

# PHILIP, SOUTH DAKOTA GEOTHERMAL DISTRICT HEATING SYSTEMS

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The Philip geothermal district heating project, which uses the waste water from the Haakon School, has now been in operation for 15 years. The origins of this project is discussed in the article by Childs, et al., (1983), presented in an abbreviated form in this issue of the Bulletin. This project was one of the 23 cost shared by USDOE starting in 1978, of which 15 became operational. The city district heating system was added on to the original USDOE cost shared project for the Haakon School (named after King Haakon V of Norway). The 4266-ft. (1,300-m) deep artesian well can provide up to 300 gpm (19 L/s). It has a shut-in pressure of 52 psi (3.6 bars) and will flow naturally at 15 gpm (0.9 L/s) (Fig 1).

Today, there are eight buildings in downtown Philip using the geothermal heat as shown in Figure 2. The waste water from Haakon School is delivered downhill in a single six-inch (15-cm) preinsulated FRP pipeline to town at 120 to 145°F (49 to 63° C), depending upon the outside temperature and the amount of heat extracted at the school. The pipeline



Figure 1. Haakon School well with maintenance person William DeLayne.

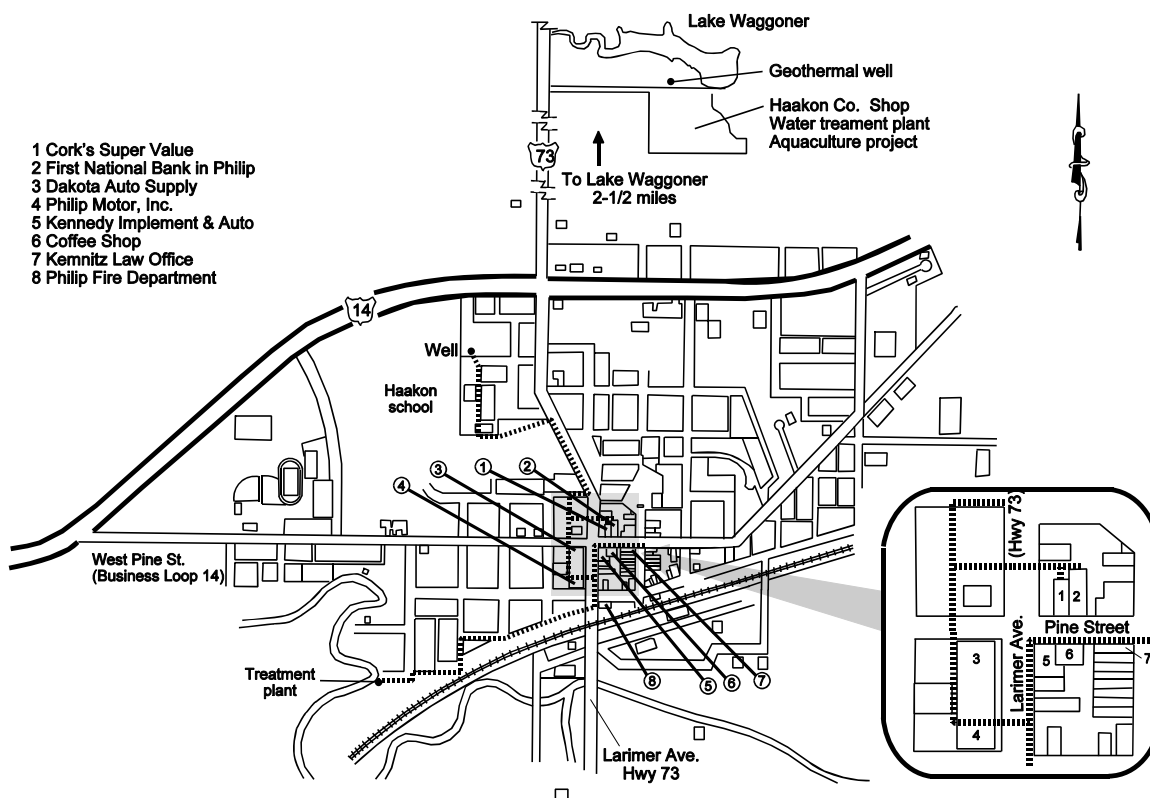


Figure 2. Philip district heat system schematic.

is buried at a depth of eight feet (2.4 m) to be below the five to six feet (1.5 to 1.8 m) of frost penetration in the winter. A 10 to 15°F (6 to 8°C)  $\Delta T$  is removed from the water in two separate distribution loops. When the outside temperature reaches -20°F (-29°C), propane backup heating is used. The pressure is balanced at the fire station, the last building on the system before the water reaches the barium chloride treatment plant. Due to the radium 22, barium chloride is used to treat the water before being wasted to the Mad River. The treatment plant has two 90 ft x 158 ft by 10 ft deep (27 m x 48 m x 3m) storage ponds that will each hold 374,000 gallons (1,416 m<sup>3</sup>).

