



# Construction of Vertical Loop Wells for Geothermal Heat Pump Systems

## Subjects

Geothermal heat pumps; ground-coupled heat pumps; groundwater source heat pumps; grouting of loop wells; loop well construction; groundwater protection

## Audience

Homeowners, legislators, governmental officials, building contractors, water well contractors, geothermal drilling contractors, building owners/developers

## Background

The loop well of a ground source heat pump system (commonly known as a geothermal heat pump) installed into the Earth is designed using a combination of loop well geometry, loop tube configuration and placement, grout thermal properties, and appropriate ground thermal characteristics (conductivity, diffusivity, and mean earth temperature) for the site.

The final step in the geothermal heat pump system design process is to design the loop field. The results of the design process will include total loop well footage requirement, loop tube diameter, loop well diameter, grout materials, loop field layout, circuit arrangement, and individual loop well depth. Some of these design parameters may be selected based on good design practice or the capacity of the available drilling equipment, while others must be computed for the specific design conditions.

## Issue

Is the loop tube an integral part of the loop well for a geothermal heat pump system?

## Position

The National Ground Water Association believes the grout and the loop tube are integral parts of the loop well and that qualified individuals, such as a Certified Vertical Closed Loop Driller (CVCLD), should be authorized to construct a loop well.

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Construction of a geothermal heat pump loop well includes, in continuous order, drilling of the vertical borehole into the Earth, placement of the loop tube to the bottom of the vertical borehole with the grout tremie, and grouting of the vertical borehole from the bottom of the vertical borehole to the Earth's surface. When these three steps are completed, the vertical borehole may now be considered a loop well. Loop emplacement and grouting should be performed in a timely manner to guarantee successful loop tube placement, grout

installation, and environmental protection.

The loop tube shall extend to the bottom of the vertical borehole. If an obstruction is encountered in the vertical borehole, preventing the installation of the loop tube to the vertical borehole bottom, the loop tube and the obstruction must be removed or provisions made for the sealing of the vertical borehole below the obstruction and the designer needs to be notified so adjustments can be made to the design of the system.

Completing a vertical borehole for a loop well requires placing grout in the space between the loop tube and the vertical borehole wall and between the loop tube by pressure pumping grout through the tremie.

The reasons for grouting are: (1) protection of the aquifer, or aquifers, including limiting the potential for water movement between aquifers, for purposes of maintaining quality or preserving the hydraulic response of the producing zone(s); (2) provide thermal contact between the loop tube and the formation (interior wall of the loop well); and (3) accomplishing 1 and 2 in an efficient and economical manner.

In determining the specific grouting requirements of a loop well at a designated site, consideration must be given to existing surface conditions, especially the location of sources of pollution, and to subsurface geologic and hydrologic conditions. In all cases, formations which yield water must be adequately sealed off to prevent cross-contamination of the overlying or underlying water-bearing zones. To accomplish this, the annular space shall be grouted to prevent surface water runoff through the annular space, as well as to seal off water-bearing subsurface zones.

The tremie should be temporarily attached to the loop tube to carry it to the bottom of the vertical borehole. After the tremie has been installed, water should be pumped through the tremie to ensure that it is open. Grout shall then be placed by pressure pumping through the tremie and the tremie should be raised slowly as the material is introduced. The tremie should be continuously submerged in the grout. All grout shall be emplaced to the maximum extent possible in a single continuous operation upward from the bottom of the loop well. Due to the specific gravity of the loop tube, it may be necessary to artificially weight the loop tube to allow placement to the bottom of the vertical borehole. External weights shall be attached to the loop tube in a manner that does not damage the loop tube. Only potable water may be placed inside the loop to add weight to the loop. Using a steel tube pipe as the tremie can assist in the placement of the loop tube to the bottom of the vertical borehole.

Qualified individuals, such as a Certified Vertical Closed Loop Driller (CVCLD), have demonstrated their knowledge of the skills and competencies necessary to construct the complete loop well. Some loop well professionals may have skills and competencies to make loop tubing connections.

## Contact

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## References

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## Dates

*Originally adopted by the NGWA Board of Directors on February 9, 2010; technical update January 5, 2016; technical update February 24, 2016. NGWA statements are updated as needed to reflect changes in information.*

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