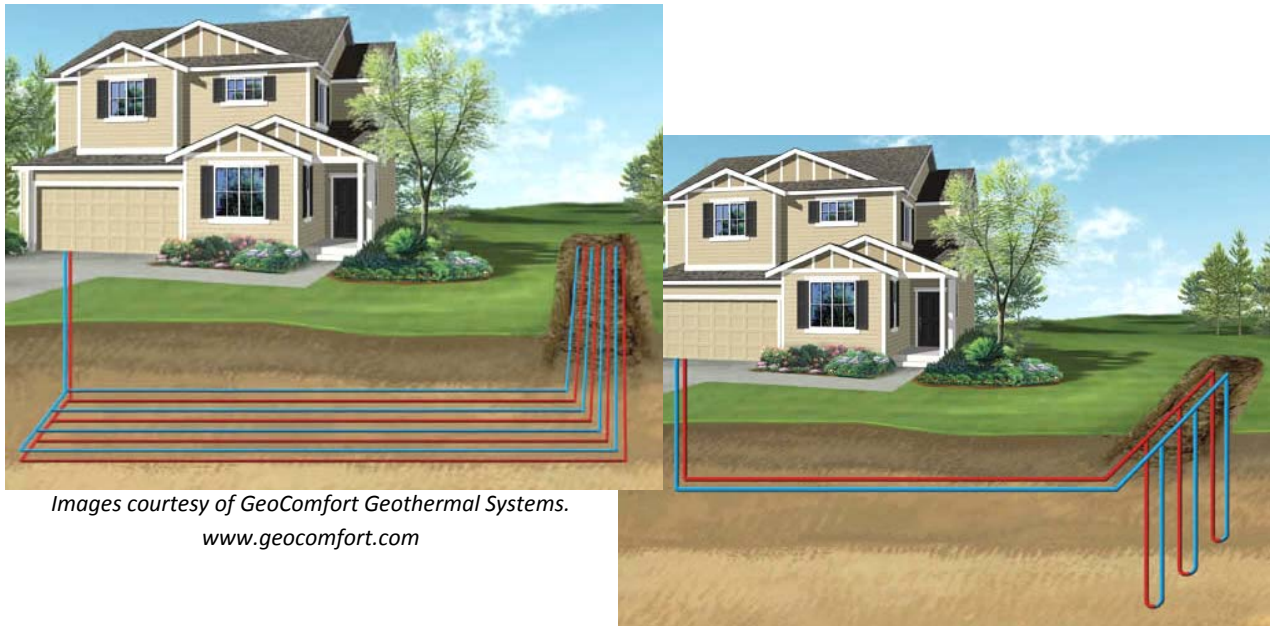


# Low-Cost Measurement of Soil Thermal Properties for Geothermal Loop Systems

As daily to seasonal delivery and recovery of heat to and from ground storage systems becomes an increasingly common component of building mechanical systems, there is opportunity for more cost-effective design and construction based on better information about the ground. Miller Engineers & Scientists can provide **accurate, low cost methods to determine** the variations in **ground thermal properties** on any site, including guidance on how to effectively configure and position the in-ground elements for heat storage in various site conditions.



*Images courtesy of GeoComfort Geothermal Systems.  
www.geocomfort.com*

## Determining the right configuration based on Soil Thermal Properties

Efficiency of heat storage varies with the thermal properties of the soil, which in turn can vary substantially at different depths and locations on any site. **Design and construction of effective and economical ground heat storage systems depends upon knowing the spatial patterns of the thermal properties; both heat capacity and thermal conductivity.**

What do these values tell us about the most efficient position for a ground heat storage system? **Look for high heat capacity and at least adequate thermal conductivity.** Since water provides most of the volumetric heat capacity in soil, wet and preferably saturated conditions are good. With that in mind, incorporating stormwater management into your ground heat storage system may be a way to improve system efficiency. Since thermal conductivity improves with soil density, a balance between moisture and density is best.

**How do we know those properties?** Site specific properties can be estimated if the patterns in soil moisture content and density are determined in the course of geotechnical exploration of the site. They can also be measured directly on soil samples obtained during soil boring exploration, or in test pits where shallow trench systems are being considered.

## Shouldn't I do a Loop Test?

Not as a first step, because “geothermal” Loop Tests do not distinguish variations between different strata in the ground, are relatively expensive, and interpretation of thermal conductivity from them requires assuming a value for the specific heat. The value of a Loop Test is to verify that the initial production holes perform as expected, but a Loop Test does not provide all the information needed for efficient system design.

Loop Tests do not indicate what distance away from the borehole that ground temperature is being affected, or what time it takes for the heat to migrate any particular distance. This requires determining both the thermal conductivity and heat capacity values, which is critical in designing shallow horizontal systems, particularly underneath buildings. Both properties are also important in designing vertical loop systems where available land area is limited. Direct measurements in the lab of heat capacity and thermal conductivity of soil samples from geotechnical exploration provide this information.

## What does this mean for my system design?

At a fraction of the cost of a Loop Test, Miller Engineers & Scientists can analyze the thermal properties of site soils and bedrock to determine optimum system configuration and placement. By working as part of your integrated site design team, this analysis can be provided as part of the standard geotechnical exploration of the site. If this exploration has already been performed by others, we are able to provide low-cost testing of soil samples obtained from your site to determine the necessary properties for efficient system design.



Achieving building energy efficiency, comfort, and lowest life cycle cost begins by evaluating all measures that will be effective, both in the building and on the site. This requires an integrated team approach with the owner; architect; structural, mechanical, civil, and geotechnical engineers; and landscape architect beginning with the initial site characterization and conceptual planning.

### ***Miller Engineers & Scientists offers the following services in support of Ground Heat Storage System design and site planning:***

- Geotechnical exploration and site hydro-geologic analysis
- Site planning, surveying and mapping, and stormwater management
- Lab testing and field verification of soil properties
- Ground heat transient calculations for system configuration and sizing
- Analysis of existing systems that aren't performing as expected