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5388

KLAMATH FALLS GEOTHERMAL DEVELOPMENT

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CITY OF KLAMATH FALLS

The City of Klamath Falls has been involved in the development of a Geothermal Heating District since 1976. The City's involvement in the project has centered around development of proper statutory authorities on the State level, development of local legislation providing for heating district rules, regulations and rates, developing marketing aspects, securing resource areas, master plan development and the construction of a geothermal demonstration project. Development of proper statutory authority, both on a State and local level, has provided for the passage, through the appropriate legislative bodies, of laws specifically identifying authorities for local involvement in geothermal development and also providing conventional utility financing as a mechanism to finance front end costs for development of the project. The City of Klamath Falls has, furthermore, taken it on as a local priority to secure proper resource areas to insure the future development for the total urban heating system.

STATE STATUTORY AUTHORITY

During the 1977 Oregon State Legislative session, the City of Klamath Falls wrote and proposed to the sponsorship of its local representatives certain bills allowing for the establishment by the City of a Geothermal Heating District. Those laws which were subsequently passed by the Oregon State Senate and House of Representatives have become identified with the Oregon Revised Statutes Chapter 523.

The purpose of the State Statutes was to identify and make available to incorporated cities the necessary legal mechanisms for development of all facets of development of a Geothermal Heating District. Contained within O.R.S. 523 are the direct statutory authorities providing for a city's involvement within the district heating development. The statutes further provide for the mechanism of providing the heating resource on a day-to-day basis.

The following is a summary of the main points within O.R.S. 523 which provide the City with the tools for development, operation and maintenance of the system. The statutes provide, in addition to the overall authority, that a City may purchase buy or lease property for the development. It goes one step further and provides that a City may condemn property for use within the District. This particular authority would be quite useful in securing property for well development at fair market value as determined, if necessary, through a condemnation court case. The condemnation authority can also be used for the securing of property for the installation of pipe line, heat exchanger building and for any other associated purpose involving the heating district.

The Oregon Revised Statutes also provide for bonding authority for the development of a heating district. That bonding authority extends itself to the use of revenue bonds and general obligation bonds. This will be a particularly useful tool for the development of the total district after completion of the demonstration project. The City has undertaken surveys of City residents to determine their desire to receive the resource. That survey indicated that over 70% of the survey participants desired to receive the geothermal fluid. Corresponding with that survey, the question was asked whether the residents would be willing to pass and/or bond themselves to receive the energy resource. The results of that question was over 60% affirmative to bond or tax themselves in order to have the geothermal resource available. The bonding authority also has been extended to provide for the selling of Bancroft Bonds for geothermal expansion. This is a traditional mechanism where local Improvement Districts are established for certain areas within the City and through a public hearing process those individuals may initiate improvements with funding to come from assessment against their property. Bancroft Bonds and General Obligation Bonds are seen as a significant future revenue potential in that traditionally interest rates for such bonds has been in the area of 6% because of the municipal tax deferment aspects of the bond.

The Oregon Revised Statutes also provide that the City may establish an appropriate rate structure. The rate structure is to be decided on the local level by the local governing body or other boards, as appointed by the governing body. The rates may be established in any manner which the locality desires. Currently the City is developing its rate structure to be handled on a BTU consumption basis. Under current Oregon Public Utilities Commissioner rules and regulations, the City would

be exempted from P.U.C. control in all facets, including rates, of this operation of a heating district.

O.R.S. 523 also provides that a City may levy, when approved by the residents of the City, an advalorem tax for development, maintenance and operation of a geothermal heating district. The taxing authority statute also provides for collection and enforcement methods for heating districts. The taxing authority may also be extended for the retirement of principal and interest for any bonding or outstanding indebtedness which the district encounters.

Other operational aspects covered in O.R.S. 523 include the granting of emergency powers, the ability to apply for financing through gifts and grants, the right to enter into cooperative agreements, the authority to perform drainage work, the right to establish service contracts, the right to enter into inter-governmental agreements, establishment of foreclosure processes and statutory authority defining administration, including the election of the board of directors, the rights of initiative and referendum, and the right to call for a special election.

