# MIDLAND, SOUTH DAKOTA GEOTHERMAL DISTRICT HEATING

**John W. Lund**
**Geo-Heat Center**

Midland, South Dakota, population 250 has a geothermal district heating system unreported in the literature. The system exists due to a joint venture between the school district and the city back in the early 1960s. The project was essential since the city needed a source of domestic water and the school district needed to reduce their heating costs. With the help from faculty from the South Dakota School of Mines, the support and encouragement of the mayor, Jerry Nemec, and the perseverance of city utilities operator, Ruben Vollmer, the system was constructed piece by piece, often by trial and error.

This small town, 60 miles (100 km) west of Pierre on Highway 14, was established in 1890. The first hot water wells were dug by the railroad back in about 1906, when the Chicago North Western originally went through the area. This was the only source of water available for use in the steam engines. The hotel in Capa, a community about 10 miles (16 km) east of Midland, was the first to put the water to use in a hot pool for bathing. It proved very successful not only for bathing, but as a health aid as well.

The first geothermal use in Midland was the establishment of the geothermal mineral baths in the old Bastian Hotel in 1939 by John and Violet Stoppel. The well for the newly named Stoppel Hotel was drilled based on successful wells in the small communities of Capa to the east and Nowlin to the west. Since these communities were not located on the main highway, Midland was selected by the Stoppels for their bath house and hotel (Figure 1). The well drilled to 1784 feet (544 m), produced 33 gpm (2 L/s) of 116°F (47°C) water. An outside tank and cooling tower is used to cool the water for the baths (Figure 2). An addition to the hotel added three dressing rooms and three bath tubs filled with hot mineral water continually flowing through them. The hotel is also heated by geothermal heat from the well during the winter months.

**Figure 1. The Stoppel Hotel with the bath area on the right.**

**Figure 2. Storage tank and cooling tower for the Stoppel Hotel.**

A municipal well was drilled on the hill above town in 1960, and the artesian hot water was used to heat the grade school and high school buildings in 1964. In 1969 a second well was drilled next to the school buildings at a cost of $75,000. This well drilled to a depth of 3300 feet (1006 m), produced 152°F (67°C) water (Figure 3 and 4). The shut-in pressure was measured at 260 psi (1.79 MPa), and when allowed to flow produced 180 gpm (11 L/s) at 10 psi (69 kPa). Originally, the geothermal water was used to heat residences adjacent to the school, but the high pressure caused problems, and thus this use was discontinued. The alternate fuel in town is propane. The chemical analysis of the water in July of 1997 gave (Table 1):

**Table 1. Chemical Analysis of Midland Well Water**

| | |
|---|---|
| Total dissolved solids | 1506 ppm (mg/L) |
| Chloride | 37.8 |
| Iron | 3.3 |
| Manganese | 0.1 |
| Sulfate | 840.0 |
| Bicarbonate | 126.0 |
| Calcium | 268.0 |
| Magnesium | 66.6 |
| Sodium | 24.5 |
| Potassium | 9.4 |
| Fluoride | 2.4 |
| Nitrate | <0.1 |
| pH | 7.72 |


**Figure 3. Well building with school in background.**

Shortly after a new fire hall was built in 1981, the city ran a hot water line to it for heating purposes, as the city has an agreement to heat and maintain this building. Soon the Legion Hall and Community Library were added to the line, along with the building housing a bar and restaurant. The waste water was then used to water cattle, before being disposed of into the Bad River. The school heating line provides water to the city water treatment plant, with the excess water again used for cattle watering.

