

Getting Started with

# Ground Loop Design

Version 3.0 for Windows

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**NOTE: To start designing immediately, begin at STEP 1 and continue through STEP 7.**



# Welcome To Ground Loop Design

**W**elcome to Ground Loop Design (GLD), Gaia Geothermal’s comprehensive Geoexchange design software. GLD offers engineers and designers a suite of rapid, user-friendly, customizable and accurate design optimization tools. With GLD, designers spend less time designing and more time offering competitive proposals, installing systems, and satisfying customers.

As you progress through this Getting Started Guide in the next 25 minutes, you will create your first design and also will learn how GLD can help you design faster and more effectively. Thank you for your interest in GLD. We think you will enjoy the program.

## GLD Features

<b>FULL POWER</b>	
3 Types of Heat Exchangers <b>Vertical • Horizontal • Surface Water</b>	2 Types of Loads Inputs <b>Zone-by-Zone • Average Block</b>

The professional version of Ground Loop Design includes three design modules: one for vertical borehole, one for horizontal and one for surface water (pond, lake, etc.) installations. By combining designs and the built-in cooling tower sizer, users can quickly create **hybrid** systems. GLD also includes two loads modules, one for average block loads and one for detailed zone-by-zone loads. Both can be used to manually or automatically select from hundreds of included **water-to-air** and **water-to-water** heat pumps. The loads data can be shared between modules using Ground Loop Design’s unique linking system. In addition, data from external loads

programs (the Trane System Analyzer, for example) as well as from Excel files can be imported conveniently into the loads modules.

### COMPLETE CUSTOMIZATION

**Pumps • Data Sheets • Reports • Help Files**

Because of the extensive customization and override features included in the software, Ground Loop Design is suited ideally for both standard and non-standard applications (which can involve significant variations in equipment, loads, and operational parameters for each zone in the design). The user, who may prefer to add his or her specific images or data sheets, has the freedom to customize the data reference files.

### EFFECTIVE COMMUNICATION

**English Units • Metric Units • Pro Reports • Multilingual**

With instant, direct metric/English unit conversions and foreign language capabilities, Ground Loop Design is a truly international program. With Ground Loop Design, communicating project parameters, equipment requirements and loads data with coworkers, partners, and vendors anywhere in the world is efficient and easy. Furthermore, after designing a project, it is effortless to email the small project and zone files to colleagues.

## Why This Guide?

The primary purpose of this Getting Started Guide is to show you how to design quickly and effectively with GLD. To meet this goal, this guide will take you step-by-step through the design of a vertical borehole heat exchanger for a commercial building.

- In chapter 2, you will learn how to choose the appropriate loads module for the sample project. After choosing a module, you will discover how easy it is to get the loads into GLD. Next, you will learn how to match the pumps to the loads using GLD's automatic and manual pump selection options.
  - After mastering the loads side of the program, you will look at the heat exchanger side. In Chapter 3 you will design a sample vertical borehole system for the project using the loads data we import in Chapter 2. You can explore the horizontal design module and surface water module on your own.
-

- In chapter 4, you will learn how to print out professional reports that are as impressive as your designs. The guide concludes with a series of tips that will help you take full advantage of the program.

The secondary purpose of this guide is to introduce you to some of the more advanced features of the program. A complete description of the program can be found in the User Manual.

The following icons appear throughout the guide:



**STEP 1**

This icon appears in the left margin of this guide at the beginning of every major step in the design process. If you want to focus your time mainly on learning how to design, just follow these icons step-by-step through the sample design.



This icon appears in the left margin when this guide offers more detailed information about GLD

With no further ado, let's get started. First, we will install the program.

## System Requirements

A full installation has the following minimum *hardware* requirements:

- 32 MB Ram
- 50 MB hard disk space (100 MB recommended)

Ground Loop Design has the following *software* requirements:

- System running under Windows<sup>®</sup> 9X/ME/NT/2000/XP
- Netscape Navigator<sup>®</sup> or Internet Explorer<sup>®</sup>

## Installation Procedure



Step 1

This section describes the installation procedure for Ground Loop Design (from a CD or downloaded version).

### Initial Installation

**STEP 1.0**

The installation should start automatically when you put the CD into the computer. If it does not, explore the CD drive and click on the **Setup.exe** file

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included on the disk. For the downloaded version, click on GLDSetup.exe to start the installation procedure.

The program is set to install in the folder:

**(Main Drive):\Program Files\Gaia Geothermal\Ground Loop Design**

If desired, the user can specify a different location during the installation sequence.

The full GLD user manual is installed on your computer when you install GLD. You can access it by going to START → Program Files → Ground Loop Design → Manual. The full manual contains extensive reference information and a full description of the entire program.



demo  
continues  
on page 9

## Reinstallation

If the user re-installs or replaces the software with a more recent version, the user either can uninstall the program (see *Note* below) or can just update a current version (versions subsequent to Version 2.0). To completely remove a version, go to the Windows Start Menu → Settings → Control Panel → Add/Remove Programs and choose to remove “Ground Loop Design”. After removing the program, please conduct the new installation as described above. As long as the user does not manually delete folders, existing work files, pumps, and zone files will not be affected.

**NOTE:** The file “**Pumplist.gld**” in the \Ground Loop Design\pumps folder will be overwritten upon re-installation. If the user has added pumps other than those originally included with the program, *this file should be copied or moved to a backup directory* prior to removal and re-installation. After re-installation, the **Pumplist.gld** file can be returned to the \Ground Loop Design\Pumps folder *or* the desired contents can be added to the contents of the new **Pumplist.gld** file using a simple text editor like **Notepad.exe**.

## Software License Dongle

Your GLD software license is stored on the “Aladdin” USB dongle that came with your program. This dongle enables you effortlessly to transfer GLD from one computer to another. Please be careful not to misplace this dongle. Lost dongles can not be replaced without the purchase of a new license.

If the dongle is not attached to your computer, GLD will function as a trial version, which is fully functional except for a few design parameters that are locked at certain values.

