GEOTHERMAL DISTRICT HEATING INSTITUTIONAL FACTORS
THE KLAMATH FALLS EXPERIENCE

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ABSTRACT

The city of Klamath Falls Geothermal District Heating System started to provide heat to 10 government buildings on March 20, 1984. This startup was two and one-half years after construction of the system was completed and the operation is scheduled for only a four-month test period. The delay was the result of citizens objecting to pumping and injecting geothermal fluids in the reservoir and was legally enforced by means of a city ordinance passed by the voters. This Initiative Ordinance essentially regulates the resource by requiring any additional water pumped from a geothermal well be returned to that same well. The state of Oregon filed a lawsuit against the city, claiming that state regulation preempted city action. The issue currently is in the Court of Appeals, after Klamath County Circuit Court ruled that the state was not preempted and the ordinance was valid and enforceable.

Historical description of development that led up to these institutional and legal problems are discussed. Citizens objections and third party mitigation measures by means of reservoir engineering studies and public meetings are described. Lessons learned from the Klamath Falls experience are pointed out so future developments in other communities may benefit.

BACKGROUND

Geothermal utilization in Klamath Falls, Oregon, has consisted of about 600 homes, multi-family housing units, almost all of the public schools, Oregon Institute of Technology, a medical center, melting snow from a state highway pavement, direct use in a laundry and for heating swimming pools. Unfortunately, the shallow resource is only located under a portion of the city as shown in Figure 1. This shallow reservoir extends for at least 11 km (7 miles) in a northwest-southeast direction with a width of about 3 km (2 miles) and is typical of the fault charged reservoirs of the Basin and Range Province. Presumably, hot water upwells along a major range front fault and flows laterally in highly permeable near surface rocks.

Unfortunately, the main known geothermal area is located along the east side of the city, and not within the main business and industrial districts. Due to the 1973 "energy crisis" and the subsequent escalation of fossil fuel prices, an interest was generated to study the possibilities of district heating by geothermal. Several limited studies (Lienau, 1976 & 1977) were performed as a result of this interest in 1976 and 1977. Both of these studies indicated that district heating was not only technically feasible, but also economically viable.

During this same period, the Oregon State Legislature established statutory authorities for a geothermal heating district (Oregon Legislature, 1977). The city was specifically involved in the adoption of the Oregon Revised Statutes, Chapter 523. Chapter 523 provides for numerous items involving geothermal heating districts, but specifically allows the city to establish a geothermal heating district and incur indebtedness for construction and maintenance of a heating district, levy user charges for providing such energy, establish rate increase procedures, levy assessments, levy taxes and enter into inter-governmental agreements in regard to operation of a such a district. The city has also actively pursued and lobbied for certain tax incentives to facilitate the changeover from conventional heating sources to geothermal sources. The city was concerned about retrofitting costs and also the costs of connection to a geothermal system as being extraordinary front-end costs which residential users could not assume. Two bills have been passed at the Oregon Legislature which allow for a 25% tax credit, up to a maximum of $1,000 for the retrofit and other costs incurred in transfer to geothermal heating. The other sponsored legislation allows for a 25% tax credit, up to a maximum of $1,00 for connection to a geothermal heating district for a total tax credit of $2,000.

In 1977, a Federal (DOE/DGE) Field Experiment Contract was awarded to the city to design, construct and initiate operation of a geothermal heating district in the central business district of the city (Lund, 1979). This project was a city-owned and operated system, initially serving 14 city, county, state and federal office buildings, and 120 residences (Phase I, 6.2 MW_t), with subsequent expansion to a 11-block area adjacent to the initial secondary supply line (Phase II, 10.2 MW_t), and final expansion to commercial buildings on 54 city blocks in the central business district (Phase III, 41.8 MW_t) as shown on Figure 2. Phase I of the project includes two production wells, an injection well, transmission lines, controls and retrofitting equipment for the government buildings. The 103°C (218°F) geothermal fluid will flow at 43 l/s (680 gpm) and will be transported from the production wells via the primary pipeline to a large central heat exchanger. After the fluid passes through the central heat exchanger, heated city water will then be distributed downtown via the secondary pipeline. The discharged geothermal fluid is then disposed of through an injection well 763 m (2,500 feet) from the production well. A second residential system will use a second heat exchanger to remove heat from the geothermal fluid in the primary pipeline to heat city water in a secondary pipeline to serve 120 homes. The primary pipeline's fluid temperature will be lowered approximately 3°C (5°F). Funds for this residential system are being provided by a Community Development Block Grant for $300,000.