**Figure 4. Geothermal well with Ruben Vollmer.**

The present well now supplies hot water for heating to the two school buildings, a church, campground buildings and pool, and car wash through a single pipe high-pressure line at

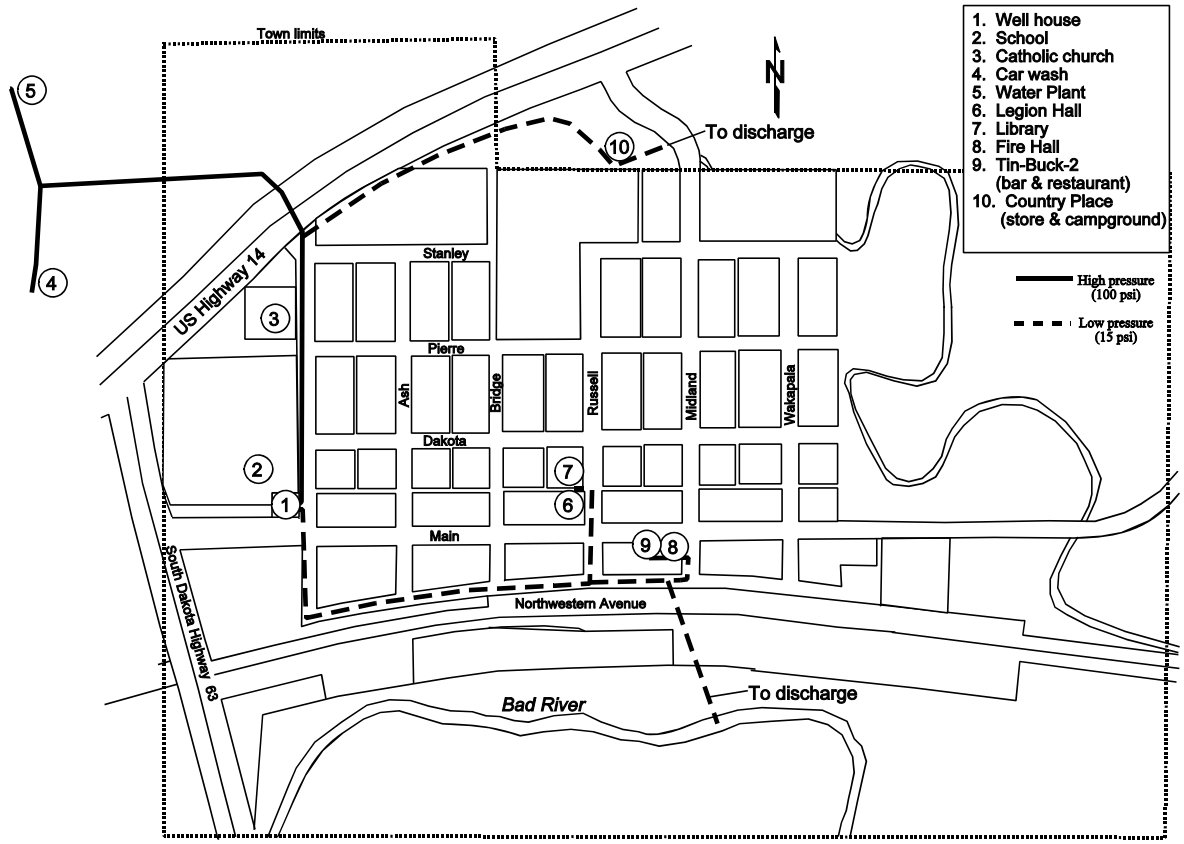



**Figure 5. Schematic of the piping system routes in Midland.**

100 psi (0.69 MPa) and to four downtown buildings through a single pipe low-pressure line at 15 - 20 psi (103 - 138 kPa) as shown in Figure 5. The high-pressure line finally delivers water to a cooling pond and water treatment plant on the hill about a mile (1.6 km) north of town. The treated water is then return to town as the domestic water supply. Waste geothermal water from the city loop and from the campground is discharged into the Bad River--the same river that Philip uses for their waste geothermal water discharge. In addition, there is a hot water valve at the well where ranchers can obtain hot water for their stock watering tanks in the winter, and highway maintenance personnel and ranchers clean their equipment in the summer.

The swimming pool and heating system was constructed for $2,000, due to the encouragement of Governor Miller, who challenged the various communities of the state to develop physical fitness programs.

