

ELKO HEAT COMPANY DISTRICT HEATING SYSTEM - A CASE STUDY -

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LOCATION

The Elko Heat Company District Heating System is located in the city of Elko, Nevada, in the southwestern part of Elko County. Elko County is located within the Basin and Range Physiographic Province in the southwestern United States (Fenneman, 1931). The Elko Heat Company district heating system is one of two district heating systems in Elko, with the other being the publicly-owned system operated by the Elko School District. The system was initiated in 1978 when the United States Department of Energy, under its "Field Experiments for Direct-Uses of Geothermal Energy" Program Opportunity Notice (PON), granted financial assistance for the development of a district heating system to serve the core business area of downtown Elko.

Original plans were to serve three large commercial customers, including an office building, a laundry and a casino/hotel complex (Figure 1).



Stockman's Casino

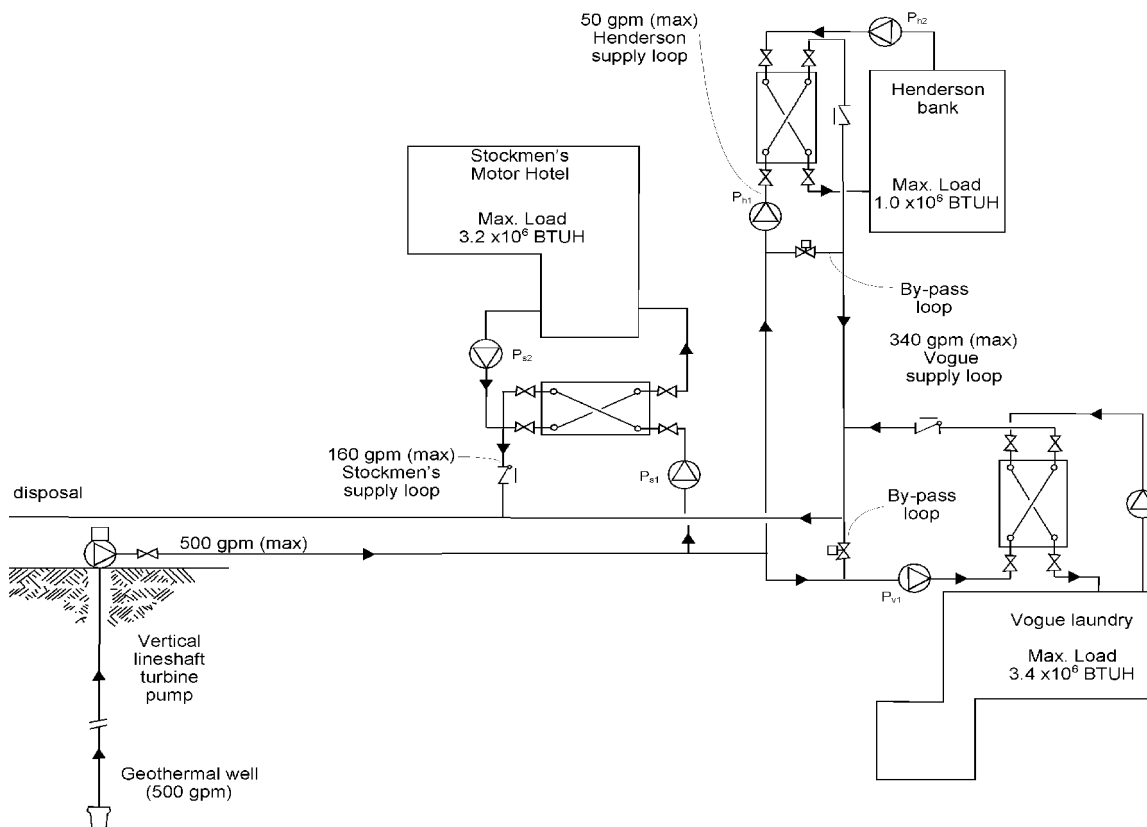


Figure 1.



