Some insights from a homeowner on

RETROFITTING WITH GEOTHERMAL

By Lorraine Manz

Earlier this year, my husband and I replaced the ageing furnace and air conditioning unit in our Bismarck home with a geothermal (ground source heat pump) heating and cooling system. Since part of the NDGS' mission is to provide the public with information about the state's natural resources, I felt duty-bound to share our experience because, after all, geothermal energy is a natural resource, and a geothermal retrofit is one way of making use of it. A discussion of the science and technicalities of geothermal systems was published in an earlier issue of the DMR Newsletter (Manz, 2007). This article is neither scientific nor technical. What follows is written from the standpoint of Ms. Manz the homeowner and not Ms. Manz the geologist. The intent is to try and convey to others who are planning or considering retrofitting their own home with a geothermal system what it is likely to entail, and to pass on a few bits of what I hope is good advice.

As the principal administrator of North Dakota's geothermal regulatory program, my participation in the planning and implementation of this project was out of the question. So the task of obtaining quotes, hiring contractors, negotiating contracts and so on was left in the capable hands of my husband, who is an engineer and much better at handling such things than I.

It goes without saying that unless the house has been emptied of all furniture, fixtures and fittings, and the entire yard is unfenced, a geothermal retrofit is not quite as straightforward as a new installation. Our ranch-style house was built in 1954 and is typical of the era, with a full basement and a little under 1,000 square feet of floor space on each level, excluding the single-car garage. Set 25 feet back from the sidewalk, it stands on a roughly 0.2-acre lot within a scant six feet of the property lines we share with our neighbors to the north and south. Such limited access to the back of the house meant that the well field would have to go in the front yard and for a while we were concerned that, unless we tore up the driveway or uprooted some fairly large shrubs, the amount of available space wouldn't be enough. Fortunately, it turned out that a three-ton heat pump and three 200-foot vertical wells

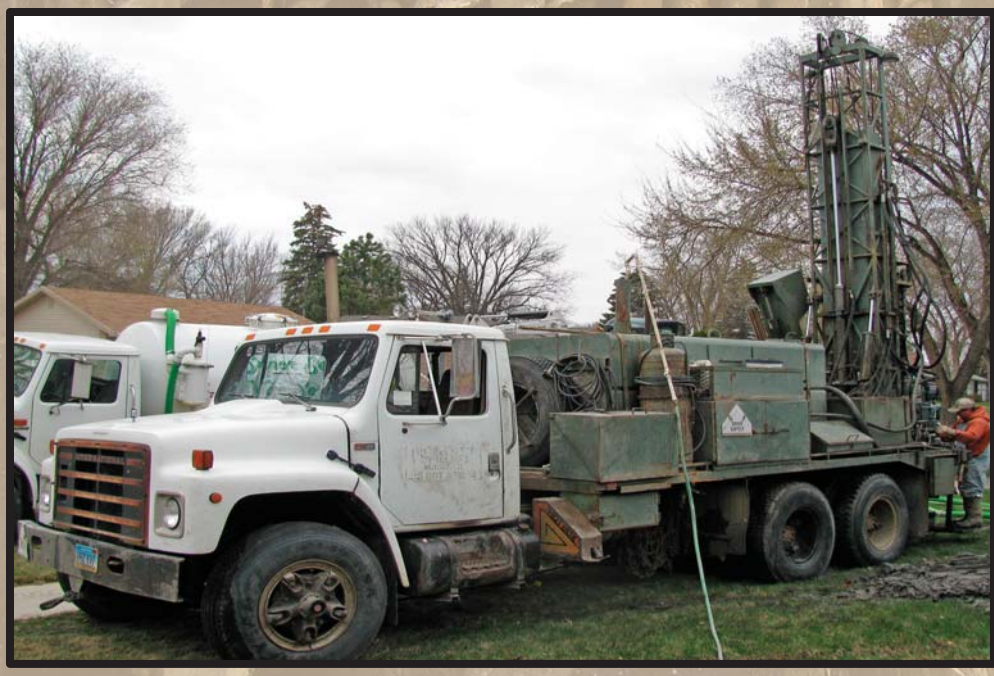

Figure 1. Drilling the wells. Space was tight, even in the front yard, as these pictures show. The truck-mounted drill rig remained within our property lines throughout the entire drilling operation, and although the grass suffered under its weight the adjacent sidewalk was undamaged.