Total cost of the project was $2.58 million, consisting of 65% federal funds, and the remainder from city, county and state funds. The Klamath Falls system will deliver about 14.9 million kW hours per year (51,000 MM Btu), which will displace almost 21.4 million kW hours (71,000 MM Btu) of natural gas and electricity. Customer geothermal energy price will be about two-thirds of the price of conventional fuels. Construction of the system was completed September 30, 1981, with a system check per operational specifications.

Citizens reaction to the building of the district heating system has caused serious delays in the startup of the geothermal system. Citizens objected to the pumping of additional fluids from the geothermal reservoir, delaying the project from the fall of 1981 to the spring of 1984. This startup is only for a four-month test period, which required the City Council to amend a city ordinance. The city ordinance required that any water pumped from a geothermal well be returned to that same well.

This Initiative Ordinance on Geothermal Conservation received voter approval on June 30, 1981. On April 6, 1984, Klamath County Circuit Court ordered the city of Klamath Falls to show cause why an order should not be issued enjoining the city from performing tests of its geothermal system; since, the test would be in violation of the geothermal ordinance passed by the voters and declared valid by the Circuit Court (Hart, 1984). A motion by the city to dismiss the order resulted in CRGD (Citizens for Responsible Geothermal Development) withdrawing its motion to suspend the test. The City Council has a right to amend its own ordinance. Table 1 is a summary of major institutional events leading up to the present test.

CITIZEN OBJECTION TO DISTRICT HEATING

The first public meeting organized by the citizens to discuss the district heating development was held in September 1980. They objected to the city pumping its production wells and injecting the geothermal fluids at a distance of about 763 m (2,500 feet) into another well.

The private well owners use downhole heat exchangers (DHEs) to heat homes. The DHE consists of two strings of pipe connected at the bottom by a reverse bend. The temperature of the well water and the predicted heat load determine the length of pipe required. Based on experience, local heating system contractors estimate approximately "one foot of coil per 0.44 kW (1,50 Btu/hr)" required. The heat exchanger pipes are connected to the supply and return of the heating system piping and the entire system is filled with city water. Figure 3 illustrates a typical system. In most wells, no geothermal fluid is pumped out of the well and the static water level must remain above the upper perforations in the well casing to work properly. Lowering the water level in a well below these upper perforations by pumping wells in the reservoir was the main concern of the private well owners.

An Open Letter was sent to the Mayor and City Council by the citizens group with 580 signatures expressing a desire that "the city's proposed Geothermal Heating District would be designed to provide maximum efficient utilization of this precious resource, while at the same time assuring adequate environmental and economic safeguards." They asked that the City Council prepare Impact Statements before further irreversible decisions were made to the proposed heating district. These impact statements were to be given wide public exposure and include the following elements (Citizen Group, 1980):

1. A full assessment of the need for this project and how that need was determined.

2. All of the impacts of all phases of the project must be described in detail.

3. What adverse economic and environmental effects cannot be avoided if the project is implemented? In particular, what personal economic impact will there be on private well owners whose wells may cool down or dry up due to pumping of geothermal fluids?

4. What mitigation measures are proposed to minimize the impact?

5. What alternatives to the proposal have been contemplated?

6. What are the risks to health and safety?

7. Is the project in conflict with any ordinances or regulations adopted or proposed by government agencies?

8. Is the project designed to achieve short-term goals to the disadvantage of future generations?

These previous events occurred after the drilling of the production wells and bids had been let for the primary pipeline. At this point, the City Council had to make a decision; to proceed with the project or to terminate it–they decided to go ahead.