The water from the well is divided into to lines (Figure 6). The high pressure line consists of schedule 80 CPVC plastic pipe supplying water to the water treatment plant. The two school buildings are connected in parallel to this line at the well house and are supplied up to 70 gpm (4.4 L/s). At the school there are two separate plate heat exchangers, one for each building. A maximum of 7°F (4°C) is taken out of the geothermal water before it is returned to the main supply line. The secondary side, supplying 140°F (60°C) water to the buildings, is a low pressure system. The building heat is supplied through unit heaters in the gymnasium and wall registers in the classrooms. The system has had trouble supplying heat to the building on the north side, especially with a wind at -20°F (-29°C). At this time the room temperature drops to 60°F (16°C), and a black chemical scale (probably bornite - a copper-iron-sulfate deposit) is deposited on the primary side of the plates (Figure 7). With cleaning of the plates and adding more plates to the heat exchanger, this problem will probably be solved. Hot domestic water is supplied directly to the building from the geothermal line.

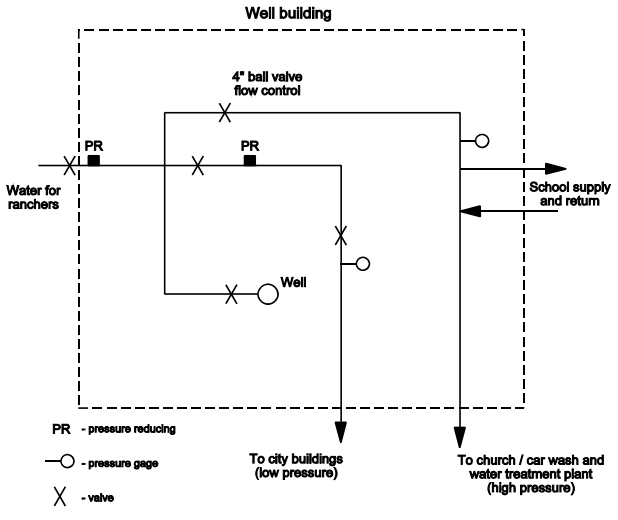



**Figure 6. Schematic of the pipelines leading from the pump house.**

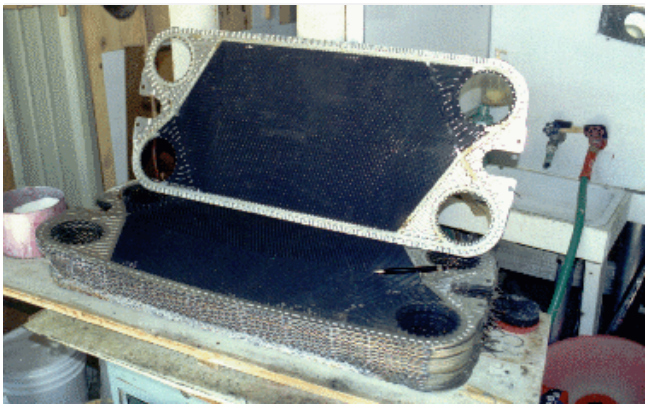


**Figure 7. Bornite deposits on plates of school heat exchanger.**

The high-pressure line then run past the Catholic Church were a plate heat exchanger, buried in a vault, provides heat to the building through a pumped secondary loop. Next the main line supplies water to the Country Place store and camp ground, controlled by a pressure reducing valve, and used to heat the swimming pool in the summer. The waste water is dump into a ditch which runs to a stream. In winter cattle and horse often will stay along this disposal ditch to take advance of the warm water. The main line then goes past the open air car wash, where it is used directly to heat the floor slab using ½-inch (12-mm) diameter tubing in the concrete slab, and for the wash water (Figure 8). Finally the line terminates in the cooling pond at the water treatment plant--supplied with about 80 gpm (5.0 L/s) in winter and 110 gpm (6.9 L/s) in summer.


**Figure 8. The geothermally heated car wash.**

The low pressure line is constructed of 1.5-inch (38-mm) PVC uninsulated pipe and supplies 3.0 gpm (0.2 L/s) of 140°F (60°C) water to four buildings where 25°F (14°C) ΔT is removed. Geothermal water is supplied directly to Modine heaters (Figure 9) in the Legion Hall, Library and Fire Hall (Figure 10) with the waste water being returned to the same line. The Tim-Buck-2 Bar and Restaurant is supplied heat through a homemade heat exchanger of ½-inch (12-mm) copper pipe inside 1.5-inch (38-mm) PVC outer tube. The secondary water then supplies heat to an air-duct fan. The waste water from this line finally disposed into the Bad River.