When you insert the dongle into a free USB port on your computer for the first time, your computer most likely will recognize the dongle and after a few seconds, the dongle light will turn on. When it turns on, your license will activate. However, if your computer indicates that the dongle is “new hardware” you have two options for installing the dongle driver:

## **How to Install the Dongle Driver:**

*Windows XP and Windows 2000 users with internet access:*

If your computer has access to the internet, your computer can automatically install the drivers. Follow along with the Windows new hardware wizard to install the drivers. The process takes a few minutes. When the installation is complete, the dongle light will turn on.

*All other users:*

Via Windows Explorer, navigate to:

**(Main Drive):\Program Files\Gaia Geothermal\Ground Loop Design\Extras**

In the Extras folder you will find a HASPUserSetup.exe program. Run the program to install the dongle driver. When the installation is complete, the dongle light will turn on.

## **After Dongle Installation is Complete:**

Now that the dongle is installed, you can access the full functionality of the GLD version that you purchased. If you remove the dongle, the program will revert to demo mode. If you reattach the dongle, the program will reactivate again.

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## What About The Loads And Pumps?



**G**round Loop Design is a commercial-grade heat exchanger design program and uses a heat transfer model that takes long-term thermal effects into account. The program is ideally suited for commercial applications but can be used effectively for residential projects as well. Regardless of the project type, note that the results that GLD calculates are only as good as the information that the designer inputs. It is ultimately the designer's responsibility to confirm that input values are reasonable.

### Why Does GLD Have Both Average Block And Zone Loads Screens (Modules)?



GLD offers two different loads input systems to match the widest possible range of users' needs. The following summarizes the benefits of and the differences between the two loads screens (modules).

#### **Average Block Loads Module**

The Average Block Loads module offers a rapid method of entering whole systems information for users who do not desire to input the loads data for a fully zone-divided installation. Rather than matching specific pumps to each zone, the Average Block Loads module uses a particular, user-defined style of pump (or COP) and matches it in an average way to the entire installation.

#### **Use The Average Block Loads Module When:**

- You want to design the heat exchanger quickly and/or

- You intend to primarily use one type of pump for the entire installation and/or
- You have total system loads data but not zone-by-zone data

## Zone Manager Loads Module

The Zone Manager Loads module is provided for designers who desire a full analysis capability. Loads are input as separate zones, and each zone is matched with a particular pump. This mode is more useful when users require thorough designs.

### Use The Zone Manager Loads Module When:

- You intend to/need to match specific pumps to specific zones and/or
- You intend to design systems with both water-to-water and water-to-air pumps and/or
- You have loads data for each zone



## What Loads Data Does GLD Need?

GLD is capable of processing hour-by-hour loads data for both the cooling and the heating sides for an entire year. However, to save time when inputting the data, designers only need the following minimum data to begin using the program. Note that the more detailed the loads data are, the more accurate the final design will be.

### Minimum Loads Data Requirements for the Average Block Module:

- Total heating and cooling loads for each month of the year (in MBtu or kWh)
- Peak hourly heating and cooling loads for each month of the year (in MBtu/hr or kW)

### Minimum Loads Data Requirements for the Zone Manager Module:

- Total heating and cooling loads for each month of the year for *each zone* (in MBtu or kWh)

- Peak hourly heating and cooling loads for each month of the year *for each zone* (in MBtu/hr or kW)

GLD uses these data both to match pumps to loads and to determine the appropriate length of the heat exchanger. The mathematical model that GLD uses is described in great detail in the User Manual. Briefly, GLD uses the loads data to determine hourly, monthly and annual heat pulses into the ground. The hourly heat pulse is based on the peak hourly heating/cooling loads. The monthly heat pulse is related to a “monthly load factor” which is calculated in the following method:

$$\frac{\text{Total heating or cooling loads for a given month}}{\text{Peak hourly heating/cooling load for a given month} \times \text{number of hours in that month}}$$

Peak hourly heating/cooling load for a given month x number of hours in that month

The annual heat pulse calculation is known as the “annual equivalent full load hours.” The “full load hours” is calculated in the following way:

$$\frac{\text{Total heating/cooling for the year}}{\text{Peak hourly heating/cooling load}}$$

Peak hourly heating/cooling load

To put it in a less mathematical way, “full load hours” is the number of hours a system would have to run continuously at its peak hourly rate to reach its total annual heating/cooling loads. For example, if the peak hourly cooling load is 100Mbtu/hr and the total annual cooling load is 1000Mbtu, the “full load hours is (1000Mbtu)/(100Mtu/hr) = 10 hours. The “full load hours” nomenclature is nothing more than a shortcut for representing total annual heating/cooling loads.

The peak hourly loads, monthly load factors and the full load hours are all used by the program. This nomenclature may seem a bit confusing initially but after designers become accustomed to it, they appreciate the time it saves them if and when they have to manually input loads data into GLD. It’s *much* faster than inputting hour-by-hour loads for an entire year!



## Where Can I Get The Loads Data?

GLD users oftentimes get their loads data from commercial loads calculation programs such as the Trane System Analyzer. This type of program outputs data that are both detailed and in a format that GLD can import automatically. On occasion, however, the output data needs

to be manually manipulated in Excel prior to transferring it into GLD. This process will be explained below. *Users with significant residential but limited commercial design experience should note that commercial applications require more detailed data than that with which they may be familiar.* GLD only outputs good results when the user inputs good loads data.

## How Do I Get The Loads Data Into GLD?



After calculating or receiving the appropriate loads data, there are three easy ways to get the data into GLD:

- GLD can automatically import the output files from programs such as the Trane System Analyzer
- GLD can import the loads data from an Excel spreadsheet *provided that the loads data follows a prescribed format* (more on this below)
- GLD can accept input directly into the loads screen (module) dialogue boxes

Each of the three methods is explained below. **For the demonstration project, please follow the first method.**



Step 2

### STEP 2.0

For the demo project, we will import a Trane System Analyzer file into the Average Block loads screen. Open up the GLD program.

