L.F.	11.59/ft.	<u>68,300</u>
Total Pipe Installed			\$68,300
<u>Discharge System</u>			
4" Pipe not Insulated	2700 L.F.	8.67/ft.	<u>23,410</u>
Total Discharge Installed			\$23,410
TOTAL			\$161,680
<u>Contingency and Engineering 20%</u>			<u>32,340</u>
Net Project Costs			\$194,020

4.2 Operating Costs

The following list is the expected operating costs for the project. The figures are based on the turbine pump operating 33% of the time and the circulating pump operating full time, both for nine months per year. It is also expected that a double 200 watt bulb will operate one half time.

The maintenance and repair costs for the system are not expected to be excessive.

	<u>Quantity</u>	<u>Unit Costs/yr</u>	<u>Total Cost/yr</u>
<u>Pumps</u>			
Turbine Pump 60 HP	1	\$3,235	\$3,235
Circulating Pump 20 HP	1	4,640	4,640
<u>Pumphouse Lighting</u>			60
Total Operating Costs per year			<u>\$7,935</u>
<u>Maintenance & Repair</u>			<u>2,000</u>
Total			<u>\$9,935</u>

4.3 Expected Revenues

The annual heating load per dwelling unit as stated in section 3.2.1, will be used to determine the revenues charged to each unit. The occupants of these units are not expected to be as conscientious with this energy as if they were buying the energy from the electric company. For this reason this report uses an assumed lower indoor temperature and the value of 14,000 kWh/yr/unit for computing the revenue charged per unit.

Charge Rate Per Unit:

$$14,000 \text{ kWh/yr} \times 0.03 \text{ \$/kW} = \$421/\text{yr/unit}$$

$$\$421/\text{yr} \div 12 = \$35/\text{unit/mo.}$$

Revenue for the system:

$$140 \text{ units} \times \$421/\text{unit} = \$58,940/\text{yr}$$

4.4 Expected Life, Financing, and Financial Benefits

In the absence of test results on the geothermal water to determine the corrosiveness of the fluid, it is difficult to fix the expected life of this hydronic system.

On the building heating side of the exchanger the fluid will be non-corrosive and should have a long life (perhaps 30 to 40 years). Depending on the corrosiveness of the water on the geothermal side of the heat exchanger, as discussed in section 3.1, it is likely that the turbine pump and heat exchanger will have a life of 10 to 20 years.

The lifespan information is sufficiently varied that a possible value from within the range must be selected for analysis. The life expectancy of this project is therefore taken as approximately 20 years. When in the future a water quality test is performed on the well, the expected life of the project should be re-assessed.

Project costs, revenues, and benefits are tabulated in Appendix C relative to several financing variables: debt/equity funding, money value rates (interest), and tax rates. The multiple listings of different rates allow the owner to approximate the outcome of the project as it will affect him under several economic environments.

Figure 16 is a printout from a computer program, showing the economic value of the system based on an interest rate of 21% and a marginal tax rate of 35%. Further runs of the program also appear in Appendix C. If the owner elects to finance the \$194,020 system with a 100% loan, the tabulated results show the \$129,737 present value of a stream of net cash proceeds (profits) after amortization of the debt over the 20-year period. If the owner provides 100% equity financing, his net cash stream includes the original investment (negative flow) as well as adjustments for the absence of interest; the final paragraph therefore shows the present value of this net cash flow as \$89,810, for an equivalent return on investment after taxes of 29.2%.

Either presentation shows a strong expectation of good profits and/or return on investment for the project.

BASIN VIEW UTILITY DISTRICT RUN NO. 7
Prepared by Center 4 Engineering

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20), with amortization of an initial investment of \$ 194020 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 8 %; revenues, 9 %.

Taxes are computed based on straight-line depreciation of the investment, interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
BASIN VIEW UTILITY DISTRICT RUN NO. 7
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	194020	0	0	-194020	
1	41665	7935	2000	51600	58940	0	7340	6066
2	41665	8649	2160	52474	64245	0	11771	8040
3	41665	9428	2333	53425	70027	0	16601	9371
4	41665	10276	2519	54460	76329	0	21869	10202
5	41665	11201	2721	55587	83199	0	27612	10646
6	41665	12209	2939	56812	90687	0	33874	10793
7	41665	13308	3174	58146	98848	0	40702	10718
8	41665	14505	3428	59598	107745	14937	33210	7228
9	41665	15811	3702	61178	117442	19088	38176	6866
10	41665	17234	3998	62897	128011	21562	43552	6474
11	41665	18785	4318	64768	139532	25395	49370	6065
12	41665	20476	4663	66804	152090	29629	55658	5651
13	41665	22319	5036	69020	165779	34310	62449	5240
14	41665	24327	5439	71431	180699	39495	69773	4838
15	41665	26517	5874	74056	196961	45244	77662	4451
16	41665	28903	6344	76912	214688	51629	86147	4080
17	41665	31504	6852	80021	234010	58732	95257	3729
18	41665	34340	7400	83405	255071	66648	105018	3397
19	41665	37430	7992	87087	278027	75465	115455	3087
20	41665	40799	8631	91095	303050	85371	126583	2797
	833296	405956	91524	1524800	3015380	566526	924058	129737

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 21 %.