**Figure 9. Modine heater in the Fire Station.**

**Figure 10. Fire station, Tim-Buck-2 Bar and Restaurant.**

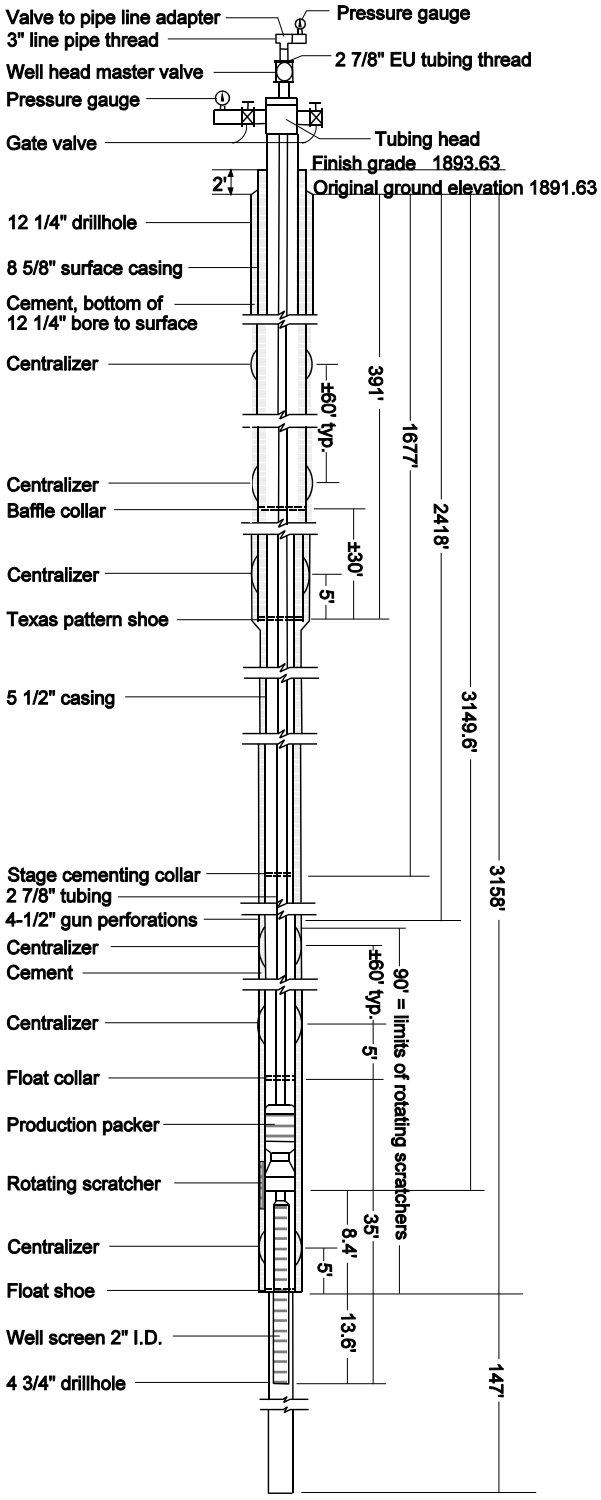

## SUMMARY

A total of approximately 30,000 square feet (2,800 $m^2$) of floor space is heated by geothermal in Midland. The high pressure line uses 80 gpm (5.0 L/s) and provides a 7°F ΔT (4°C), and the low pressure line uses 3 gpm (0.2 L/s) and provides a 25°F ΔT (14°C) at maximum use. The system then has a peak power of approximately 0.1 MWt and an annual use of 834 million Btu (0.24 GWh). This provides as estimated annual saving in propane cost of $15,000 to the community.



## ACKNOWLEDGMENTS

I would like to thank Jerry J. Nemec, mayor of Midland, for providing a critical review of this article, to Ruben Vollmer, the city utilities operator, and to Bob Sheeley, school maintenance person for their assistance during my visit to Midland. Mr. Vollmer was especially helpful is diagraming and explaining the operation of the system to me.


**Midland well profile.**