DEVELOPMENT OF LOCAL AUTHORITY

In addition to the City's active involvement in the development of the State authority for operation of the heating district, the City has undertaken on itself, through a grant with the Oregon Department of Energy, the development of a local Geothermal Management Ordinance. The purpose of the local ordinance is to specifically define the rules and regulations under which the City will operate its heating district, using the State Statutes as a general basis for local involvement in the development of a heating district. Again, the local ordinance is to lay out the specifics of the operation which the City is undertaking with the development as a provider of the geothermal heating resource. The local management ordinance will provide and define the means, types of rates, fees and charges that will be associated with the heating district. The management ordinance will provide for a hearings process and a notification provision for the establishment of rates, fees and charges and for any future increases of such charges. The hearings process will include a public hearing after sufficient notice and publication has been made to allow public input to the City Council before it initiates any rates, fees or charges.

The management ordinance further provides for the establishment of district boundaries. Although under O.R.S. 523 the City limits boundaries would be identified as the district boundaries, there is the possibility that the boundaries may exceed the City limits boundaries for the distribution of the resource to non-incorporated areas. The management ordinance would establish the district boundaries by attachment of map and direct reference through the passage of the ordinance. The Geothermal Management Ordinance also establishes what would be referenced as the Geothermal District Resource Data Center. The Data Center's main purpose will be to receive data concerning the geothermal district and private individual wells operating within the district. The purpose of the data collection would be to analyze and evaluate the geothermal reservoir. The underlying reasoning behind the purpose of the Data Center is to provide a management mechanism of the reservoir to the benefit of all users, whether the district or private individuals. Such information to be collected by the District Resource Data Center will include pumping figures, drawdown measurements, all drill logs, records of well completions, disposal methods, reinjection information and records of any alleged well interference. Additionally, the ordinance as now drafted will require the completion of an annual well survey. The survey will be mailed to all registered well owners within the district and will request up-date of significant well operation characteristics of the foregoing.

The management ordinance also provides for an application procedure for connection to the district. The procedure provides for an application to be made to the Public Works Department and for a decision to be made by the Public Works Director or his authorized representative. Any decision denying connection must be accompanied by written findings and may be appealed to the City Council for final and binding decision. Such connection will also be inspected and done in accordance with standards provided for in the management ordinance.

The ordinance provides for the entering into a contract with individuals wishing to receive the service. The service provision of the ordinance provides for a service deposit and service charges. The service charges will be developed on a metered BTU basis and broken out into single residential, multi-family residential and commercial structures. The metering will be accomplished through the existing City's water meter reading and will be billed out on existing water bill forms. The computer programming and software has already been developed to provide for a geothermal service charge.

Other areas included within the management ordinance include the appointment of a local official as the City representative concerning the operation of the heating district, provision and inspection of non-district geothermal facilities, annexation to the district, low income retrofitting assistance, the tie-in of non-geothermal heat sources for peaking purposes, the filing of impact assessment statement on the existing and future wells in relationship to reservoir influences, surface discharge and municipal court authority for non-compliance of the ordinance.

MARKETING

The City has been concerned about the development of an urban heating district from the marketing aspect and specifically its concern centers with already developed areas. The concern with the developed areas is basically with the retrofitting costs which the individual property owner will have to absorb in order to be connected to the system. Within the Klamath Falls area, in the residential areas, the property turns to new owners on a average of once every five years. With that turnover, the individuals will have to be able to amortize the retrofit investment within that period of time or assume that by connection to the geothermal system the property sale will increase enough to offset the retrofit investment. Because of this concern, the City has been active in two areas which are tax incentives and revolving retrofit loans. During the 1979 legislature, the City again went to the Oregon State Senate and House of Representatives and proposed to appropriate sub-committees ' legislation for tax incentives for geothermal heating districts. The legislation provided for $1,000 state income tax credit for the retrofit cost for connection to a geothermal heating district. Additionally, the City proposed redefining previously passed legislation for tax incentive for development of other alternative energy forms. That redefinition allowed for an additional $1,000 credit on the state income taxes for geothermal heating district connection. In total, then, under both programs, there would be available a maximum of a $2,000 state tax credit for retrofit costs for connection to a geothermal heating district.