The equivalent Return on Investment after taxes for an owner funding the entire project (with no interest offset on taxes) is 29.2 %. The present value of its net cash flow including initial investment is \$ 89810

FIGURE 16

5.0 POLITICAL FEASIBILITY

The political feasibility covers local governmental arrangements and state wide regulations governing the owning, operating and discharging of water with respect to the geothermal heating district.

5.1 Local Governmental Arrangements

The Basin View Geothermal Heating District is to be a privately owned heating district which will provide services to structures in the vicinity. Mel Stewart of the Basin View Utility District owns a twenty year franchise with the City of Klamath Falls to provide said services.

A new city of Klamath Falls ordinance is being presented to the City that would restrict surface discharge of geothermal water. The ordinance would not allow any additional discharging in excess of present discharging rates for existing wells. No new wells would be allowed to have surface discharge. The ordinance's effective date is reported to be January 31, 1982.

5.2 Government Regulations

In a contact with Gill Hardgrave of the Department of Environmental Quality (DEQ) it was found that if discharge was to be made to natural drainage a permit to do so must be obtained from the DEQ. The request for discharge to natural drainage must include the water's quality, bacterial make-up, temperature and the quantity of flow.

A communication with Luran Forcella of the State Water Resources Department revealed that at this time there are no legal regulations governing the discharge of geothermal water. However, it is likely that regulations will be published in the fall of 1981. The said regulations could provide three methods of disposing of the spent geothermal water. These methods are: 1) reinject the water to the aquifer from which it came, 2) find a secondary use for the water (such as drinking or watering lawns), or 3) discharge to a natural surface drainage.

5.3 Evaluation

Political feasibility appears to be attainable providing the project is allowed by governing agencies. The conclusions and possible actions shall be the responsibility of the owner and should include the contacting of the appropriate governmental agency for project approval. Upon the owner conferring with the appropriate agency, this report finds the project politically feasible.

1. Heating District Experience Comparisons

It is instructive to compare the analysis contained in the study report with field practices in the extensive heating district experience found in Europe.

Most European district heating systems use a two-pipe (supply/return) distribution scheme for pressurized hot water at temperatures ranging from 110°C to 190°C. Pipes in all but the largest sizes are pre-insulated; loose fill insulations such as "Gilsullate" are avoided out of concern that the protective material will leach out with time. Heat exchangers were once of shell-and-tube design, but new installations use plate heat exchangers. These preferred conditions coincide with those analyzed and recommended in the Basin View Heating District Study, except that the available temperature is lower.

Some European districts are unmetered, but most of them meter water flow, while the present trend is toward heat metering. The trend is promoted by findings that meter costs are more than offset by the added number of consumers (and hence revenues) which can be served. Final system design for the Basin View Heating District should evaluate the meter tradeoff situation to select the best alternative.

District heating plans in Europe have enjoyed considerable success. In Denmark these range downward in size to a community of 200 persons. The most successful districts benefit from special circumstances such as heat from refuse incineration, surplus industrial heat, or geothermal sources. The feasibility finding for Basin View is consistent with those results.

In one example, a sub-community in France is served in part by a geothermal resource with heating season and peak loads supplemented from fossil fuel boilers. Nearly 3,000 persons are served there based on a geothermal well with delivery temperatures and flows only modestly better than available for Basin View. While there are further differences in apartment size, extent of outside walks, occupant expectations, and climatic design conditions, the comparison strongly suggests that the Center 4 Engineering analysis of Basin View Heating District feasibility provides a conservative result and that it may indeed be possible to extend the system to additional customers.

2. Domestic Hot Water Heating

Heating districts carry with them the potential for heating domestic hot water. While the total number of dwellings served would be reduced accordingly, the revenues per unit would be increased, probably with a shorter overall distribution system (and costs adjusted downward). Heating of water for domestic purposes is widely practiced in European heating districts, usually with a distribution system in common with the space heat, and of course benefiting from a common power plant. A further advantage is that hot water demand continues during summer months, thus contributing a year-round revenue component.

This option should be reviewed and evaluated prior to final design of the Basin View Heating District.

3. Other Considerations

- a. The cost of the geothermal well for the Basin View Heating District was intentionally omitted from the analysis and report. It is an existing well, and its cost is therefore a "sunk cost", irrelevant in a comparative analysis of which current course of action is best for its owner. An analysis of a system requiring the future drilling of a well would appropriately include those costs.
- b. The anticipated temperature of the geothermal waters upon discharge from the Basin View Heating District is high enough that they might serve as an effective resource for operation of water source heat pumps (to supply additional dwellings). The further reduction in discharge water temperature would be environmentally favorable. This possibility can be studied separately during final system design.
- c. The references on page 12 of the report to a "direct use reinjection system" should be "direct use recirculation system".

4. Financial Table Revisions

Section 4.4 of the report presents information on expected project life, amortization, and funding. Figure 16 and all of Appendix C support this presentation with printouts of computer runs analyzing the cost and revenue data over a 20-year period.

The computer presentations were found to contain two programming errors which have no effect on the overall conclusions, but do affect the detailed results. The same is true of Table 2 and Appendix B. The several sheets which follow this therefore contain corrected pages as follows:

Page 20 (Table 2), page 33 (Section 4.4), page 34 (Figure 16), pages 40-48 (Appendix B), and pages 49-55 (Appendix C) (In place of the former pages 49-67).

In each instance the new pages replace the old ones.

APPENDIX A

Appendix A contains the well reports of the State of Oregon Water Resources Department and the Valley Pump and Equipment Company.