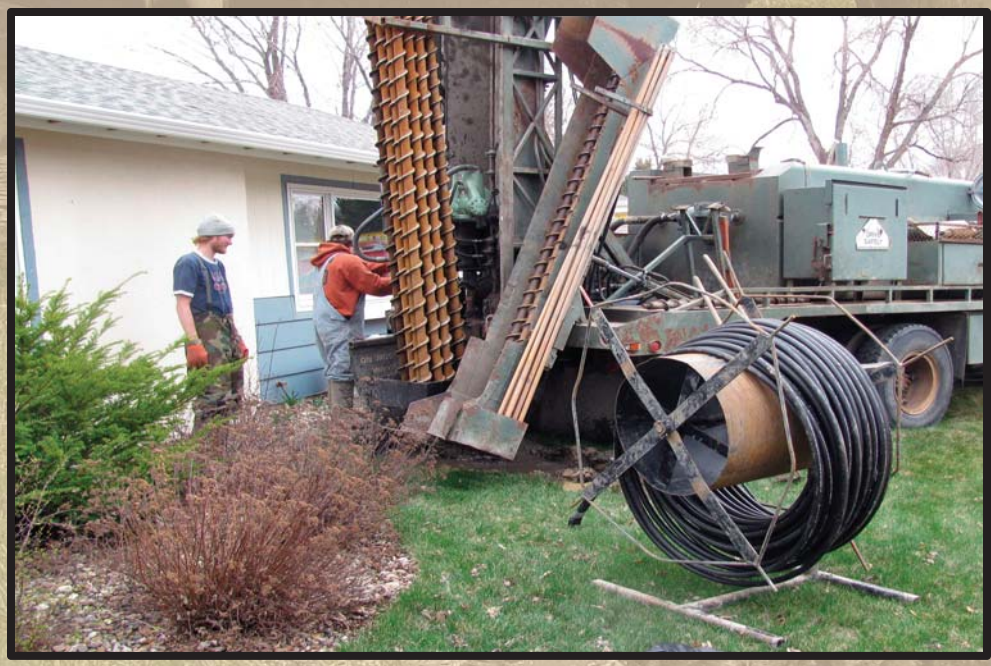

Figure 2. The 4.75-inch-diameter wells were drilled using a hollow-stemmed auger sectioned into 20 -foot lengths. The coiled hose on the right is one of the ground loops. It is actually two lengths of high density polyethylene (HDPE) piping connected by a U-shaped coupling that is fitted by the loop manufacturer. Each ground loop is also pressure-tested for leaks and integrity before it leaves the factory.

Figure 3. Trenching on day 2. The 2.5-foot-wide by 4-foot-deep trench extended from the house to the first well about ten feet away, then branched into two arms - one for each of the two remaining wells. The ends of the ground loops are heat-fused to a manifold (headered) and the assembly laid along the bottom of the trench. The header piping is guided into the basement through holes in the wall. Metallized tracer tape was placed in the trench when it was about one-quarter backfilled to mark its location for future reference.

would provide us with all the heating and cooling we were ever likely to want and more besides. Arranged in a triangular configuration and spaced fifteen feet apart, these wells would fit into the front yard with no trouble at all.

In addition to the heat pump and all its accoutrements our retrofit package included, as optional extras, a steam humidifier, an energy recovery ventilator (which uses heat energy and moisture in the exhaust air to condition the incoming air), an electronic air cleaner (in place of the furnace filter) and a desuperheater for making hot water. Some months earlier, we had replaced our antiquated natural gas-fired water heater and its maze of plumbing with a high-efficiency electric model, which we were able to plumb into the geothermal system. A desuperheater is nothing more than a secondary heat exchanger whose function is to transfer excess heat from the heat pump's compressor to the water heater. The result is free to cheap hot water, depending on the amount of available heat (there is more in summer when the system is in cooling mode).