### STEP 2.1

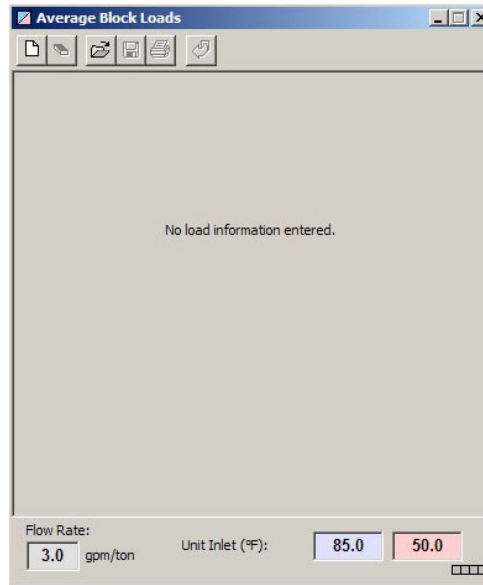
You will see the program desktop (also known as the Design Studio). Near the top of the program you will see a row of icons. The icon for the Average Block Loads module looks like this:



Click on the icon.

### STEP 2.2

The Average Block Loads module is now open. It looks like this:



Average Load Block Module With No Open Zone

**STEP 2.3**

Click on the New icon to open up a new loads file. The icon looks like:



and can be found at the top of the Average Block Loads module. A new loads screen with zeros for every parameter is now open.

**STEP 2.4**

We are now ready to import a sample Trane System Analyzer file that is included with GLD. At the top of the Average Block Loads module, there are a series of icons:



Click on the Loads Files Import button:



A dialog box opens up that allows you to choose a loads file to import into GLD. To find the sample Trane file, confirm that you are in the Program Files/Gaia Geothermal/Ground Loop Design/Zones folder. Open the **sample.gt1** file.

When you select a valid import file, GLD automatically transfers the loads data into the Average Block Loads module. An Import Loads

window opens as well and shows the imported data in detail. Both windows are shown below:

	Total (MBtu)	Peak (MBtu/hr)	Monthly Load Factor
January	17859.0	27.5	0.87
February	16113.0	27.6	0.87
March	19432.0	140.7	0.19
April	51266.0	372.1	0.19
May	100432.0	447.1	0.30
June	160586.0	552.1	0.40
July	153721.0	536.6	0.39
August	159662.0	543.8	0.39
September	114720.0	477.0	0.33
October	27758.0	298.6	0.12
November	21229.0	258.8	0.11
December	18000.0	120.3	0.20
<b>Total   Max:</b>	<b>860778.0</b>	<b>552.1</b>	
<b>Full-Load Hours:</b>	<b>1559</b>	<b>hr</b>	

Import Loads Window: Cooling

Days Occupied per Week	Time of Day	Heat Gains (MBtu/Hr)	Heat Losses (MBtu/Hr)
7.0	8 a.m. - Noon	157.2	201.4
	Noon - 4 p.m.	552.1	0.0
	4 p.m. - 8 p.m.	157.2	0.0
	8 p.m. - 8 a.m.	157.2	0.0
Annual Equivalent Full-Load Hours:		1559	54

	Pump Name	Heat Pump Specifications at Design Temperature and Flow Rate	
		Cooling	Heating
Capacity (MBtu/Hr)	(Select)	0.0	0.0
Power (kW)		0.00	0.00
EER/COP		0.0	0.0
Flow Rate (gpm)		0.0	0.0
Partial Load Factor		0.00	0.00

Average Block Loads Module With Imported Data

**STEP 2.5**

In the Import Loads window above there are three columns: Total Monthly Loads, Peak hourly loads (for each month) and the Monthly Load Factor. The Monthly Load Factor is described in great detail in the full User Manual. Near the bottom of the window are total MBtus (a summation of January through December) and the peak hourly MBtu for the year.

At this step in the design, it is possible to modify the imported cooling and/or heating loads data. Click on the Heating button at the bottom of the Import Loads window. It will look like this:

	Total (MBtu)	Peak (MBtu/hr)	Monthly Load Factor
January	6402.0	201.4	0.04
February	4487.0	144.6	0.05
March	0.0	0.0	0
April	0.0	0.0	0
May	19.0	1.0	0.02
June	0.0	0.0	0
July	0.0	0.0	0
August	0.0	0.0	0
September	0.0	0.0	0
October	0.0	0.0	0
November	1.0	0.3	0.01
December	49.0	8.2	0.01
<b>Total Max:</b>	<b>10958.0</b>	<b>201.4</b>	
<b>Full-Load Hours:</b>	<b>54</b>	<b>hr</b>	

Import Loads Window: Heating

**STEP 2.6**

In this step, you will modify the imported heating loads data. GLD offers designers flexibility at every step in the design process and this data modification capability is just one example of that flexibility. Modify the imported data by inputting these values in the appropriate Total and Peak boxes:

- January:                      **90000 MBtu    370 MBtu/hr**
- February                      **108000 MBtu    410 MBtu/hr**
- March                              **54000 MBtu    340 MBtu/hr**

- April                                   **20000 MBtu**   **150 MBtu/hr**
- May                                     **9000 MBtu**    **70 MBtu/hr**
- June                                    **7000 MBtu**    **60 MBtu/hr**
- July                                     **4000 MBtu**    **33 MBtu/hr**
- August                                 **2600 MBtu**    **22 MBtu/hr**
- September                            **4000 MBtu**    **27 MBtu/hr**
- October                               **23000 MBtu**   **145 MBtu/hr**
- November                             **37000 MBtu**   **210 MBtu/hr**
- December                             **55000 MBtu**   **300 MBtu/hr**

After inputting this modified data, the heating side of the Import Loads window will look like this:

	Total (MBtu)	Peak (MBtu/hr)	Monthly Load Factor
January	90000.0	370.0	0.33
February	108000.0	410.0	0.39
March	54000.0	340.0	0.21
April	20000.0	150.0	0.19
May	9000.0	70.0	0.17
June	7000.0	60.0	0.16
July	4000.0	33.0	0.16
August	2600.0	22.0	0.16
September	4000.0	27.0	0.21
October	23000.0	145.0	0.21
November	37000.0	210.0	0.24
December	55000.0	300.0	0.25
<b>Total Max:</b>	<b>413600.0</b>	<b>410.0</b>	
<b>Full-Load Hours:</b>	<b>1009</b>	<b>hr</b>	