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report
are to be filed with the

WATER RESOURCES DEPARTMENT,
SALEM, OREGON 97310
within 30 days from the date
of well completion.

WATER WELL REPORT

STATE OF OREGON

(Please type or print)

(Do not write above this line)

State Well No. _____

State Permit No. _____

(1) OWNER:

Name RASIN VIEW UTILITY CO

Address 411 PINE ST

KLAMATH FALLS, ORE

(2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☒ Driven ☐

Cable ☐ Jetted ☐

Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☐

Irrigation ☐ Test Well ☒ Other ☒

(5) CASING INSTALLED:

Threaded ☐ Welded ☒

1 1/4" Diam. from 1 ft. to 341 ft. Gage 250

" Diam. from _____ ft. to _____ ft. Gage _____

" Diam. from _____ ft. to _____ ft. Gage _____

(6) PERFORATIONS:

Perforated? ☐ Yes ☒ No

Type of perforator used _____

Size of perforations in. by in.

perforations from _____ ft. to _____ ft.

perforations from _____ ft. to _____ ft.

perforations from _____ ft. to _____ ft.

(7) SCREENS:

Well screen installed? ☐ Yes ☒ No

Manufacturer's Name _____

Type _____ Model No. _____

Diam. _____ Slot size _____ Set from _____ ft. to _____ ft.

Diam. _____ Slot size _____ Set from _____ ft. to _____ ft.

(8) WELL TESTS:

Drawdown is amount water level is
lowered below static level

Was a pump test made? ☒ Yes ☐ No If yes, by whom? 1/41/79

Yield: gal./min. with ft. drawdown after hrs.

275 200 1

Ballor test gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m.

Temperature of water 5.2 Depth artesian flow encountered _____ ft.

(9) CONSTRUCTION:

Well seal—Material used CEMENT

Well sealed from land surface to 341 ft.

Diameter of well bore to bottom of seal 1 1/4 in.

Diameter of well bore below seal _____ in.

Number of sacks of cement used in well seal 350 sacks

How was cement grout placed? PUMPED

Was a drive shoe used? ☒ Yes ☐ No Flugs _____ Size: location _____ ft.

Did any strata contain unusable water? ☒ Yes ☐ No

Type of water? COLL depth of strata 210

Method of sealing strata on CASINO CEMENT

Was well gravel packed? ☐ Yes ☒ No Size of gravel: 37

Gravel placed from _____

(10) LOCATION OF WELL:

County KLAMATH Driller's well number _____

SE 1/4 NE 1/4 Section 55 T. 32S R. 7E W.M.

Bearing and distance from section or subdivision corner _____

(11) WATER LEVEL: Completed well.

Depth at which water was first found 1108 ft.

Static level 71 ft. below land surface. Date 7/10/79

Artesian pressure _____ lbs. per square inch. Date _____

(12) WELL LOG:

Diameter of well below casing 8-1/2

Depth drilled 1450 ft. Depth of completed well 1391 ft.

Formation: Describe color, texture, grain size and structure of materials, and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
BROWN SANDY CLAY	0	10	
YELLOW CLAYEY SANDSTONE	10	25	
GREEN CLAY	25	75	
GRAY SANDSTONE	75	210	
GRAY CLAY	210	260	
GRAY SANDSTONE	260	265	
GRAY SANDSTONE	265	266	
GRAY SANDSTONE	266	267	
GRAY SANDSTONE	267	268	
GRAY SANDSTONE	268	269	
GRAY SANDSTONE	269	270	
GRAY SANDSTONE	270	271	
GRAY SANDSTONE	271	272	
GRAY SANDSTONE	272	273	
GRAY SANDSTONE	273	274	
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GRAY SANDSTONE	285	286	
GRAY SANDSTONE	286	287	
GRAY SANDSTONE	287	288	
GRAY SANDSTONE	288	289	
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Work started 5/31/79 Completed 7/10/79

Date well drilling machine moved off of well 8/11/79

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used, and information reported above are true to my best knowledge and belief.

(Signed) Don M. Stetson Date 10/12/79

(Drilling Machine Operator)

Drilling Machine Operator's License No. 656

Water Well Contractor's Certification:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name E. E. Storey & Son Well Drilling Inc.

(Person, firm or corporation) (Type or print)

Address 3841 HOPE K FALLS ORE

(Signed) Don M. Stetson

(Water Well Contractor)

ARTHUR E. PARK, OWNER

7364 SOUTH SIXTH ST.

KLAMATH FALLS, OREGON 97601

CUSTOMER

Lucia View Habit Co

DATE: July 9

1972

ADDRESS

TIME	GPM	PRESSURE (PSI)	TEMPERATURE
12" well 1350' deep static 71'			
350' 6" column 8" bore			
3:00	Started pumping		
3:00	200		148
4:00	250		150
5:00	250		150
6:00	Stopped pumping		
July 10 1970			
2:00	Started pumping		
2:00	200	319	126
2:30	275	320	142 Water cloudy
3:00	275	316	152 Water little cloudy
3:30	Surged well, water little cloudy		148
4:00	Surged well no change		
4:15	275	250 320*	152
5:00	200	270	152
5:30	150		152
6:00	Stopped pumping		
* correct per Art Farr (Valley Pump) 6/9/81 telecall			

CC 6/2/81

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APPENDIX B

This Appendix contains printouts showing present values of periodic payments for construction and energy operating costs for Systems A, B, C, and D. (See section 3.2.2.2).