The citizen group then formally organized, calling themselves "Citizens for Responsible Geothermal Development (CRGD)" and initiated an ordinance on geothermal conservation by means of the Oregon Initiative Process. Voters approved the Initiative Ordinance on June 30, 1981, which essentially regulates the use of geothermal water by requiring that any water pumped from a well be returned to that same well.

On July 17, 1981, the state of Oregon filed suit, with the city as defendant, asking that the City Geothermal Ordinance be declared invalid, claiming that state regulation of geothermal fluids preempted city action. After denying CRGD's request to intervene as co-defendant with the city (January 12, 1982), reconsidering and allowing intervention by CRGD (April 6, 1982), Klamath County Circuit Court ruled on November 18, 1982, that the state was not preempted and the ordinance is valid and enforceable. On March 10, 1983, the state appealed the decision to the Court of Appeals and at this time (April 1984), no decision has been issued.

Mr. I. H. Hart, Director of CRGD, stated that "the citizen group is not opposed to the demonstration project, but the manner the city has handled the development and that they were fearful of a boomtown growth, where the reservoir could not sustain delivery.

MITIGATION MEASURES

Early in the planning process, the city undertook, in conjunction with adoption of its comprehensive plan, a survey of the residents of Klamath Falls to obtain their unofficial reaction to the city's involvement with a geothermal program. The city asked residents as to their desire of having geothermal provided, whether they wished the city to be involved as the major entity in pursuing the development of geothermal energy, and whether the city residents would bond themselves for the possibility of having available geothermal energy. The response to these questions was affirmative (Derrah, 1979).

Later, after drilling and testing of the city production well CW-1 and the citizen group having expressed objections, the city established a Geothermal Advisory Committee including well owners, published a newsletter, and held numerous public meetings.

Regardless of the legality of the ordinance discussed in the previous section, the existing well owners made it known that they did not wish the resource to be pumped and injected. Because of the complications surrounding the potential use of the resource from a pumping aspect, the city developed a contingency plan. The contingency plan provided for the collection along the primary pipeline of existing geothermal fluids which are being dumped into the city sanitary and storm sewer system. The city identified 30 l/s (500 gpm) of 79ºC (175ºF) fluids that could be collected into the primary pipeline and passed through the exchanger building (Derrah, 1981). The contingency plan has not been implemented.

Five interference tests were completed to determine effects on static water levels in private wells: Museum (injection) Well in 1976, site of CW-1 (Parks well) in 1978, city production well CW-1 in 1980, system check in 1981 and the Klamath Aquifer Test in 1983 (Lund, 1978; Lund, 1979; Benson, 1979 and Benson, 1984). The aquifer test in 1983, together with concurrent data gathering from over 50 wells, was perhaps the most extensive and, in some ways, the most complete aquifer test ever conducted (Sammel, 1984). Data from the seven-week pressure interference test and doublet tracer testing involved the cooperation of many citizens, local organizations, USGS, LBL, Stanford University and OIT. Preliminary results of the test were made public at a presentation by E. A. Sammel, USGS, and Sally Benson, Lawrence Berkeley Laboratory, on January 25, 1984. The findings are as follows: 1) an extensive aquifer was identified; 2) the reservoir has a rapid response; 3) no change in temperature was observed; 4) injection makes a significant difference in water levels for the entire system; 4) theory shows good agreement with actual test results; 6) there is a double porosity reservoir; 7) no hydraulic boundaries were detected; 8) air temperature is an accurate prediction of water use; and 10) a prediction model was presented for pressure changes in the reservoir for short-term pumping and injection. It was clearly made public by the Principle Investigator that the forthcoming report on statements would not recommend specific actions with regard to development and management of the geothermal resource.

Third-party mitigation by the Chamber of Commerce Renewable Energy Committee was responsible for the successful initiation and coordination of the Klamath Falls Aquifer Test. This mitigation resulted in many community groups and outside institutions working together to establish valuable baseline data (Sammel, 1984) which appeared to change the attitude of a majority of the citizens regarding the development of the resource.