Buttons: Close, Cooling, Heating (selected), Clear, Modify

Import Loads Window: Modified Heating Data

Notice that the total annual MBtus and the Full Load Hours have increased accordingly. You also can calculate the Full Load Hours by clicking the Modify button. A new window, the Equivalent Hours Calculator, will open up:



Annual Equivalent Full-Load Hours

Peak Hourly Load:  MBtu/hr

Monthly Total Loads: MBtu

January	90000.0
February	108000.0
March	54000.0
April	20000.0
May	9000.0
June	7000.0
July	4000.0
August	2600.0
September	4000.0
October	23000.0
November	37000.0
December	55000.0

Full-Load Hours:  hr

Close Calculate Clear

Equivalent Hours Calculator



The Equivalent Hours Calculator is a handy tool included with GLD to help you calculate the full load hours. Notice that the peak hourly load, the monthly total load and the full load hours are identical to those in the Import Loads window. In the future, as you design with GLD, use this tool when you want to quickly calculate full load hours. For the time being, please click the Close button to close the calculator.

**STEP 2.7**

Now we are ready to take our first detailed look at the Average Block Loads module. On your screen, you should still have both the Import Loads and the Average Block Loads windows open. Take a look at the Average Block Loads data:

Design Day Loads

Days Occupied per Week:

Transfer Calculate Hours

Time of Day	Heat Gains (MBtu/Hr)	Heat Losses (MBtu/Hr)
8 a.m. - Noon	157.2	201.4
Noon - 4 p.m.	552.1	0.0
4 p.m. - 8 p.m.	157.2	0.0
8 p.m. - 8 a.m.	157.2	0.0

Annual Equivalent Full-Load Hours:

Average Block Loads Data

Notice that the Annual Equivalent Full-Load Hours is 1559 for cooling and 54 for heating. In the Import Loads window, however, the full load hours for heating is 1009. The heating value in the Import Loads window is higher because we modified the data. To transfer the modified data into the Average Block Loads module do the following:

- Push the Transfer button in the Average Block Loads module. It is located right beneath “Days Occupied per Week.”

The heating full load hours value should have increased to 1009, just as we wanted it to do. Your screen will look like this:

Design Day Loads			
Days Occupied per Week	Time of Day	Heat Gains (MBtu/Hr)	Heat Losses (MBtu/Hr)
7.0	8 a.m. - Noon	157.2	410.0
	Noon - 4 p.m.	552.1	110.9
	4 p.m. - 8 p.m.	157.2	110.9
	8 p.m. - 8 a.m.	157.2	110.9
Annual Equivalent Full-Load Hours:		1559	1009

Modified Average Block Loads Data



As the Average Block Loads image above indicates, the entire hour-by-hour loads for an entire year for both heating and cooling are distilled down to five key values. These values include four time periods (8am-noon, noon-4pm, 4pm-8pm and 8pm-8am) and the Annual Equivalent Full Load Hours. GLD calculates based on hour-by-hour data. However, for simplification, average peak loads for the design day (the day of heaviest usage in the year) for both cooling (heat gains) and heating (heat losses) can be input for up to four separate times of the day.

A detailed description of how GLD determines the loads for each time period can be found in Chapter 3 of the User Manual.

### STEP 2.8

Finally, take a look at the days per week value, which represents the occupation of the installation. In the demo, the school is only occupied during weekdays. Input the following data:

- Days Occupied Per Week: **5.0**



demo  
continues  
on page  
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**SUMMARY:** So far we’ve imported a Trane System Analyzer loads file into GLD. When we imported the file, the data were transferred

automatically into *both* the Import Loads window and the Average Block Loads module. The Import Loads window opened so that we could examine the imported data and also so that we could have a chance to modify it if necessary. Since we did modify the data, we had to click the transfer button in the Average Block Loads module to transfer the data into the Loads Module. GLD does the pump matching and the heat exchanger design based *only* on the loads data in the Loads module and not on the data sitting in the Import Loads window. Therefore, we had to transfer the modified data into the Average Block loads module.



## Excel Data: How To Get Excel-Based Loads Data Easily Into GLD

Designers oftentimes receive loads data in Excel spreadsheets. GLD has an Excel import function to handle this situation. In this section of the Getting Started Guide, we will explain the general procedure for importing Excel data and then work through an example.

The easiest way to import data from an Excel file is by using the ‘Import Loads’ command found under the Loads menu which is located at the top of GLD. Select ‘Import Loads’ and a empty Import Loads window will appear:

	Total (MBtu)	Peak (MBtu/hr)	Monthly Load Factor
January	0.0	0.0	0
February	0.0	0.0	0
March	0.0	0.0	0
April	0.0	0.0	0
May	0.0	0.0	0
June	0.0	0.0	0
July	0.0	0.0	0
August	0.0	0.0	0
September	0.0	0.0	0
October	0.0	0.0	0
November	0.0	0.0	0
December	0.0	0.0	0

Total Max: 0.0    0.0    Clear

Full-Load Hours: 0 hr    Modify

Close    Cooling    Heating

Empty Import Loads Window

The next step is to prepare the data in the Excel file so that it matches the format that GLD expects. This is an important step. If the designer fails to follow this step, data will not be imported correctly. GLD expects the Excel data to be in the following column order and units

(note that Ground Loop Design can accept a maximum of 12 data rows per column):

Month	Total Heating 1000 BTU	Total Cooling 1000 BTU	Peak Heating 1000 BTU/hr	Peak Cooling 1000 BTU/hr
January				
...				
December				

To import the Excel data, simply highlight the four columns in the Excel spreadsheet and copy them onto the clipboard (Ctrl-C). **Note: highlight only the numeric data. DO NOT highlight the column and row descriptions.** Then in the Import Loads window click on the green *Excel* icon found near the top of the Import Loads window. The data will be imported. Data can be modified (if necessary) and transferred into the loads modules following the method described in step 2.6 above.