The systems are identified by the letter and by the size of pipe used. For example, A-3 would be System A with pipe size equal to 3 inches.

These sheets do not show any revenues, maintenance, or taxes.

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20), with amortization of an initial investment of \$ 12061 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment. Interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
B V U D SYSTEM A-3
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	12061	0	0	-12061	
1	2590	1391	0	3981	0	0	-3981	-3290
2	2590	1516	0	4106	0	0	-4106	-2805
3	2590	1653	0	4243	0	0	-4243	-2395
4	2590	1801	0	4391	0	0	-4391	-2049
5	2590	1964	0	4554	0	0	-4554	-1756
6	2590	2140	0	4730	0	0	-4730	-1507
7	2590	2333	0	4923	0	0	-4923	-1296
8	2590	2543	0	5133	0	0	-5133	-1117
9	2590	2772	0	5362	0	0	-5362	-964
10	2590	3021	0	5611	0	0	-5611	-834
11	2590	3293	0	5883	0	0	-5883	-723
12	2590	3589	0	6179	0	0	-6179	-627
13	2590	3912	0	6502	0	0	-6502	-546
14	2590	4265	0	6855	0	0	-6855	-475
15	2590	4648	0	7238	0	0	-7238	-415
16	2590	5067	0	7657	0	0	-7657	-363
17	2590	5523	0	8113	0	0	-8113	-318
18	2590	6020	0	8610	0	0	-8610	-279
19	2590	6562	0	9152	0	0	-9152	-245
20	2590	7152	0	9742	0	0	-9742	-215
	51801	71164	0	135025	0	0	-135025	-22217

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 21 %.

The following table presents project life cycle costs and revenues
 20 Yearly periods (N= 20),
 with amortization of an initial investment of \$ 14905
 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected:
 energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment.
 Interest paid on the effective loan balance, suitable tax deferrals and
 credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
 B V U D SYSTEM A-4
 Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	14905	0	0	-14905	
1	3201	1249	0	4450	0	0	-4450	-3677
2	3201	1361	0	4562	0	0	-4562	-3116
3	3201	1484	0	4685	0	0	-4685	-2644
4	3201	1617	0	4818	0	0	-4818	-2248
5	3201	1763	0	4964	0	0	-4964	-1914
6	3201	1922	0	5123	0	0	-5123	-1632
7	3201	2095	0	5295	0	0	-5295	-1394
8	3201	2283	0	5484	0	0	-5484	-1193
9	3201	2489	0	5689	0	0	-5689	-1023
10	3201	2713	0	5913	0	0	-5913	-879
11	3201	2957	0	6158	0	0	-6158	-756
12	3201	3223	0	6424	0	0	-6424	-652
13	3201	3513	0	6714	0	0	-6714	-563
14	3201	3829	0	7030	0	0	-7030	-487
15	3201	4174	0	7375	0	0	-7375	-423
16	3201	4549	0	7750	0	0	-7750	-367
17	3201	4959	0	8160	0	0	-8160	-319
18	3201	5405	0	8606	0	0	-8606	-278
19	3201	5892	0	9092	0	0	-9092	-243
20	3201	6422	0	9623	0	0	-9623	-213
	64015	63899	0	142819	0	0	-142819	-24024

The Present Worth total is the present value of the cash flow developed
 after loan amortization, discounted at a money market rate of 21 %.

The following table presents project life cycle costs and revenues
 20 Yearly periods (N= 20),
 with amortization of an initial investment of \$ 13501
 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected:
 energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment.
 Interest paid on the effective loan balance, suitable tax deferrals and
 credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
B V U D SYSTEM B-3
 Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	13501	0	0	-13501	
1	2899	1499	0	4398	0	0	-4398	-3635
2	2899	1634	0	4533	0	0	-4533	-3096
3	2899	1781	0	4680	0	0	-4680	-2642
4	2899	1941	0	4841	0	0	-4841	-2258
5	2899	2116	0	5015	0	0	-5015	-1934
6	2899	2306	0	5206	0	0	-5206	-1659
7	2899	2514	0	5413	0	0	-5413	-1425
8	2899	2740	0	5640	0	0	-5640	-1227
9	2899	2987	0	5886	0	0	-5886	-1059
10	2899	3256	0	6155	0	0	-6155	-915
11	2899	3549	0	6448	0	0	-6448	-792
12	2899	3868	0	6767	0	0	-6767	-687
13	2899	4216	0	7115	0	0	-7115	-597
14	2899	4596	0	7495	0	0	-7495	-520
15	2899	5009	0	7909	0	0	-7909	-453
16	2899	5460	0	8359	0	0	-8359	-396
17	2899	5951	0	8851	0	0	-8851	-346
18	2899	6487	0	9386	0	0	-9386	-304
19	2899	7071	0	9970	0	0	-9970	-267
20	2899	7707	0	10607	0	0	-10607	-234
	57985	76689	0	148175	0	0	-148175	-24446

The Present Worth total is the present value of the cash flow developed
 after loan amortization, discounted at a money market rate of 21 %.

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20).