A Geothermal Advisory Board has been recommended that will consist of a cross-section of representatives from all interested groups. Presumably, the board's role will be to recommend specific action with regard to development and management of the geothermal resources.

LESSONS LEARNED

Based on the Klamath Falls experience and problems encountered in the establishment of a municipal Geothermal Heating District, the following suggestions and recommendations are offered.

1. Public Awareness Program. Early in the planning process, a community survey should be conducted of citizen use and attitude towards further development of the resource and establishment of a district heating system. Obtain as much support as possible from citizens, community service organizations and government entities that have overlapping authority on the area involved. Organize a Geothermal Advisory Board representing a cross-section of

all citizens to recommend specific action with regard to development and management of the resource. The Board may also encourage citizens to become involved in monitoring and other programs, provide factual information to interested individuals and establish communication channels through newsletters, new media, neighborhood meetings and public presentations.

2. Test Programs. Identify and perform reservoir test programs early in order that a solid baseline of data may be obtained in the event a legal question arises concerning the heating district influence on environmental items. This database may also substantiate the initial system application for future expansion.

3. Mitigation Measures. An independent third part, possibly from commercial sources outside the community, is recommended so that discussions can begin on both sides of an issue when one group is threatened by some aspect of the development. Conditions of the development that will affect citizen property, such as interference of private wells, need to be identified early so that damage and compensation measures can be instituted, possibly by insurance policies or legal methods. A continuing monitoring program throughout the life of the project is essential, especially in environmentally-sensitive areas.

4. Statutory Authority. Identify existing statutory authority and incentives for development. The entity involved should become as active as possible within the law making process to provide and develop necessary strategy and incentives for future users of the system.

5. Market Survey. An in-depth market survey of the surrounding area should be conducted. A market survey of potential users of the system should be a continuous process which is a function of the reservoir potential and its performance with regard to existing as well as future users. Market development should consider heat loads versus time of day; heat loads are greatest for commercial sectors during the day and for residential during morning and evening hours.

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TABLE 1
INSTITUTIONAL SUMMARY
Klamath Falls Geothermal District Heating

Conceptual Design	January 1977
Geothermal District Heating Statue	March 1977
Public Survey	June 1977
DOE/Division of Geothermal Energy Proposal (PON)	September 1977
Design/Planning/Bidding	February 1978
Environmental Report	January 1979
Drill and Test Production Well CW-1	August 1979
First Public Meeting on Geothermal Project	September 1980
Open Letter of Concern	November 1980
Citizens for Responsible Geothermal Development Organized	December 1980
City Charter Amendment for District Heating Defeated	March 1981
Mayor Appoints Geothermal Advisory Committee	March 1981
City Council Approves Contingency Plan	May 1981
Initiative Geothermal Ordinance Approved	June 1981
State of Oregon Files Lawsuit	July 1981
City Council Approves Residential Project	December 1981
Klamath Circuit Court Rules	November 1982
State of Oregon Appeals Decision to Court of Appeals	March 1983
Klamath Falls Aquifer Test - Hydrologic Research	July 1983
City Council Amends Ordinance	March 1984
City Starts Four-Month Operation Test	March 1984
Klamath Circuit Court Orders City to Show Cause	April 1984
Klamath Circuit Court Dismisses Order	April 1984
Klamath County Recommends Advisory Board	April 1984