Note that it is possible to import a single column of data. Following the column order listed above, put the single column of data in the correct position. Fill the remaining columns with zeros and then copy all four columns to the clipboard.

Now we are ready for a specific example of how to import loads from an Excel sheet. Suppose a client sends you the following data:

Month	Hours per Month	Total Heating 1000 BTU	Total Cooling 1000 BTU	Peak Heating 1000 BTU/hr	Peak Cooling 1000 BTU/hr
Jan	744	526422	0	3324	0
Feb	678	400388	0	3324	0
Mar	744	282331	1268	3324	15.81
Apr	720	113920	11185	3324	399.304
May	744	64571	131659	2789.833	1803.555
Jun	720	47584	62255	2162.927	1074.876
Jul	744	924	208745	46.204	1886.659
Aug	744	10031	164235	436.109	1565.797
Sep	720	56751	150608	2741.968	2026.921
Oct	744	112429	24775	3324	861.239
Nov	720	254385	1434	3324	15.81
Dec	744	375790	486	3324	12.364

According to the import template above, GLD requires the following data: total heating and cooling in MBtus and peak heating and cooling in Mbtus/hour. The sample Excel data contains all this information in the proper format. **Note:** if the data is not in the proper format, the user will have to modify the Excel file prior to importing the loads.

The next step is to select the data. The highlighted data should look like this. Note that *only* the data are highlighted:

Month	Hours per Month	Total Heating	Total Cooling	Peak Heating	Peak Cooling
		1000 BTU	1000 BTU	1000 BTU/hr	1000 BTU/hr
Jan	744	526422	0	3324	0
Feb	678	400388	0	3324	0
Mar	744	282331	1268	3324	15.81
Apr	720	113920	11185	3324	399.304
May	744	64571	131659	2789.833	1803.555
Jun	720	47584	62255	2162.927	1074.876
Jul	744	924	208745	46.204	1886.659
Aug	744	10031	164235	436.109	1565.797
Sep	720	56751	150608	2741.968	2026.921
Oct	744	112429	24775	3324	861.239
Nov	720	254385	1434	3324	15.81
Dec	744	375790	486	3324	12.364

Copy the highlighted data to the clipboard (Ctrl-C), then click the green Excel button in the Import Loads window. The Import Loads window will look like this:

Import Loads

Import Data

Filename:

Generated By:

	Total (MBtu)	Peak (MBtu/hr)	Monthly Load Factor
January	0.0	0.0	0
February	0.0	0.0	0
March	1268.0	15.8	0.11
April	11185.0	399.3	0.04
May	131659.0	1803.6	0.10
June	62255.0	1074.9	0.08
July	208745.0	1886.7	0.15
August	164235.0	1565.8	0.14
September	150608.0	2026.9	0.10
October	24775.0	861.2	0.04
November	1434.0	15.8	0.13
December	486.0	12.4	0.05

Total | Max: 756650.0 2026.9

Full-Load Hours: 373 hr

Cooling
  Heating

### Excel Data Are Imported Successfully

The data are simultaneously imported into the Loads Module (either Average Block or Zone-Manager, depending on which one the designers has opened).

**Summary:** We have learned how to easily import Excel data into GLD. Two key points to remember are the following: confirm that the Excel data are in the correct units and make sure the columns are in the appropriate order prior to copying the data onto the clipboard.



## Manually Inputting Data Into The Average Block Loads Module

Loads can be entered directly in the individual loads data time slots in the Average Block Loads module. If only one peak value during the day is provided to the designer, it can be entered into one or several of the time slots, depending on how the loads will be expected to change during the course of a day. Slightly reduced values can be added for off-peak hours if the building still will be in operation but not at full load. Insignificant time slots can be left at zero.

If only cooling or only heating loads data are to be used, all of the non-used slots **should remain as zeroes**. Only the side with the loads provided will be calculated.



Step 3

### How Do I Choose A Pump?

With the Average Block Loads module, the user selects a single pump type from the GLD Heat Pump Database (information about the built in and fully modifiable Database can be found in the full User Manual) to approximate the average characteristics of the installation. For example, if the designer is planning to use the highest efficiency pumps, a pump in a series with a higher coefficient of performance (COP) might be chosen over a lower efficiency pump. If specific pump characteristics are required, they can be input directly, overriding the automatic functions.

#### STEP 3.0

To choose a pump, look at the bottom half of the Average Block Loads module:



Heat Pump Specifications at Design Temperature and Flow Rate

Custom Pump    Pump Name: (Select)

	Cooling	Heating
Capacity (MBtu/Hr)	0.0	0.0
Power (kW)	0.00	0.00
EER/COP	0.0	0.0
Flow Rate (gpm)	0.0	0.0
Partial Load Factor	0.00	0.00

Flow Rate: 3.0 gpm/ton    Unit Inlet (°F): 85.0 50.0

### Pump Characteristics in the Average Block Loads Module

With no pump currently selected, the Custom Pump box is checked, and all pump performance values are at 0.0. To select a pump, click the Select button. This is what you will see:

Heat Pump Specifications at Design Temperature and Flow Rate

Addison    Horizontal 1/2-10 Ton, HGY

Pump Name: HGY 007    Select Pump

Cancel

Flow Rate: 3.0 gpm/ton    Unit Inlet (°F): 85.0 50.0

### Pump Selection in the Average Block Loads Module

#### STEP 3.1

In this screen, you can choose a manufacturer, pump series, and pump name and then click the Select Pump button. Note that performance specification data for all the heat pumps in the GLD heat pump database can be accessed through the Heat Pump Module. To access this module, click on the Edit/Add Heat Pumps choice under the Heat Pumps menu item that can be found at the top of the GLD program (above the main program icons). For this demonstration, please choose:

- manufacturer:            **Florida Heat Pumps**
- pump series:             **EV Series**
- pump name:              **EV048**

Click on the Select Pump button. The screen now looks like this:

Heat Pump Specifications at Design Temperature and Flow Rate

Custom Pump    Pump Name: **EV048**

	Cooling	Heating
Capacity (MBtu/Hr)	552.1	562.8
Power (kW)	44.17	36.68
EER/COP	12.5	4.5
Flow Rate (gpm)	138.0	123.0
Partial Load Factor	1.00	0.87