With amortization of an initial investment of \$ 16345 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment, interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
B V U D SYSTEM B-4
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	16345	0	0	-16345	
1	3510	1357	0	4867	0	0	-4867	-4022
2	3510	1479	0	4989	0	0	-4989	-3408
3	3510	1612	0	5122	0	0	-5122	-2891
4	3510	1757	0	5267	0	0	-5267	-2457
5	3510	1916	0	5426	0	0	-5426	-2092
6	3510	2088	0	5598	0	0	-5598	-1784
7	3510	2276	0	5786	0	0	-5786	-1524
8	3510	2481	0	5991	0	0	-5991	-1304
9	3510	2704	0	6214	0	0	-6214	-1118
10	3510	2947	0	6457	0	0	-6457	-960
11	3510	3213	0	6723	0	0	-6723	-826
12	3510	3502	0	7012	0	0	-7012	-712
13	3510	3817	0	7327	0	0	-7327	-615
14	3510	4160	0	7670	0	0	-7670	-532
15	3510	4535	0	8045	0	0	-8045	-461
16	3510	4943	0	8453	0	0	-8453	-400
17	3510	5388	0	8898	0	0	-8898	-348
18	3510	5873	0	9383	0	0	-9383	-304
19	3510	6401	0	9911	0	0	-9911	-268
20	3510	6977	0	10487	0	0	-10487	-232
	70200	69424	0	155969	0	0	-155969	-26253

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 21 %.

The following table presents project life cycle costs and revenues
 over 20 Yearly periods (N= 20).
 with amortization of an initial investment of \$ 65700
 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected:
 energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment.
 Interest paid on the effective loan balance, suitable tax deferrals and
 credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
B V U D SYSTEM C-3
 Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	65700	0	0	-65700	
1	14109	2140	0	16249	0	0	-16249	-13429
2	14109	2333	0	16441	0	0	-16441	-11230
3	14109	2543	0	16651	0	0	-16651	-9399
4	14109	2771	0	16880	0	0	-16880	-7875
5	14109	3021	0	17130	0	0	-17130	-6604
6	14109	3293	0	17401	0	0	-17401	-5545
7	14109	3589	0	17698	0	0	-17698	-4660
8	14109	3912	0	18021	0	0	-18021	-3922
9	14109	4264	0	18373	0	0	-18373	-3305
10	14109	4648	0	18757	0	0	-18757	-2788
11	14109	5066	0	19175	0	0	-19175	-2356
12	14109	5522	0	19631	0	0	-19631	-1993
13	14109	6019	0	20128	0	0	-20128	-1689
14	14109	6561	0	20670	0	0	-20670	-1433
15	14109	7151	0	21260	0	0	-21260	-1218
16	14109	7795	0	21904	0	0	-21904	-1037
17	14109	8496	0	22605	0	0	-22605	-835
18	14109	9261	0	23370	0	0	-23370	-756
19	14109	10095	0	24203	0	0	-24203	-647
20	14109	11003	0	25112	0	0	-25112	-555
	282175	109483	0	457357	0	0	-457357	-81325

The Present Worth total is the present value of the cash flow developed
 after loan amortization, discounted at a money market rate of 21 %.

The following table presents project life cycle costs and revenues
 over 20 Yearly periods (N= 20).
 with amortization of an initial investment of \$ 83276
 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected:
 energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment,
 interest paid on the effective loan balance, suitable tax deferrals and
 credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
B V U D SYSTEM C-4
 Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	83276	0	0	-83276	
1	17883	1318	0	19201	0	0	-19201	-15869
2	17883	1437	0	19320	0	0	-19320	-13196
3	17883	1566	0	19449	0	0	-19449	-10978
4	17883	1707	0	19590	0	0	-19590	-9139
5	17883	1860	0	19744	0	0	-19744	-7612
6	17883	2028	0	19911	0	0	-19911	-6344
7	17883	2210	0	20094	0	0	-20094	-5291
8	17883	2409	0	20292	0	0	-20292	-4416
9	17883	2626	0	20509	0	0	-20509	-3689
10	17883	2863	0	20746	0	0	-20746	-3084
11	17883	3120	0	21003	0	0	-21003	-2580
12	17883	3401	0	21284	0	0	-21284	-2161
13	17883	3707	0	21590	0	0	-21590	-1812
14	17883	4041	0	21924	0	0	-21924	-1520
15	17883	4404	0	22287	0	0	-22287	-1277
16	17883	4801	0	22684	0	0	-22684	-1074
17	17883	5233	0	23116	0	0	-23116	-905
18	17883	5704	0	23587	0	0	-23587	-763
19	17883	6217	0	24100	0	0	-24100	-644
20	17883	6777	0	24660	0	0	-24660	-545
	357662	67429	0	508367	0	0	-508367	-92897

The Present Worth total is the present value of the cash flow developed
 after loan amortization, discounted at a money market rate of 21 %.

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20), with amortization of an initial investment of \$ 61868 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment, interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
 B V U D SYSTEM D-3
 Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	61868	0	0	-61868	
1	13286	2100	0	15386	0	0	-15386	-12716
2	13286	2289	0	15575	0	0	-15575	-10638
3	13286	2493	0	15781	0	0	-15781	-8903
4	13286	2720	0	16005	0	0	-16005	-7467
5	13286	2964	0	16250	0	0	-16250	-6265
6	13286	3231	0	16517	0	0	-16517	-5263
7	13286	3522	0	16803	0	0	-16803	-4426
8	13286	3839	0	17125	0	0	-17125	-3727
9	13286	4184	0	17470	0	0	-17470	-3142
10	13286	4561	0	17847	0	0	-17847	-2653
11	13286	4971	0	18257	0	0	-18257	-2243
12	13286	5419	0	18705	0	0	-18705	-1899
13	13286	5907	0	19192	0	0	-19192	-1610
14	13286	6438	0	19724	0	0	-19724	-1368
15	13286	7018	0	20303	0	0	-20303	-1164
16	13286	7649	0	20935	0	0	-20935	-992
17	13286	8338	0	21623	0	0	-21623	-846
18	13286	9088	0	22374	0	0	-22374	-724
19	13286	9906	0	23192	0	0	-23192	-620
20	13286	10797	0	24083	0	0	-24083	-532
	265717	107436	0	435021	0	0	-435021	-77201

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 21 %.