The other aspect which the City has established for connection to the heating district, is the establishment of revolving loan fund for retrofit costs. The revolving loan fund will provide financing to district residents who desire to connect up to the system. The City will make available a loan to cover retrofit costs for connection to the system. The loan will be secured by the property and recorded against the benefitted property. At the time of this paper, the interest rate for such loans has been not officially decided upon but will be in the range of 3% to 8%. With the low interest rate on the loan, it is seen as a very attractive marketing tool for property owners to use in absorbing retrofit costs.

RESOURCE AND MASTER PLAN DEVELOPMENT

In developing the total urban heating district, resource area identification has been undertaken to align itself with the Master Plan Development with priority areas identified and a time table for development associated with those priority areas. The purpose of the Master Plan is to identify, as indicated above, resource areas, pipe routing, necessary GPM peaking plan, whether geothermal or conventional energy and storage locations. Perhaps the most significant area within the Master Plan will be identification of potential resource areas. With that information in hand, the City will be able to go out and attempt to secure the necessary property and water rights to provide the specified sub-districts with the resource. Below, in Figure I, you will see the tentative district boundary with established priority areas and also the time table for development of those areas.

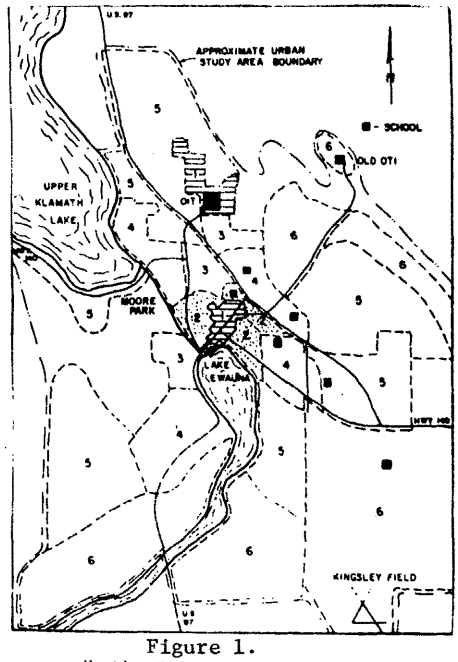

Figure 1.
Heating District Boundaries

District Priority	Time of Development
1	0-2 years
2	2-5
3	5-10
4	10-15
5	>15
6	>20

The sub-district boundaries in the urban areas were located under the following criteria: 1) Natural topography features; 2) Man made features; 3) Political boundaries; 4) Land use. Natural and man made features were the primary controlling items. These included the two lakes, Link River, 3 bridges, the main ridge line, railroad crossing and an irrigation canal. Any of these items would be costly to cross and for this reason the local distribution boundaries within a sub-district were aligned and the boundaries developed. Production and resource areas were located and analyzed within the above criteria under an additional set of criteria which are as follows: 1) Proximity to users in order to buy a supply of pipeline lengths; 2) Elevation head to provide gravity feed wherever possible; 3) Availability of public land for development; 4) Information on geothermal fluid existing and/or adjacent to the site. With the culmination of the physical hardware items required and identifying of the existing land information relative to geothermal development, the City has the basic tools in which

to initiate the development of the total urban heating district.

DEMONSTRATION PROJECT

The following is a summary of the Conceptual Design Report and the proposed Geothermal Heating District Project awarded to the City of Klamath Falls under PON EG-77-N-03-1553 to design, construct and initiate operation of a geothermal space heating district. The district utilization project is for a City owned and operated system serving 14 city, county, state and federal office buildings. The project is essentially broken down into three phases which include establishment of wells, construction of a distribution line and the retrofiting of the existing buildings.