Flow Rate:  gpm/ton    Unit Inlet (°F):

### Selected Pump Performance Characteristics

#### STEP 3.2

Click on the Details button to see details about the selected EV048 pump:

Heat Pump Specifications at Design Temperature and Flow Rate

Pump Manufacturer: Florida Heat Pump   

Pump Series: EV Series

Pump Type: Water to Air

Inlet Air Temperatures and Flow Rate - Load

**EAT:**    Cooling (WB):  °F    Heating (DB):  °F

Flow Rate:  gpm/ton    Unit Inlet (°F):

### Selected Pump Details

This screen displays details about the selected pump. It also displays the load side Entering Air Temperature (EAT) for both cooling and heating. GLD employs an accurate system for modeling heat pump performance. Both source and loads side factors affect heat pump performance and GLD models these factors. Users can modify the EAT as necessary for specific design applications. In this demonstration, the EAT values will not be modified. More information about how GLD models heat pumps can be found in Chapter 2 of the User Manual.

#### STEP 3.3

Click the Return button to go back to the original view:



Heat Pump Specifications at Design Temperature and Flow Rate

Custom Pump      Pump Name: **EV048**

	Cooling	Heating
Capacity (MBtu/Hr)	552.1	562.8
Power (kW)	44.17	36.68
EER/COP	12.5	4.5
Flow Rate (gpm)	138.0	123.0
Partial Load Factor	1.00	0.87

Flow Rate:  gpm/ton      Unit Inlet (°F):

### Selected Pump Performance Characteristics

Users now have the opportunity to modify system flow rates, unit inlet temperatures and pump performance parameters, Note that when we design the vertical borehole heat exchanger in the next chapter, you will have the opportunity to modify the flow rate and unit inlet temperatures. For the time being, use the following values:

- Flow Rate: **3.0 gpm/ton**
- Cooling Inlet Temp: **85°F**
- Heating Inlet Temp: **50°F**

Note that if you want to use metric units, just click on the English/Metric units conversion button:



It can be found at the top of the GLD program at the very right end of the row of icons.

#### STEP 3.4

In addition, users can manually override any performance values by simply clicking in the appropriate dialog box and typing in a new value. If you do this, the “custom pump” box will become checked automatically to remind you that you have modified the standard data. Modifying the standard pump data is useful when you intend to use a customized pump. Also, some designers modify the Partial Load Factor by dropping it down from the idealized value of 1.0. As a final step in optimizing the loads data, change the following input:

- Cooling Partial Load Factor: **0.93**

When you do so, notice how the other performance characteristics on the cooling side are modified automatically.

**STEP 3.5**

At the top of the Loads module, enter the following reference label:

- Reference Label: **Vertical Demo Project**

**STEP 3.6**

Now save the loads data. Click on the floppy disk icon at the top of the Average Block Loads module. Save the file in Program Files/Gaia Geothermal/Ground Loop Design/Zones as **Demo.zon**.



demo  
continues  
on page  
24

**Summary:** We have imported loads data into the Average Block Loads module, set the occupation level to 5.0 days a week, selected a pump, and modified the cooling partial load factor. This is what your Average Block Loads module should look like:

Reference Label: Vertical Demo Project

Design Day Loads

Days Occupied per Week	Time of Day	Heat Gains (MBtu/Hr)	Heat Losses (MBtu/Hr)
5.0	8 a.m. - Noon	157.2	410.0
	Noon - 4 p.m.	552.1	110.9
	4 p.m. - 8 p.m.	157.2	110.9
	8 p.m. - 8 a.m.	157.2	110.9
Annual Equivalent Full-Load Hours:		1559	1009

Heat Pump Specifications at Design Temperature and Flow Rate

Custom Pump Pump Name: **EV048**

	Cooling	Heating
Capacity (MBtu/Hr)	593.7	605.2
Power (kW)	47.50	42.41
EER/COP	12.5	4.5
Flow Rate (gpm)	138.0	102.5
Partial Load Factor	0.93	0.68

Flow Rate: 3.0 gpm/ton Unit Inlet (°F): 85.0 50.0

Average Block Loads Module: Ready for Heat Exchanger Design

## Heat Exchanger Design

**G** Round Loop Design (GLD) includes vertical, horizontal and surface water heat exchanger design modules. As you continue with the vertical heat exchanger design, you will begin to see how the modular nature of GLD offers powerful design assistance (modular meaning the Average Block loads module is a separate and independent module, the Vertical Borehole design module is a separate and independent module, etc). Although each module is stand-alone and independent, the modules communicate and share data with each other via the Studio Link system.



STEP 4

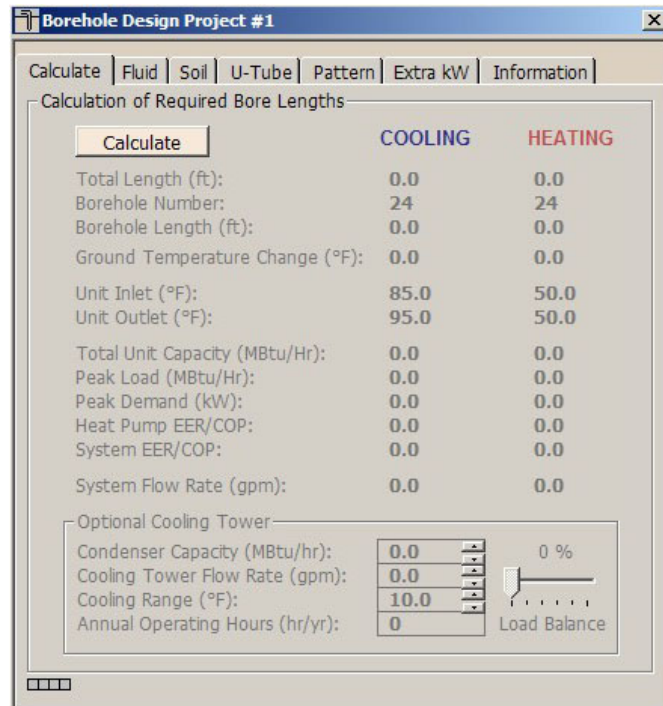
**STEP 4.0**

### What Is the Studio Link System?

The best way to describe the Studio Link system is to demonstrate it. Please open a new Vertical Borehole Design module. You can do this by clicking on the Vertical Borehole icon. It is the first icon to be found in the top left corner of GLD and looks like this:



When you click it, a new window will open in GLD. This is the Vertical Borehole Design window (or module). It looks like this:

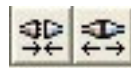


### New Vertical Borehole Design Module

#### STEP 4.1

Push the Calculate button and see what happens. Nothing happens because there is no loads data that are linked to the Borehole module. We now have to connect the data we entered in the Average Block Loads module to the Borehole Design module. The Studio Link system will help us do this.