The following table presents project life cycle costs and revenues
 20 Yearly periods (N= 20).
 With amortization of an initial investment of \$ 78310
 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected:
 energy costs, 9 %; maintenance and repair costs, 0 %; revenues, 0 %.

Taxes are computed based on straight-line depreciation of the investment.
 Interest paid on the effective loan balance, suitable tax deferrals and
 credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
 B V U D SYSTEM D-4
 Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	78310	0	0	-78310	
1	16817	1307	0	18124	0	0	-18124	-11978
2	16817	1425	0	18241	0	0	-18241	-12459
3	16817	1553	0	18370	0	0	-18370	-10369
4	16817	1693	0	18509	0	0	-18509	-8635
5	16817	1845	0	18662	0	0	-18662	-7195
6	16817	2011	0	18828	0	0	-18828	-5999
7	16817	2192	0	19009	0	0	-19009	-5006
8	16817	2389	0	19206	0	0	-19206	-4180
9	16817	2604	0	19421	0	0	-19421	-3493
10	16817	2839	0	19655	0	0	-19655	-2922
11	16817	3094	0	19911	0	0	-19911	-2446
12	16817	3373	0	20189	0	0	-20189	-2050
13	16817	3676	0	20493	0	0	-20493	-1719
14	16817	4007	0	20824	0	0	-20824	-1444
15	16817	4368	0	21184	0	0	-21184	-1214
16	16817	4761	0	21577	0	0	-21577	-1022
17	16817	5189	0	22006	0	0	-22006	-861
18	16817	5656	0	22473	0	0	-22473	-727
19	16817	6165	0	22982	0	0	-22982	-614
20	16817	6720	0	23537	0	0	-23537	-520
	336333	66866	0	481510	0	0	-481510	-87853

The Present Worth total is the present value of the cash flow developed
 after loan amortization, discounted at a money market rate of 21 %.

APPENDIX C

Appendix C contains computer printouts showing project benefits under a variety of financial conditions:

Run No.	Money Market	Marginal	Debt Financing	Equity Financing	
	Interest Rate	Tax Rate	Cash Flow PV	Cash Flow PV	ROI
1	19%	35%	\$166,884	\$123,700	29.2%
4	19%	40%	\$158,799	\$128,153	29.9%
7	21%	35%	\$129,737	\$89,810	29.2%
10	21%	40%	\$124,758	\$94,713	29.9%
13	23%	35%	\$98,685	\$61,818	29.2%
16	23%	35%	\$94,860	\$66,945	29.9%

BASIN VIEW UTILITY DISTRICT RUN NO.1
Prepared by Center 4 Engineering

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20), with amortization of an initial investment of \$ 194020 on money having a value of 19 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 8 %; revenues, 9 %.

Taxes are computed based on straight-line depreciation of the investment, interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
BASIN VIEW UTILITY DISTRICT RUN NO.1
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	194020	0	0	-194020	
1	38037	7935	2000	47972	58940	0	10968	9217
2	38037	8649	2160	48846	64245	0	15399	10874
3	38037	9428	2333	49797	70027	0	20230	12005
4	38037	10276	2519	50832	76329	0	25497	12714
5	38037	11201	2721	51959	83199	0	31240	13091
6	38037	12209	2939	53184	90687	0	37502	13206
7	38037	13308	3174	54518	98848	0	44330	13118
8	38037	14505	3428	55970	107745	16377	35398	8902
9	38037	15811	3702	57550	117442	19531	40361	8434
10	38037	17234	3998	59269	128011	23002	45740	8032
11	38037	18785	4318	61140	139532	26824	51569	7610
12	38037	20476	4663	63176	152090	31035	57879	7177
13	38037	22319	5036	65392	165779	35680	64707	6743
14	38037	24327	5439	67803	180699	40806	72089	6313
15	38037	26517	5874	70428	196961	46470	80064	5892
16	38037	28903	6344	73284	214688	52735	88669	5483
17	38037	31504	6852	76393	234010	59671	97946	5090
18	38037	34340	7400	79777	255071	67359	107936	4713
19	38037	37430	7992	83459	278027	75891	118677	4355
20	38037	40799	8631	87467	303050	85371	130211	4015
	760734	405956	91524	1452230	3015380	580751	982394	166834

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 19 %.

The equivalent Return on Investment after taxes for an owner funding the entire project (with no interest offset on taxes) is 29.2 %. The present value of its net cash flow including initial investment is \$123700

BASIN VIEW UTILITY DISTRICT RUN NO.4
Prepared by Center 4 Engineering

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20), with amortization of an initial investment of \$ 194020 on money having a value of 19 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 8 %; revenues, 9 %.

Taxes are computed based on straight-line depreciation of the investment, interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 40 %.