The production area to produce the geothermal waters for the heating of the district is to be in the vicinity of the Old Fort Road area which is further described in the Conceptual Design Report. The production area is located within the second largest KGRA, as reported by the U.S. Geological Survey. The project will involve two production wells of approximately 1,000' deep with an estimated production of 500 gallons per minute each. The anticipated temperature from the production wells is 220°F, and the required flow for the 14 buildings is 768 gallons per minute. The estimated peak load for the 14 buildings is 15.326 x 10^6 BTU per hour.

Each production well will be outfitted with a 7.5 h.p. turbine pump with variable speed drive. Each well and pump will be enclosed by a 10' x 10' well head building. The geothermal waters will be transported 4,060' to the vicinity of the County Museum and the City Fire Station. The geothermal waters will be transported by single 8" diameter steel pipe with urethane wrap insulation and placed in a concrete tunnel. The tunnel will be 58" x 38". The tunnel will be installed in 10' sections with removable tops for easy maintenance and future expansion. The tunnel will be placed in existing public rights-of-way and, wherever possible, will become a part of the sidewalk surface that currently exists.

The concrete tunnel was chosen for the following reasons:

1. It will provide a sterile environment, eliminating outside corrosion factors which, through past experience, has been the main corrosion factor in the Klamath Falls area.

2. Provide for an extended life cycle from 20 years to 70 years.

3. Provide easy accessibility for maintenance in the future.

4. The tunnel is designed for easy expansion for future pipe lines for distribution of the resource into the other parts of the urban area.

The steel pipe in a concrete tunnel is insulated with 2 in. of rigid fiberglass insulation (K - .32 BTU-in/ft^2 - °F - hr) and the buried steel pipe in an FRP protective covering is insulated with 2 in. of urethane foam (K - .25 BTU-in/ft^2 - °F - hr).

Expansion of the steel pipe is controlled by "Flexionics" expansion joints (bellows type). Flexionics controlled-flexing expansion joints take pressures up to 300 psi and have temperature limits of -20 to 800°F. These units may be either single or dual acting with welding ends. The dual expansion joints are furnished with an anchor base and can be employed for application where large amounts of any combination of the three basic movements; i.e., axial movement, lateral deflection and angular rotation, cannot be absorbed by a single expansion joint.

Bellows type expansion joints were selected over expansion loops because of the limited space available in developed streets, less head loss and cost effectiveness.

At the end of the geothermal line, a centralized heat exchanger building 30' x 40' will be used to house two plate heat exchangers. The two plate heat exchangers will then transfer the heat from the geothermal line to a closed loop domestic water line. In addition to the two heat exchangers, a heat exchange building will include two vertical turbine circulation pumps of 50 h.p. capable of pumping 400 gallons per minute each. To handle surges and expansions, a 1,000 gallon pressure and surge tank will be housed at the central heat exchange building. A telemetry system controlling pumping requirements, heating requirements and the appropriate flow for those requirements will be the basic control system which also will be housed in the central heat exchange building.

The control system for the project is outlined in the attached Figure 2 and described as follows:

1. The flow in the primary geothermal fluid supply line is regulated by the pneumatic butterfly valves (V-1 and V-2) located on the reject side of the heat exchangers which are controlled by outside air temperature (T_1) temperature (T_2) via Receiver-Controller #1. Closing of control valves V-1 and/or V-2 results in increased pressure in the primary supply line which, in turn, is relayed to a pressure control regulator located at the production pump, reducing the pumping rate of the variable speed/fluid drive deep well vertical turbine pumps (TP1 and TP2). A reduction in pressure due to opening of valves resulting from a drop in outside air temperature (T_1) and geothermal return fluid temperature (T_2) causes the pressure controller to increase the pumping rate.

2. The flow in the secondary closed loop is regulated by the temperature and pressure difference between the supply and return lines. The most remote point in the system, at the County Courthouse complex, will be the critical location. In order to provide sufficient heat to subscribers, the pipe temperature loss to this point will be kept to a minimum of .3°F and the pressure to a minimum of 60 psi.