Generally speaking, a geothermal heat pump does not reach as high a temperature as a traditional furnace of comparable size. To compensate, it needs a larger air delivery system. In our case this would require the installation of three additional return air plenums and the replacement of any ductwork less than four inches in diameter (which was most of it) with a six-inch upgrade. Several large holes had to be cut into the basement ceiling to achieve this because almost all of the ductwork of interest was housed above it in cavities formed by the joists supporting the upper level floor.

Work started on April 19 and by the end of day one the heat pump was in place, our old air conditioner and furnace, along with its associated ductwork, had been disconnected, and the remaining ducts cleaned and sanitized. Outside, all three wells had been drilled, the ground loops installed (figs. 1 and 2), and the front yard was a mess. A few places remained unscathed but the truck-mounted drill rig had left deep ruts in the lawn and despite everyone's best efforts to keep waste water and other muck under control, the area surrounding each well was plastered with muddy piles of drill cuttings, sludge and spilled grout. It was all par for the course, unavoidable, and it was going to get worse.

The well field was completed by noon on day two. This involved the use of a small backhoe to excavate a roughly 4-foot-deep trench from the side of the house to each well (fig. 3). To avoid their otherwise certain destruction, several plants in the vicinity of this operation had been lifted and moved to a safer location the evening before. Down in the trench the free ends of the ground loops were tied-in to a manifold, or header pipe to form a single, continuous circulatory system that would later be connected to the heat pump via supply and return lines entering our basement through a pair of holes drilled in the wall. The system was pressure tested with water and verified to be free of leaks before the trench was backfilled.

Drill cuttings and excess fill were obligingly removed by the contractor, whose crew did an excellent job of restoring our battered front yard (fig. 4). Meanwhile, the interior work was progressing well. An electrician was busy hooking up the heat pump, the new ductwork had been delivered, and sundry other jobs, including the removal of the rest of our old HVAC system were underway.

Some of the contractors were committed to other projects on day three so there was a lull in activity but it picked up again on day four with the purging, cleaning, and connection of the loop field to the heat pump; installation of the ductwork; the new water heater (and removal of the old); and completion of the electrical work. With the addition of the heat transfer fluid on day five the system was ready to be commissioned, and by late afternoon it was up and running.

A little over two months later the front yard has almost fully recovered (fig. 5) and the house is back in order. In the basement, after a couple of minor, easily fixed glitches, the heat pump is quietly going about its business of keeping us cool and water hot, and succeeding admirably at both. The very noticeable increase in air flow from the new ductwork helps to maintain a more even temperature throughout the house, which means less cycling on and off of the heat pump, and consequently less wear and tear on the system. And although sometimes I think the house is a little too cool, that's just my opinion, my husband thinks the temperature is perfect. Of course, the real test of our geothermal system will come this winter because more energy is required to heat a building than cool it. We are confident it will pass with honors.