LIFE CYCLE COST ANALYSIS
BASIN VIEW UTILITY DISTRICT RUN NO.4
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	194020	0	0	-194020	
1	38037	7935	2000	47972	58940	0	10968	9217
2	38037	8649	2160	48846	64245	0	15399	10874
3	38037	9428	2333	49797	70027	0	20230	12005
4	38037	10276	2519	50832	76329	0	25497	12714
5	38037	11201	2721	51959	83199	0	31240	13091
6	38037	12209	2939	53184	90687	0	37502	13206
7	38037	13308	3174	54518	98848	5390	38940	11523
8	38037	14505	3428	55970	107745	18716	33059	8221
9	38037	15811	3702	57550	117442	22322	37571	7851
10	38037	17234	3998	59269	128011	26288	42454	7455
11	38037	18785	4318	61140	139532	30656	47737	7044
12	38037	20476	4663	63176	152090	35469	53446	6628
13	38037	22319	5036	65392	165779	40777	59610	6212
14	38037	24327	5439	67803	180699	46635	66260	5802
15	38037	26517	5874	70428	196961	53109	73425	5403
16	38037	28903	6344	73284	214688	60268	81136	5017
17	38037	31504	6852	76393	234010	68195	89422	4647
18	38037	34340	7400	79777	255071	76981	98313	4293
19	38037	37430	7992	83459	278027	86732	107836	3957
20	38037	40799	8631	87467	303050	97567	118015	3639
	760734	405956	91524	1452230	3015380	669106	894040	158799

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 19 %.

The equivalent Return on Investment after taxes for an owner funding the entire project (with no interest offset on taxes) is 29.9 %. The present value of its net cash flow including initial investment is \$128153

BASIN VIEW UTILITY DISTRICT RUN NO.7
Prepared by Center 4 Engineering

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20),
 with amortization of an initial investment of \$ 194020
 on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected:
 energy costs, 9 %; maintenance and repair costs, 8 %; revenues, 9 %.

Taxes are computed based on straight-line depreciation of the investment,
 interest paid on the effective loan balance, suitable tax deferrals and
 credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
BASIN VIEW UTILITY DISTRICT RUN NO.7
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	194020	0	0	-194020	
1	41665	7935	2000	51600	58940	0	7340	6066
2	41665	8649	2160	52474	64245	0	11771	8040
3	41665	9428	2333	53425	70027	0	16601	9371
4	41665	10276	2519	54460	76329	0	21869	10202
5	41665	11201	2721	55587	83199	0	27612	10646
6	41665	12209	2939	56812	90687	0	33874	10793
7	41665	13308	3174	58146	98848	0	40702	10718
8	41665	14505	3428	59598	107745	14937	33210	7228
9	41665	15811	3702	61178	117442	18088	38176	6866
10	41665	17234	3998	62897	128011	21562	43552	6474
11	41665	18765	4318	64768	139532	25395	49370	6065
12	41665	20476	4663	66804	152090	29629	55658	5651
13	41665	22319	5036	69020	165779	34310	62449	5240
14	41665	24327	5439	71431	180699	39495	69773	4838
15	41665	26517	5874	74056	196961	45244	77662	4451
16	41665	28903	6344	76912	214688	51629	86147	4080
17	41665	31504	6852	80021	234010	58732	95257	3729
18	41665	34340	7400	83405	255071	66648	105018	3397
19	41665	37430	7992	87087	278027	75485	115455	3087
20	41665	40799	8631	91095	303050	85371	126583	2797
	833296	405956	91524	1524800	3015380	566526	924058	129737

The Present Worth total is the present value of the cash flow developed
 after loan amortization, discounted at a money market rate of 21 %.

The equivalent Return on Investment after taxes for an owner funding
 the entire project (with no interest offset on taxes) is 29.2 %. The
 present value of its net cash flow including initial investment is \$ 89810

BASIN VIEW UTILITY DISTRICT RUN NO. 10
Prepared by Center 4 Engineering

The following table presents project life cycle costs and revenues
for 20 Yearly periods (N= 20),
with amortization of an initial investment of \$ 194020
on money having a value of 21 % annual interest

During the lifetime of the project, these annual increases are expected:
energy costs, 9 %; maintenance and repair costs, 8 %; revenues, 9 %.

Taxes are computed based on straight-line depreciation of the investment,
interest paid on the effective loan balance, suitable tax deferrals and
credits, and an assumed owner marginal tax rate of 40 %.

LIFE CYCLE COST ANALYSIS
BASIN VIEW UTILITY DISTRICT RUN NO. 10
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	194020	0	0	-194020	
1	41665	7935	2000	51600	58940	0	7340	6066
2	41665	8649	2160	52474	64245	0	11771	8040
3	41665	9428	2333	53425	70027	0	16601	9371
4	41665	10276	2519	54460	76329	0	21869	10202
5	41665	11201	2721	55587	83199	0	27612	10646
6	41665	12209	2939	56812	90687	0	33874	10793
7	41665	13308	3174	58146	98848	0	40702	10718
8	41665	14505	3428	59598	107745	17070	31076	6763
9	41665	15811	3702	61178	117442	20673	35591	6401
10	41665	17234	3998	62897	128011	24643	40472	6016
11	41665	18785	4318	64768	139532	29023	45742	5619
12	41665	20476	4663	66804	152090	33861	51425	5221
13	41665	22319	5036	69020	165779	39212	57547	4829
14	41665	24327	5439	71431	180699	45137	64131	4447
15	41665	26517	5874	74056	196961	51707	71198	4080
16	41665	28903	6344	76912	214688	59005	78771	3731
17	41665	31504	6852	80021	234010	67123	86866	3400
18	41665	34340	7400	83405	255071	76169	95497	3089
19	41665	37430	7992	87087	278027	86269	104671	2798
20	41665	40799	8631	91095	303050	97567	114387	2527
	833296	405956	91524	1524800	3015380	647453	843125	124758

The Present Worth total is the present value of the cash flow developed
after loan amortization, discounted at a money market rate of 21 %.