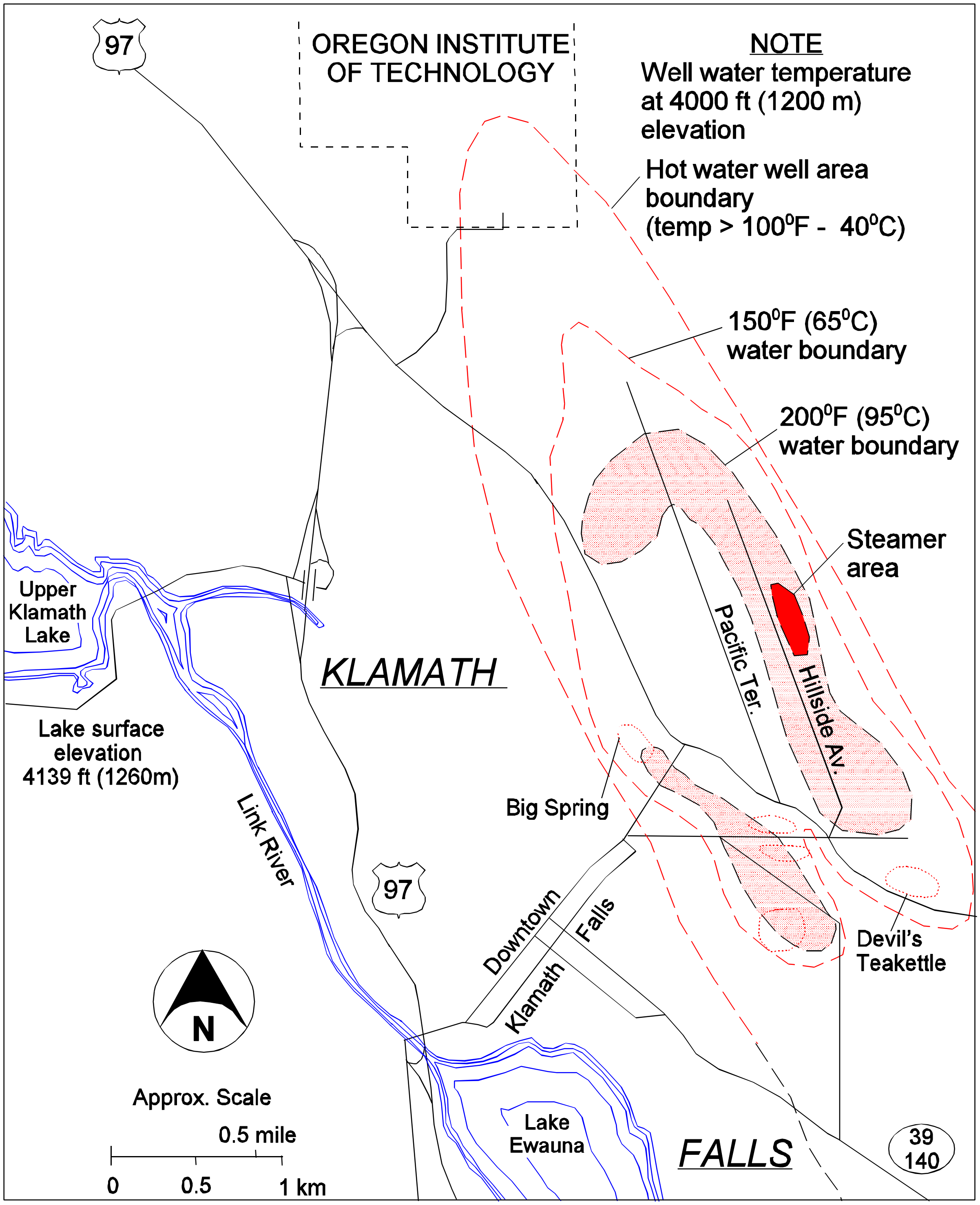

Figure 1. Klamath Falls Geothermal Resource.