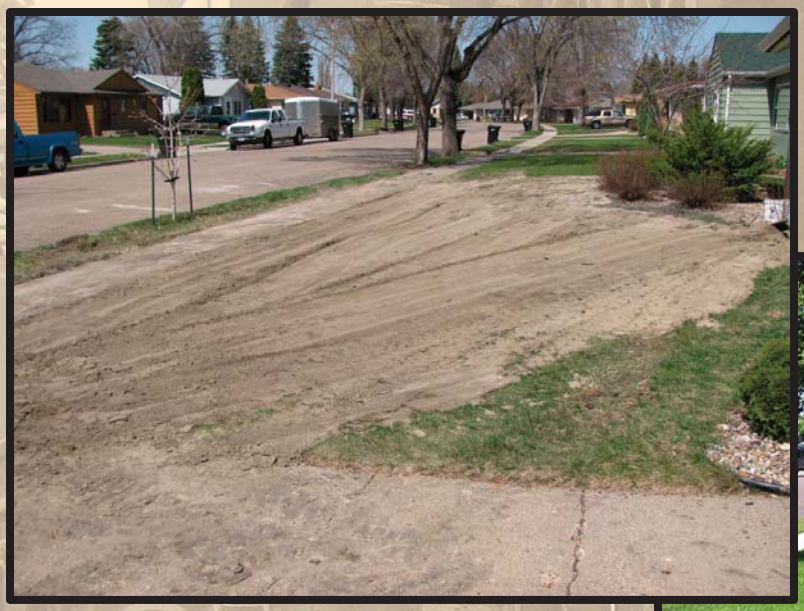

Figure 4 (left). *The completed well field. Drill cuttings and other debris were removed and the surface smoothed and regraded. Copious amounts of topsoil and compost were required to recondition the soil before reseeding the lawn.*

Figure 5 (right). Two-and-a-half months later. There is no surface indication of the well field at all. Some ground settling may occur over the winter but that is easily corrected. Externally, our geothermal system is, to all intents and purposes, completely invisible.

And finally, here are a few suggestions for anyone else who is thinking about a geothermal retrofit including some websites with more useful information:

- As with any project that requires special skills, use only qualified personnel. A list of North Dakota-certified geothermal well drillers is available on the State Water Commission's web site at http://www.swc.state.nd.us/4dlink2/4dcgi/contractsearchform/Map%20and%20Data%20Resources. The Geothermal Heat Pump Consortium (http://www.geoexchange.org/) and the International Ground Source Heat Pump Association (IGSHPA) (http://www.igshpa.okstate.edu/) also have directories on their respective web sites, although they are not comprehensive. If you are in any doubt, please call me (701-328-8000).
- Know your house well, especially the layout of the plumbing and electrical systems.
- Although smaller units are becoming available, the truck-mounted drill rigs currently favored by most geothermal well drillers are about 35 feet long and weigh about 40,000 pounds or 20 (short) tons. If the lot is small there is a good chance that the back of the property will be inaccessible to a vehicle of this size; (this was the reason we had to put our well field in the front yard).
- Find the locations of buried utility lines (electric, cable TV, gas, sewer, etc.) before obtaining any quotes because they will affect the siting of the well field. One Call (800-795-0555 or 811 in North Dakota) will do this for free.
- Be prepared to have to re-landscape all or part of your yard.
- Shop around and get at least three quotes.
- Move plants, yard ornaments, and anything else of value away from the drill site, preferably before the heavy equipment arrives.
- If ductwork needs to be upgraded and/or extended, expect holes in walls and ceilings.
- Take care of pets. A geothermal retrofit is a noisy operation and may frighten them.
- Take lots of photos.
- Be sure that entryways are wide enough to accommodate the heat pump (ours measured 25 x 34 x 52 inches) and other equipment!
- Get a copy of the layout of the well field and file it with the other documentation for the geothermal system. At this time One Call does not locate geothermal ground loops, so to avoid damage by any future digging, it's important to know where they are.
- There are a number of state and federal financial incentives that apply to geothermal heating and cooling systems. A full state-by-state listing can be found on the Database of State Incentives for Renewables & Efficiency (DSIRE) at http://www.dsireuse.org.
- Some other useful websites:
  http://www.energysavers.gov/
  http://www1.eere.energy.gov/geothermal/heatpumps.html
  http://www.toolbase.org/Technology-Inventory/HVAC/geothermal-heat-pumps
  http://www.exchangenergy.ca/geothermal-retrofit/
  http://www.consumerenergycenter.org/home/heating_cooling/geothermal.html

Reference

Manz, L.A., 2007, Geothermal energy - another alternative: DMR Newsletter, Vol. 34 No.1, p. 6-11.