Vogue Dry Cleaners

After completing resource assessment activities, a well was drilled in 1981 which was successfully completed to a depth of 869 ft (265 m). The well was found to be capable of producing approximately 1,000 gpm (63.09 L/s) of 177°F (81°C) water from the primary production zone that lies at a depth of 845-850 ft (258-259 m). The district heating system was completed and put online in 1982 at a total cost of \$1,382,346 including \$281,000 in customer retrofits. Of the total amount, \$827,404 or 59.8% of the total was provided by the USDOE grant. Since coming online in late-1982, the system has grown appreciatively to include 19 consumers, and with gross revenues in 2001 of \$184,267. The owners continue to attract new customers and the system appears to be capable of serving nearly double its existing load without the need for additional wells or central peaking. The only limitations on growth at the present time appear to be pumping capability and possible disposal issues.

RESOURCE

Elko County is located within the Basin and Range Physiographic Province. The distinctive features of this province are isolated, longitudinal fault-block mountain ranges separated by long, alluvial-filled basins. The city of Elko is located on the floor of one of these basins. The County's geothermal resources are located within the Battle Mountain Heat Flow High, as defined by Sass, et al. (1971). The area has been defined as a region of high heat flow; where, 194-302°F (90-150°C) resources are associated with deep fluid circulation along range front faults (Converse Consultants, 2002). The Elko area has a long history of geothermal water use and development, beginning with Native American use of the water at the "Hot Hole" in southwestern Elko. Continued use and reference to the Hot Hole and associated hot water springs were made by pioneers along the Oregon Trail in the 1840s. Development of the hot springs in the area provided for the old "Elko Home for the Aged" and subsequently, the Elko County Association for Retarded Children used the area's hot water into the late-1970s (Converse Consultants, 2002). Review of the geologic literature suggests that there may be an extension of a fault or fault zone from the Sulfur Springs hot springs southwest of the city, which travels northwest through the community and intersects the Hot Hole and its associated springs as well as the geothermal high in the area of the Elko Junior High School.

The Elko Heat Company well was drilled to a depth of 869 ft (265 m). Hot water at a temperature of 177°F (81°C) was encountered at approximately 705 ft (215 m) (Therma Source, 1982). The primary production zone, however, appears to be in the interval 845-850 ft. (258-259 m). The well has an artesian shut in pressure of 55 to 60 psi (379 to 414 kPa).

Other wells in the area include the Elko Junior High School well which was drilled in 1985 to a depth of 1,876 ft (572 m) and which encountered approximately 190°F (88°C) water at a flow rate of 300+ gpm (18.93+ L/s). The resource currently supplies the Elko County School District district heating system. Robinson and Pugsly (1981) reported surface temperature in the area ranging from 150-192°F (66 to 89°C) and geothermometers point to a resource temperature of from 176-237°F (80 to 114°C).

USE

The Elko Heat Company district heating system provides for the heating requirements of 19 customers including both public and private entities. Considering that the system was originally designed to serve only three primary customers, the success of the system in attracting new customers is noteworthy and highly commendable. The system now serves the Bank of America, Chilton Engineers (personal residence), City of Elko (STP), Elko County Detention, Elko County Court House (Meter #1), Wells Fargo Bank, Stockman's Casino and Hotel, Commercial Casino, Callagher Building, Thomas H. Gallagher (private residence), Henderson Investment Company, Ormaza Investor's, U.S. Post Office, Sierra Pacific Power, Vogue Laundry and Dry Cleaners, Western Folk Life Center, America High Votage, Ormaza Investor's Old Newmont Building and Elko Court House (Meter #2) (Elko Heat Company, 2003a). These customers are served via a 9,358-ft (2,852-m) distribution system of primarily asbestos concrete construction. Each customer is required by the Energy Connection and Service Agreement to provide his/her own backup heating system in order to provide energy service in the event that the geothermal system is shut down (Elko Heat Company, 1989). The distribution piping is insulated and jacketed. The return line is also of asbestos concrete construction; however, the return line is uninsulated. Piping runs from the distribution loop to individual consumers is 304 stainless steel using welded connections. Geothermal fluid at approximately 177°F (81°C) is circulated directly from the wellhead through the distribution system to each consumer. Each consumer, with the exception of the Vogue Laundry and Dry Cleaners, is connected to the system via a plate-and-frame heat exchanger of stainless steel construction. In the case of the Vogue Laundry and Dry Cleaner, the geothermal fluid (after softening) is used directly in the laundry. Geothermal fluid, after passing through the customer heat exchangers, enters the return line and is carried to the disposal facility. Disposal is via ponds used to cool the water and allow for some percolation. Some water, once cooled, is allowed to flow to the Humboldt River.