Initially, the city businesses were retrofitted with cast iron heat exchangers at a cost of \$30,000, however, due to corrosion, these were replaced with stainless plate heat exchangers (Fig. 3). Treated water is then used in a closed loop in each building. Heat in the various building is supplied either through Modine heaters, unit heaters, or by piping in the floor (Fig. 4 and 5). The Philip Geothermal Corporation (for profit) now pays the school district \$5,000, carries a \$1,000 liability policy, pays taxes, and spends about \$500 for repair, for a total annual cost of about \$6,500. Each user pays a share of the cost based on the percentage of the water used. For example, the bank pays 17% of the annual cost and saves \$7,000 to \$9,000 per year in heating costs (Fig. 6). The total savings for all eight buildings is over \$100,000 annually, whereas the school district saves \$175,000. Thus, the consumer pays about 20% of the corresponding cost of propane or fuel oil, the alternate fuel in the area.



**Figure 3. Plate heat exchanger in First National Bank building**



**Figure 4. Modine ceiling heater in Philip Motor, Inc.**



**Figure 5. Floor heating loops in the Philip Fire Department.**

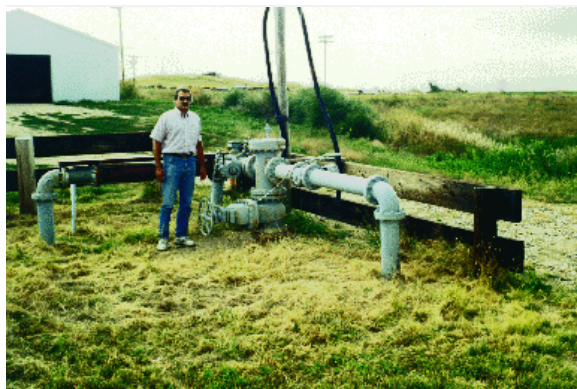


**Figure 6. Corky's Super Value and First National Bank buildings.**

#### **LAKE WAGGONER**

A second well, drilled by the city to a depth of 5280 feet (1,600 m) (Fig. 7), and is located near Lake Waggoner, about 2.5 miles (4 km) north of town, can produce 700 gpm (44 L/s) at 157°F (69°C) with a shut in pressure of about 80 psi (5.5 bars). The water from the well is used to heat the Haakon County water treatment plant and highway maintenance shop, and a aquaculture project housed in greenhouses (Figure 8). The waste water to fed to ponds on the adjacent golf course.

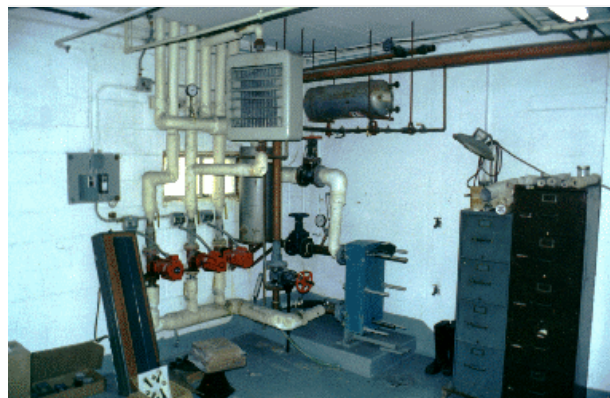




**Figure 7. Lake Waggoner Well with Steve Wegman**

The water treatment plant uses a plate heat exchanger to separate the geothermal water from treated, which is then run through unit heaters for space heating (Figure 9). The highway maintenance shop (Figure 10) uses PVC pipe embedded under the concrete for heating the shop floor. Two-inch diameter schedule 40 pipe is place in five loops under the 114 ft x 60 ft (35 m x 18 m) floor slab. The maintenance personnel can work comfortably all winter in this building.