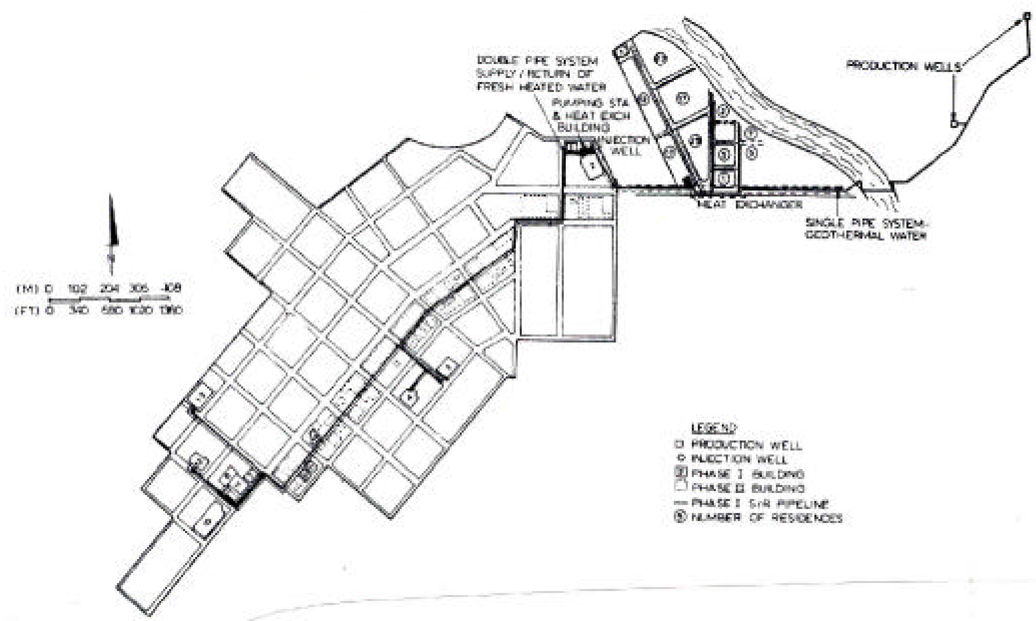

Figure 2. Commercial and Residential Heating Districts.

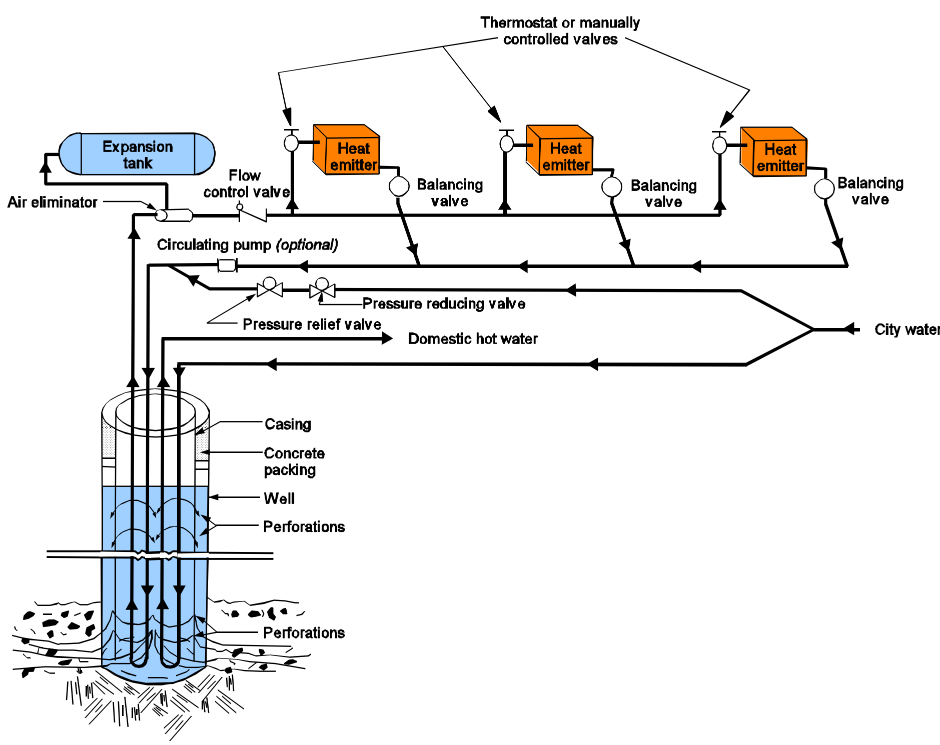

Figure 3. Typical Downhole Heat Exchanger System.