Customers are billed on the basis of gallons used. Flow is measured via hot water, totalizing, multi-jet, turbine meters that are read each month. At present, the rate is \$1.50/1,000 gal (3,785 L). Originally, the rate had been set at \$1.15/1,000 gal (3,785 L). That rate was increased to \$1.38/1,000 gal in 1992 (3,785 liters) and to \$1.50 in 2001 (Elko Heat Company, 2003b). Two residential consumers (Mark Chilton and Thomas Gallagher) are charged a flat rate of \$122.10 per month (Elko Heat Company, 2003b). Total gallonage for 2000 was 6,659,286 (25,208,140 L), for 2001 4,190,126 (15,861,352 L) and in 2002 it was 4,901,980 (18,556,013 L). The system is capable of providing approximately 400 gpm (25 L/s) under artesian conditions (i.e., to meet baseload requirements). Flow rates in excess of 400 gpm (25 L/s) require pumping to boost the pressure. Total system capacity is estimated at approximately 1,000 gpm (63.09 L/s) and with a 15-hp (11-kW) pump approximately 700 gpm (44.16 L/s) can be provided. Pumping is accomplished via 2-stage vertical turbine pump (lineshaft turbine) equipment with a 15-hp (11-kW), 1,800-rpm motor. Although the system was originally equipped with sensors that would activate the pumping when pressure fell below 35 psi (241 kPa), the automated controller was removed and pump activation is now manual. The system appears to be capable of meeting the needs of additional consumers even in its present configuration, and could meet the heating needs of additional consumers through addition of pumping to increase flow to a peak of approximately 1,000 gpm (63.09 L/s), drilling of additional wells or addition of a fossil fuel peaking unit. The addition of a fossil fuel peaking unit would, from the author's experience, appear to provide the greatest near term as well as future benefit; as, it would allow not only for expansion of the system to new customers but would also provide backup to the existing geothermal wells and thus, eliminate the need for in- building backup/peaking equipment.

OPERATING COSTS

The Elko Heat Company system was reportedly built at a cost of \$1,101,346 (Elko Heat Company, 1989). The largest expenditures were \$169,739 for resource assessment work, \$166,314 for drilling the production well and \$320,938 for construction of the distribution system. An additional \$281,000 was spent for retrofitting the original three customers to the system. Maintenance of the system accounted for expenditures of \$19,105; while, contract services and materials accounted for \$22,135. Information relative to subsequent retrofits is not available. Of the total cost of \$1,382,346 including the \$281,000 for retrofits, \$827,404 was provided by a grant from the United States Department of Energy under its program for "Field Experiments for Direct-Uses of Geothermal Energy."

Based on the latest figures available (Elko Heat Company, 2001), the operating revenue for 2001 was \$184,267. Total operating expenses were \$47,840 or an increase of \$4,465 from the previous year. Maintenance of the system accounted for an expenditure of \$19,105 while contract services and materials accounted for \$22,135. (Elko Heat Company, 2003b).

No numbers are available for customer savings.

REGULATORY/ENVIRONMENTAL ISSUES

The project encountered only one significant regulatory/environmental hurdle. This was related to the issue of water rights. The project had initially secured a state permit for non-consumptive use of water. However, a non-consumptive use permit required that all geothermal fluids be returned to the same aquifer from which they had been pumped. After carefully evaluating a number of disposal options, the project developers finally decided upon surface disposal as the preferred alternative. This resulted in the Elko Heat Company having to go through the entire water rights permitting process a second time (Gordon, 1985).

It remains to be seen whether or not surface disposal will be allowed over the long term and if it will have a potential negative impact upon further expansion of the system and thus, increase requirements for disposal. The Elko School District System is already facing serious surface disposal issues, and surface disposal that results in any runoff into the Humboldt River will no longer be permitted.

PROBLEMS AND SOLUTIONS

The project has experienced ongoing problems associated with corrosion of various components of the distribution system. Initially, customer branch piping consisted of carbon steel lines running from the main asbestos concrete distribution lines. Several failures, including one inside the customer building, resulted in a requirement that all new customer branch lines be constructed using 304 stainless steel. There were also corrosion problems associated with carbon steel service saddle components. The current practice is to use stainless steel bands (Elko Heat Company, 2003c).

