

# Ground Source Heat Pumps Fact Sheet

Ground source heat pumps (GSHPs) use the earth's constant temperature to provide heating, cooling, and hot water for buildings. During the winter, the system uses the earth as a heat source to heat the building. In the summer, the earth is a heat sink, where extra heat from the building is deposited. The heat is transferred through a system of pipes and refrigerant. Waste heat can be used to heat hot water.



Ground source heat pumps at Harvard

## System Types

There are two types of ground source heat pumps, closed loop and open loop systems. Closed loop heat pumps use the earth as the heat source and heat sink and has antifreeze in the loop water. Open loop systems use a surface or underground water source as both the heat source and heat sink.

There are different types of open loop systems, including standing column wells (which extract and return water to the same source ) and production or injection wells (which dump the used water into a different water body when done). Harvard has installed standing column wells to date.

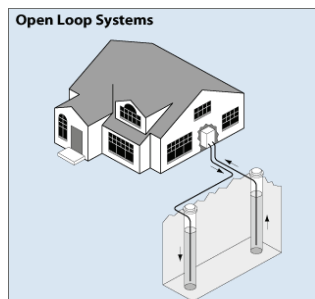
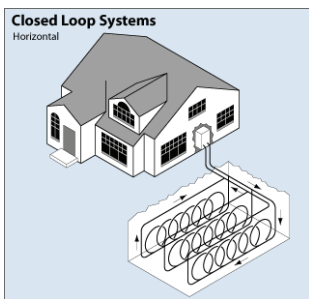


Image source: U.S. Department of Energy (EERE Division)

## Benefits

- Use less energy than conventional HVAC systems & reduce greenhouse gas emissions
- Can be more efficient than conventional heating systems
- Up to 44% more efficient than air source heat pumps & 72% more efficient than electrical resistance heating
- Lowers energy costs by 20 – 50%
- Lowers maintenance costs due to fewer moving parts and equipment is not exposed to weather
- Aesthetically more attractive- no cooling towers or HVAC equipment on roofs
- No noise from HVAC equipment

## Recommendations

There is a growing interest in ground source heat pump (GSHP) systems as a renewable energy technology. Several departments within Harvard's University Operations Services, including Environmental Health and Safety, Facilities and Maintenance Operations, and the Harvard Green Campus Initiative, have collected information on Harvard's six existing GSHP systems and developed a list of design, installation, and operation and maintenance recommendations for these systems. These recommendations are based on open-loop, standing column well systems.

For more detailed recommendations, please contact Harvard Green Campus Initiative or Environmental Health & Safety or look at our Ground Source Heat Pump [Lessons Learned Powerpoint](#).

## Design Recommendations

**1. Drill a test well.** No one can predict underground conditions at your site with certainty. A test well can give invaluable information about:

- Water temperatures,
- Water chemistry (e.g., salinity, iron content),
- Bedrock character and thermal conductivity, and
- Number and depth of wells needed.



**2. Design for zero bleed.** Open-loop ground source heat pumps systems may **not** discharge bleed water to the MWRA wastewater system.

**3. Design the system for zero net heat transfer.** If these summer and winter loads are not equal, there will be a long-term heating or cooling of the ground. This will decrease the life of the system and decrease efficiency. To avoid this, systems should be used for heating and cooling.

**4. Specify and install adequate well monitoring and controls.** At a minimum, the following meters should be installed:

- Flow meter on supply and return lines,
- Temperature gauge on supply and return lines,
- Sample port on the return line

**5. Allow access to wells.** Wells may need to be accessed if problems arise or to replace parts. Ensure that it is possible to remove the well pump, which is usually mounted at the bottom of 5 20-foot lengths of PVC piping.

**6. Avoid R-22.** While R-22 refrigerant does accommodate higher supply water temperature, it should be avoided. High supply water temperature reduces heat pump efficiency and is a sign of an undersized system. Use an environmentally preferable refrigerant, like R-410A, instead.

**7. Do not allow VOCs to enter groundwater.**

The conventional “glue and screw” PVC joining method can allow VOCs from the glue to enter ground water if glue is not allowed to fully cure. To prevent groundwater contamination, allow for full curing before introducing the pipe into the well, or use CertaLok™ or other glueless PVC systems.

**8. Contact EH&S during the Design Phase regarding permitting requirements.** EH&S can assist with applying for permits from the DEP or EPA, as needed.

## Installation Recommendations

**1. Drill wells to full design depth.** Some well drillers are accustomed to drilling extraction wells, where the primary determinant of success is water yield in gallons per minute. In a GSHP system, the more important success factor is surface area of the well.

**2. When drilling new wells, monitor neighboring, existing wells.** The disturbance of drilling a new well can cause debris to be loosened locally. Monitor neighboring wells closely to ensure that debris is not being transferred.

**3. Ensure that the supply, return, and inner sleeve are positioned correctly.** Someone on the owner’s team should ensure that the supply, return, and inner sleeve are positioned correctly. UOS’s Owners Services Program can be of help in ensuring that these mistakes are not made during installation.

## Maintenance Recommendations

**1. Preventive maintenance begins on day one.** While some well equipment may be under warranty for up to a year, warranties do not cover damage or failure due to improper maintenance. During the first months of a well’s operation, be sure to clean strainers regularly. As the well ages, water clarity will improve and you may be able to clean strainers less often. Failure to clean strainers can result in heat pump failure.

**2. Do not put additives in the well.** Bleach should never be added to a GSHP system. No other additives should be used without first consulting EH&S.

Harvard Well Inventory						
	Wells	Depth (feet)	Designed to Bleed	Pump Depth (feet)	Pump Capacity (GPM)	VFDs*
Blackstone	2	1500	Yes	110	180	Yes
QRAC	2	1500	Yes	100	180	Yes
90 Mount Auburn	3	450 - 650	Yes	100	270	Yes
Radcliffe Gym	2	1500	Yes	100	160	Yes
2 Arrow St (condo).	3	1500	No			Yes
1 Francis Ave.	2	750, 850	Yes	100	160	Yes
Future Projects						
Byerly Hall	5	1500	No	100	410	Yes
Weld Hill (Closed Loop)	88	500	No	N/A	680	Yes

©Harvard UOS, 2007 \* Variable Frequency Drives allow a pump to run at partial capacity, reducing energy cost

Harvard Well Inventory as of May 2008



Ground source heat pump well at Harvard