The equivalent Return on Investment after taxes for an owner funding
the entire project (with no interest offset on taxes) is 29.9 %. The
present value of its net cash flow including initial investment is \$ 94713

BASIN VIEW UTILITY DISTRICT RUN NO.13
Prepared by Center 4 Engineering

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20), with amortization of an initial investment of \$ 194020 on money having a value of 23 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 8 %; revenues, 9 %.

Taxes are computed based on straight-line depreciation of the investment, interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 35 %.

LIFE CYCLE COST ANALYSIS
BASIN VIEW UTILITY DISTRICT RUN NO.13
Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	194020	0	0	-194020	
1	45346	7935	2000	55281	58940	0	3659	2974
2	45346	8649	2160	56156	64245	0	8089	5347
3	45346	9428	2333	57107	70027	0	12920	6943
4	45346	10276	2519	58142	76329	0	18187	7946
5	45346	11201	2721	59268	83199	0	23930	8500
6	45346	12209	2939	60494	90687	0	30192	8719
7	45346	13308	3174	61828	98848	0	37020	8692
8	45346	14505	3428	63280	107745	13491	30974	5912
9	45346	15811	3702	64859	117442	16636	35946	5578
10	45346	17234	3998	66578	128011	20109	41324	5214
11	45346	18783	4318	68449	139532	23947	47136	4835
12	45346	20476	4663	70485	152090	28196	53409	4454
13	45346	22319	5036	72701	165779	32908	60169	4080
14	45346	24327	5439	75113	180699	38143	67443	3718
15	45346	26517	5874	77737	196961	43971	75254	3372
16	45346	28903	6344	80594	214698	50472	83622	3017
17	45346	31504	6852	83703	234010	57741	92566	2742
18	45346	34340	7400	87086	255071	65890	102095	2459
19	45346	37430	7992	90769	278027	75048	112210	2197
20	45346	40799	8631	94777	303050	85371	122902	1936
	906929	405956	91524	1598430	3015380	551922	865028	98685

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 23 %.

The equivalent Return on Investment after taxes for an owner funding the entire project (with no interest offset on taxes) is 29.2 %. The present value of its net cash flow including initial investment is \$ 61818

BASIN VIEW UTILITY DISTRICT RUN NO. 16
 Prepared By Center & Engineering

The following table presents project life cycle costs and revenues for 20 Yearly periods (N= 20), with amortization of an initial investment of \$ 194020 on money having a value of 23 % annual interest

During the lifetime of the project, these annual increases are expected: energy costs, 9 %; maintenance and repair costs, 8 %; revenues, 9 %.

Taxes are computed based on straight-line depreciation of the investment, interest paid on the effective loan balance, suitable tax deferrals and credits, and an assumed owner marginal tax rate of 40 %.

LIFE CYCLE COST ANALYSIS
 BASIN VIEW UTILITY DISTRICT RUN NO. 16
 Yearly Periods - Amounts in Dollars

PERIOD	DEBT SERVICE	ENERGY EXP	MAINT EXP	TOTAL PAYMENTS	REVENUES	TAXES	NET CASH	PRESENT WORTH
0	0	0	0	194020	0	0	-194020	
1	45346	7935	2000	55281	58940	0	3659	2974
2	45346	8649	2160	56156	64245	0	8089	5347
3	45346	9428	2333	57107	70027	0	12920	6943
4	45346	10276	2519	58142	76329	0	18187	7946
5	45346	11201	2721	59268	83199	0	23930	8500
6	45346	12209	2939	60494	90687	0	30192	8719
7	45346	13303	3174	61828	98848	0	37020	8692
8	45346	14505	3428	63280	107745	15418	29047	5544
9	45346	15811	3702	64859	117442	19013	33569	5210
10	45346	17234	3998	66578	128011	22981	38452	4851
11	45346	18785	4318	68449	139532	27368	43715	4484
12	45346	20476	4663	70485	152090	32224	49381	4118
13	45346	22319	5036	72701	165779	37609	55468	3761
14	45346	24327	5439	75113	180699	43592	61994	3417
15	45346	26517	5874	77737	196961	50252	66972	3091
16	45346	28903	6344	80594	214688	57682	76412	2784
17	45346	31504	6852	83703	234010	65990	84317	2498
18	45346	34340	7400	87086	255071	75303	92682	2232
19	45346	37430	7992	90769	278027	85770	101489	1987
20	45346	40799	8631	94777	303050	97567	110706	1762
	906929	405956	91524	1598430	3015330	630769	786182	94360

The Present Worth total is the present value of the cash flow developed after loan amortization, discounted at a money market rate of 23 %.

The equivalent Return on Investment after taxes for an owner funding the entire project (with no interest offset on taxes) is 29.9 %. The present value of its net cash flow including initial investment is \$ 66945