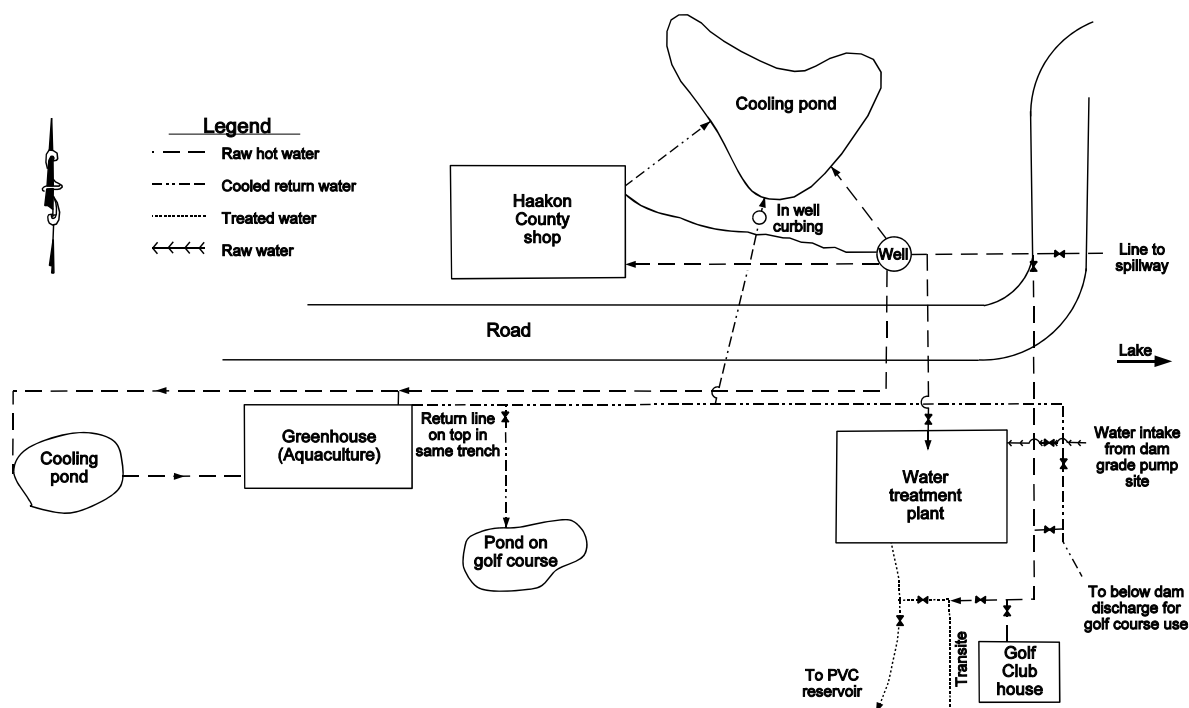
Min-Kota Fisheries, based in Renville, Minnesota, a part of Minaqua Fisheries Coop of Chicago, New York and Toronto, raises talpia inside a series of greenhouses (Fig. 11). These greenhouses with an area of 114 ft by 300 ft (35m x 91 m) were originally constructed to raise vegetables and flowers. They are now used to raise juvenile fish for shipment to Minnesota, where the fish are then raised to maturity and sold as fresh fillets



**Figure 9. Plate heat exchanger and unit heater in water treatment building.**



**Figure 10. Highway maintenance building.**



**Figure 8. Schematic of the geothermal supply system at Lake Waggoner**





**Figure 11. Greenhouses with storage tanks on right.**

The 157°F (69°C) water is delivered to a cooling pond (see Figure 8) where it is reduced in temperature by aeration. It then goes to two 5,000-gallon (18.9-m<sup>3</sup>) tanks where it is kept at approximately 95°F (35°C) in one and 85°F (29°C) in the other. The storage temperature may be as high as 105°F (40°C) in the winter to allow for heat loss. The higher temperature water is then piped into nine lined earth ponds, 20 ft by 100 ft by 35 ft deep (6 m x 30 m x 1 m) (Figure 13). These ponds, kept at 92 to 94°F (33 to 34°C), are the brood ponds where the fry are first raised after birth. After about a week, the fry are transferred to sixteen 600-gallon (2.3-m<sup>3</sup>) concrete tanks (Figure 14). These tanks receive water from the lower temperature storage tank and are kept at 82 to 84°F (28 to 29°C). After about 30 days in these tanks, the fingerlings are shipped to Minnesota where they are raised to adult size. The fingerlings at this time, average 1.5 to 2 inches long (3.8 to 5.1 cm) and weigh 0.035 to 0.105 oz (1 to 3 grams) each. When at maturity, the fish sell for \$1.80 to \$2.10 per pound (\$4.00 to \$4.60 per kg) live and \$6.00 per pound (\$13.20 per kg) as fillets. The building is also heated with large unit heaters suspended from the ceiling (Figure 15).



**Figure 12. Aeration pond with storage tanks and greenhouses in background.**

#### **ACKNOWLEDGMENTS**

I wish to thank Steve Wegman of the South Dakota Utilities Commission for arrangement the visit to Philip for me, Charles Ekstrum, president of the First National Bank

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**Figure 13. Lined earth fish ponds.**



**Figure 14. Concrete fish tanks.**



**Figure 15. Unit heaters with Pat Seager, manager and Steve Wegman.**

#### **REFERENCES**

- Childs, F. W., L. D. Kirol, R. D. Sanders, and M. J. McLatchy, 1983. "Description and Operation of Haakon School Geothermal Heating System," *Geothermal Resources Council Transactions*, Vol 7, Davis, CA, pp. 579-584.