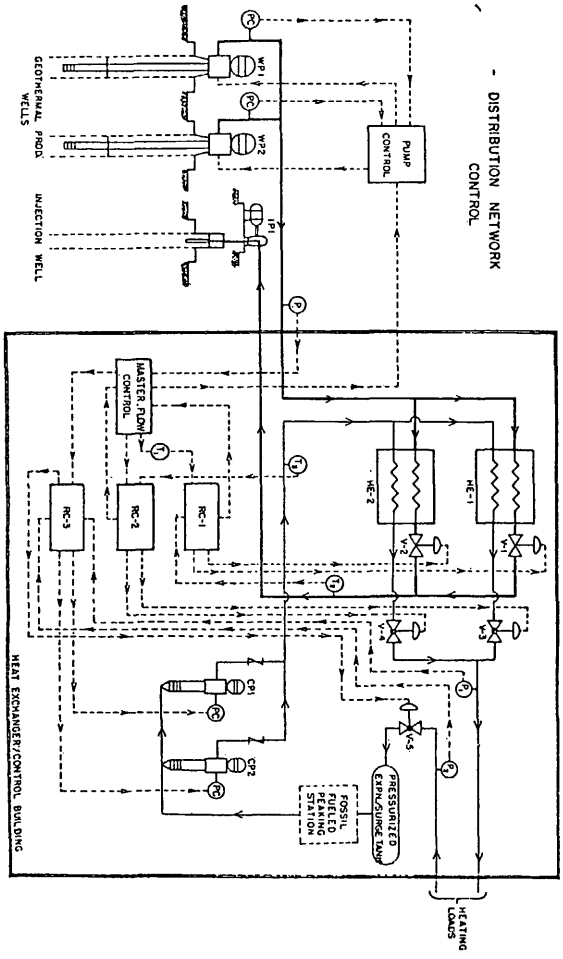

Figure 2

3. The supply temperature in the closed secondary loop is controlled on the basis of measured outside air temperature (T_1) and heating water return temperature (T_3). Receiver-Controller #2 will activate pneumatic globe valves V-3 and/or V-4 to open when outside air temperature (T_1)and heating water return temperature (T_3) drop. The result is a reduction of pressure in the heating water supply (P_1) and return (P_2) line, causing an increased pumping rate of the variable speed/fluid drive vertical turbine circulation pumps (CP1 and CP2).

4. Receiver-Controller #3 regulates the pressure in the closed loop network through the balancing globe valve V-5 when sensing supply pressure (P_1) and return pressure (P_2). This assures that design pressures are maintained to subscribers.

5. Failures in pumps or pipelines and unusual flow rates, temperatures or pressures will be monitored by a master flow controller (MCL). This includes the pressures in the pipeline as well as the expansion tank. The master flow controller, under these circumstances, will shut down the pumps in either pipe system and sound an alarm in the heat exchanger/control building. This alarm will be monitored in the Fire Station.

6. Examples of possible critical situations would be a "fully open" indication from a control valve under low heat load conditions; a reduction in pipeline pressure under high pumping rates (due to a rupture); or a drop in supply temperature (caused by a closed valve or stopped pump).

After the geothermal waters have circulated through the two steel plate exchangers, the water will be reinjected into an existing well in the vicinity of the County Museum. The centrifugal injection pump of 20 h.p. will be installed for injection.

The closed loop domestic pipe will supply the fourteen buildings at an estimated temperature of 200°F. The line will consist of 8", 6" and 3" RFP pipe which will be directly buried along the pipe route.

The secondary line will then provide service to the U.S. Post Office, State Employment Office, State Welfare Office, City Hall, City Hall Annex, City Jail, County Courthouse, Veterans Memorial Building, County Jail, County Courthouse Annex, County Library, County Courthouse Extension, County Museum and City Fire Station.

The capital cost of the intended system is as follows and more detailed costs are attached in Figure 3.