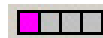
At the top of GLD look for the following two icons:



**link unlink**

#### STEP 4.2

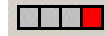
The icon on the left is the link icon and the icon on the right is the unlink icon. Click on the link icon and see what happens. Notice in the bottom left corner of both modules (the Borehole module and the Loads module) that there is a lighted box. It looks like this:



This box indicates that the two modules are linked and have bidirectional communication.

**STEP 4.3**

Now click the unlink icon. You will notice that the position and color of the light has changed, indicating that the two modules are no longer communicating. It looks like this:

**STEP 4.4**

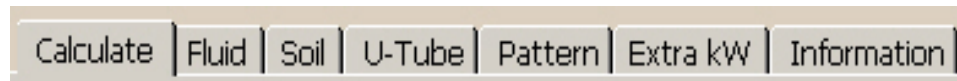
Push the link button again to reestablish communications.



Step 5

## Now That My Loads Data Are Linked To The Borehole Designer, How Do I Start Designing?

The Borehole Design module allows the user to enter various parameters with respect to the desired vertical borehole system using a tabbed series of panels as seen below:



**Borehole Design Panel List**



Users generally start designing from the Information panel and then work their way to the left.

In this demo, we are designing a loop field for a building that has a number of small, identical rooms. Just as a reminder, we entered the loads into the Average Block Loads module. We chose to use the Average Block Loads module instead of the Zone Manager because the Average Block Loads module is ideally suited for situations in which you want to a) start designing quickly and/or b) use the same pump throughout most of the design.

**STEP 5.0**

Click on the Information tab to open the Information panel. Any information you type in this panel will be included in all reports. Reports will be introduced in Chapter 4.

**STEP 5.1**

In the Information panel, please enter the following data:

- project name: **Gaia Headquarters**
- client name: **Your Choice**
- address: **Your Choice**

**STEP 5.2**

Now click on the Extra kW panel that is directly to the left of the Information Panel. This is what you will see:

The screenshot shows the 'Borehole Design Project #1' window with the 'Extra kW' tab selected. The interface includes the following elements:

- Navigation Tabs:** Calculate, Fluid, Soil, U-Tube, Pattern, Extra kW, Information.
- Section 1: Circulation Pumps**
  - Required Input Power: 0.0 kW
  - Pump Power: 0.0 hP
  - Pump Motor Efficiency: 80 %
- Section 2: Optional Cooling Tower**

	Pump	Fan
Required Input Power:	0.0 kW	0.0 kW
Power:	0.0 hP	0.0 hP
Motor Efficiency:	85 %	85 %
- Section 3: Additional Power Requirements**
  - Additional Power: 0.0 kW

Extra kW panel



The top entry box, “Circulation Pumps”, is for the energy required by the system circulation pumps. The middle entry box, “Optional Cooling Tower”, is for the energy required by a cooling tower (if used). The lower entry box, “Additional Power Requirements”, is for all other elements (besides the heat pump units) in the system that may require energy input.

*Generally, cooling tower inputs are left at zero initially, and then modified once the program suggests the cooling tower size and flow rate.*

**Note:** To make a kilowatt entry in the ‘Pump Power’ box, switch to metric units, enter the kilowatt value, and then return to English units. You can do this by clicking on the metric/English units conversion button:

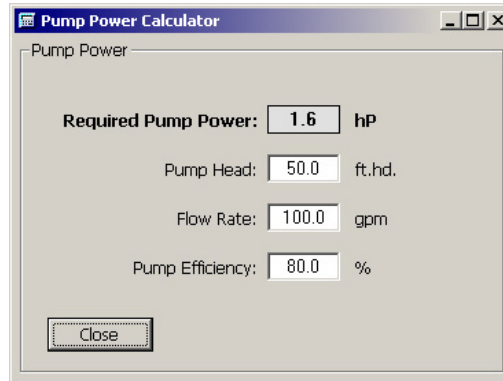


This button can be found near the top of the program at the far right end of the row of icons.

## Pump Power Calculator



Click on the Pump Power Calculator button to open the calculator. It looks like this:



Pump Power Calculator

If the pump efficiency, system flow rate and head loss are known, the *Pump Power Calculator* can be used to determine the pump power. Click on the Close button.

### STEP 5.3

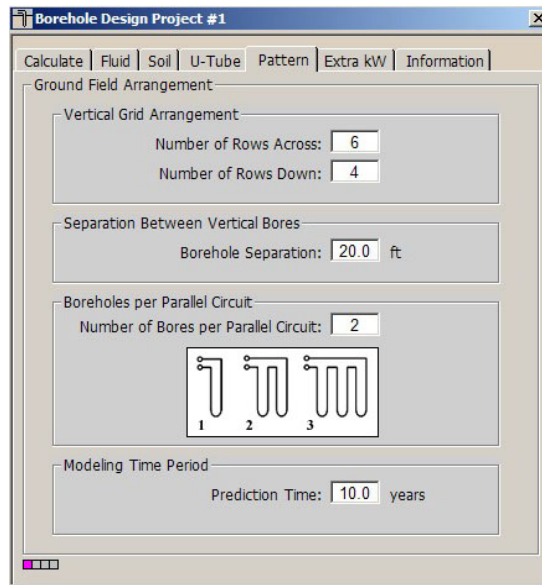
For this demo, we will input the following values in the Extra kW Panel:

- Pump Power: **2hp**
- Pump Motor Efficiency: **85%**
- Additional Power: **1 Kw**
- Cooling Tower Inputs: **0.0 for all**

After we finish the basic design, we can decide whether or not to use a cooling tower. If we decide to use a cooling tower, we can come back and input the appropriate values later.