Other system components have also failed due to corrosion related issues and in 1997, the Elko Heat Company reported the need to replace several components due to corrosion failure, including ductile iron valves, fittings and steel bolt up hardware (Lattin, 1997). In 1999, Converse Consultants submitted a metallurgical report to Elko Heat Company that detailed a number of corrosion related issues, probable cause for corrosion and recommendations for further action (Converse Consultants, 1999).

Converse concluded that corrosion was probably caused by geothermal water leaking into or in contact with various metal components. The geothermal water contains about 17 ppm of chloride ions and 75 ppm of sulfate ions. Hydrolysis involving chloride and sulfate ions is expected to have increased acidity of water and resulted in a pH of around 4.0 or lower. Such acidified water in confined regions (e.g., in the annular region of flanges), under corrosive residues or in the soil encasing system components (e.g., valves) can chemically react with susceptible components and result in harmful corrosion. Converse further concluded that if water could not be kept away from susceptible components, then it would be necessary to install structural materials that can resist deterioration by corrosive waters better than Type 304L stainless steel. Recommended materials included 310L, Monel and Titanium. It was also noted that galvanic corrosion

was also a factor with certain components and that cathodic protection should be provided.

The only other major problem occurred with the direct use of geothermal fluid through one customer's existing heating system (Elko Heat Company, 2003). That customer subsequently left the system.

The potential still exists for disposal related problems if all runoff to the Humboldt River is required to be terminated.

CONCLUSIONS

The Elko Heat Company geothermal district heating system has operated successfully since 1982 and has grown from three customers to nineteen. The system is economically viable, and maintenance and operating costs have been held to manageable levels. Rates have risen very slowly since system start up and still provide an economic incentive for new customers to hook up to the system. Corrosion-related problems have resulted in changing out several components, use of more corrosion resistant materials, use of cathodic protection and increased attention to workmanship. The system has the capacity to serve additional customers, but would require additional pumping and could possibly result in disposal problems. An alternative may be to look at the installation of a central peaking boiler, but increasing water temperature could have an adverse impact on return lines that are constructed of non-metallic material.

Because the system is based on the direct circulation of geothermal fluid to each customer on the distribution loop, it provides an interesting contrast to the Elko School District district heating system which is based on the circulation of non-geothermal fluids.

REFERENCES

Converse Consultants, 1999. "Metallurgical Report – Corrosion Analysis of Test Material, Geothermal District Heating System." Flange-Coupling Adapter taken in November 1998, Elko, Nevada, p 18.

Converse Consultants, 2002. "Elko County Economic Diversification Authority, Elko County Geothermal Resource Assessment Report," p 34.

Elko Heat Company, 1989. "Annual Report to the Nevada Public Service Commission," p 21.

Elko Heat Company, 2001. "Public Utilities Commission and Accountant's Compilation Report."

Elko Heat Company, 2003a. Customer File.

Elko Heat Company, 2003b. "General Information and Procedures."

Elko Heat Company, 2003c. Personal Communication.

Fennemen, N. M., 1931. *Physiography of the Western United States*, McGraw Hill Book Co.

Gordon, Sheldon S., 1985. "Elko Heat Company," *Geo-Heat Center Quarterly Bulletin*, Vol.9 No. 1, pp 13-14.

Lattin, Mike, 1997. "Elko, Nevada District Heating System," *Geo-Heat Center Quarterly Bulletin*, Vol. 18 No. .3, pp 1-4.

Robinson, S. and M. Pugsley, 1981. "Geothermal Resource Area 3, Elko County, Area Development Plan." A: Department of Energy publication. United States Department of Energy Contract DE-FC03-80RA50075, p 79.

Sass, J. H.; Lachenbruch, A. H.; Munroe, R. J.; Greene, G. W. and T. H. Moses Jr., 1971. "Heat Flow in the Western United States," *Journal of Geophysical Research*, Vol. 76, No. 26, pp 6376-6413.

Sass, J. H.; Priest, S. S.; Blanton, A. J.; Sackett, P. C.; Welch, S. L. and M. A. Walters, 2000. "Geothermal Industry Temperature Profiles from the Great Basin," *U.S. Geological Survey Open-file Report 99-425* (on-line database).

ThermaSource, Inc., 1982. "Geothermal Well Testing, Elko Heat Company Well No. 1," (unpublished).