A.	Wells and Well Head Equip.	$ 169,772
B.	Pipe Lines	835,293
C.	Heat Exchanger Facilities	197,506
	Subtotal	$ 1,242,571
D.	Engineering & Inflation	197,429
	TOTAL	$ 1,400,000

TOTAL COST SUMMARY

Case Ia
(8", 6" Steel Pipeline on Concrete Tunnel)

Item	Cost
A. Wells and Well Head Equipment:	
1. Production well (2) @ $38,898	$ 77,796
2. Production well pumps (2) @ $41,988	83,976
3. Well head buildings (2) @ $3,500	7,000
4. Power hook-up in buildings (2) @ $500	1,000
Subtotal	$ 169,772
B. Distribution Piping Network:	
5. Primary supply pipeline (8" steel in concrete tunnel)	506,175
6. Secondary supply pipeline (8", 6" & 3" FRP Direct burial)	329,118
Subtotal	835,293
C. Heat Exchanger Building:	
7. Plate heat exchangers (2) @ $14,000	28,000
8. Control system, wiring, etc. (basic)	44,537
9. Circulation pump (2) @ $13,691	27,382
10. Expansion/surge tank	5,000
11. Building, including installation of equipment	90,000
12. Injection well (museum)	-
13. Injection well pump	2,587
Subtotal	$ 197,506
Total Equipment & Installation Costs	$ 1,202,571
D. Overhead Costs:	
Admin. & Engineering @ 10%	120,260
Contingency (inflation @ 5%)	77,169
Total Cost	$ 1,400,000

Figure 3.

The estimated equivalent annual cost of capital for this system, based on a 20-year life and 6.5% interest, with the inclusion of operation and maintenance costs, are $201,601. Using an expanded system heat load for 11 commercial blocks, the estimated cost of the geothermal energy is $0.29/therm through a 20-year period. The equivalent annual cost for natural gas over the same 20-year period is $662,291, which is based on Oregon Department of Energy projections. This amounts to an average annual cost of natural gas of $0.94/therm, or 335% higher than geothermal.

The project size and future plans for the Geothermal Heating District calls for expansion to both commercial and residential users. Such expansion, in all likelihood, shall be predicated on voter approval for bond issues for construction funding.

STATUS

The City has currently completed the drilling of two production wells. Well #1 has been drilled to a depth of 360' and cased with 12" casing. The pump test has been concluded with the results of 224°F water and 780 gallons per minute. The static water level drop at the 780 gallon per minute pumping rate was 70'.

Well #2 has been completed to 900' with the producing zone from 190' to 240'. The original intent of Well #2 was to break through the lower aquifer and intercept deep aquifer. In drilling to 900', no indication was found of the deep aquifer, so the 190' to 240' zone was perforated with flows not being determined at this time. Temperature gradients indicate 225°F with heavy flows in that production zone.

The major milestones contemplated within the project were the construction of the wells, installation of the geothermal line, construction of the heat exchanger building and construction of the distribution line.

The following are the currently proposed start up and completion dates for each of the major milestones.

	Start Up	Completion
Construction of Wells	8/79	1/31/80
Installation of Geo. Lines	12/15/79	8/15/80
Constr. of Heat Ex. Bldg.	4/30/80	8/15/80
Constr. of Dist. Lines	4/30/80	10/31/80

COST

The costs, as reiterated herein, for the project are still current based on existing knowledge. We have explored the cost with various suppliers, and they have indicated that we are still in line with today's market.

The only real cost vs. actual expenditure to be related at this time is for the production wells. As stated in the Cost Summary, the production well estimate is $77,796. The City has drilled two production wells and also abandoned one well where equipment was lost and not able to be secured from the well. The estimated cost of the production wells is to be $65,000.

The City was able to obtain a cost saving by implementing a program where it leased the drill rig, hired licensed drillers and purchased supplies such as casing and drilling mud directly. The City did bid the drilling of the wells on a normal contractural basis and the bids received were in excess of $135,000.