### STEP 5.4

Now click on the Pattern tab. This is what you will see:



Pattern Panel



Information pertaining to the ground field arrangement is in the Pattern panel. This includes the vertical boreholes pattern, the borehole separation, the number of boreholes per parallel loop, and the modeling time.

**Note:** The separation between vertical bores value is the center-to-center distance between adjacent bores.

**Note:** For the modeling time period, ten years is used as a standard length of time for the ground temperature to stabilize, although longer time periods may be entered if desired.

#### STEP 5.5

For this demo project, input the following values:

- Number of Rows Across: **10**
- Number of Rows Down: **2**
- Borehole Separation: **20 ft**
- Bores per Parallel Circuit: **1**

After we finish our initial design and determine what our total pipe and drilling requirements are, we will be able to come back to this screen and modify the input values.

#### STEP 5.6

Now click on the U-Tube tab. The screen will look like this:



### U-Tube Information



The U-Tube panel contains information related to the pipe and bore. The main purpose of the panel is to obtain a value for the borehole thermal resistance. The thermal resistance calculation takes into account the pipe parameters and positioning, the borehole diameter, and the grout thermal conductivity. If desired, an experimentally determined value of the borehole resistance also may be entered into the textbox, which then overrides all calculations. **Note:** By pressing the ‘Check Pipe Tables’ button, the ‘Pipe Properties’ tables will open.

**Note:** The radial pipe placement can be one of the following:

- **Close together** - 1/8” average distance between the pipes
- **Average** - pipes are centered at a point halfway between the wall and the center of the bore
- **Along outer wall** - pipes are along the outer wall as is the case when Geoclips™ are used in the installation process

***Note::** The ‘Double’ U-tube configuration at this stage is added more for reference than for practical use. Currently, the values Ground Loop Design uses are based on experimental data and a new theoretical model accounting for a lower pipe and convective resistance, and a larger displacement of the grout. Designers should be aware of this fact, and remember that a ‘single’ U-tube is the standard option.*

**STEP 5.7**

In this demo, input the following values:

- Pipe Size: **1 in**
- Pipe Type: **SDR11**
- Flow Type: **Turbulent**
- Radial Pipe Placement: **Average**
- U-tube Configuration: **Single**
- Borehole Diameter: **5.00 in**
- Thermal Conductivity: **1.0**

Notice that the borehole thermal resistance changes automatically as you modify the pipe size and the thermal conductivity. After we complete the initial design we will return to this panel to modify other parameters.

**STEP 5.8**

Now please click on the Soil tabbed panel. You should see the following screen:

The screenshot shows a software window titled "Borehole Design Project #1" with a menu bar containing "Calculate", "Fluid", "Soil", "U-Tube", "Pattern", "Extra kW", and "Information". The "Soil" tab is active, displaying "Soil Temperatures and Properties". Under this heading, there is a section for "Undisturbed Ground Temperature" with a text box containing "62.0" and a unit label "°F". Below that is a section for "Soil Thermal Properties" with two text boxes: "Thermal Conductivity: 1.30 Btu/(h\*ft\*°F)" and "Thermal Diffusivity: 0.75 ft^2/day". At the bottom of this section are two buttons: "Diffusivity Calculator" and "Check Soil Tables".

Soil Panel



Input parameters relating to the soil are located in the Soil panel, as shown above. These include the average ground temperature and the soil thermal properties. Since thermal conductivity has a particularly large effect on the bore length calculations, it should be determined with care through *in-situ* tests or comparisons with other projects installed in the local vicinity.

## Diffusivity Calculator

For the designer's assistance, Ground Loop Design includes a *Diffusivity Calculator* that can be used to determine the actual diffusivity if all the soil parameters are known. To access the calculator, click on the Diffusivity Calculator button located near the bottom of the Soil tabbed panel.

### STEP 5.9

For this demo, input the following values into the Soil panel:

- Ground Temperature: **58<sup>0</sup>F**
- Thermal Conductivity: **1.22**
- Thermal Diffusivity: **0.75**

### STEP 5.10

Now we are ready for the Fluid panel. Please click on the Fluid tab. Your screen will look like this:

The screenshot shows a software window titled "Borehole Design Project #1" with a menu bar containing "Calculate", "Fluid", "Soil", "U-Tube", "Pattern", "Extra kW", and "Information". The "Fluid" tab is selected. The interface is organized into three main sections:

- Fluid Temperatures and Flow Rate:** Contains two input fields for "Design Heat Pump Inlet Fluid Temperatures". The "Cooling" field is set to 85.0 °F and the "Heating" field is set to 50.0 °F.
- Design System Flow Rate:** Contains one input field for "Flow Rate" set to 3.0 gpm/ton.
- Solution Properties:** Contains three input fields: "Fluid Type" (set to 100% Water), "Specific Heat (Cp)" (set to 1.00 Btu/(°F\*lbm)), and "Density (rho)" (set to 62.4 lb/ft<sup>3</sup>). A "Check Fluid Tables" button is positioned below these fields.

Fluid Panel

The circulating fluid parameters may be entered in the *Fluid* panel.

**Note:** The system flow rate per installed ton is included on the *Fluid* panel. *This is the system flow rate per ton of peak load, not installed capacity* (This is because it is assumed that all units will not be running at full load simultaneously, even in the peak load condition).

**Note:** GLD is a modular program meaning that the program consists of several modules that work together to assist you with your designs. The fluids panel offers one of the most obvious examples of how the different modules communicate with one another. Take a look at the Average Block Loads module once again. Notice that the flow rate and the unit inlet temperatures at the bottom of the Average Block Loads Module match those of the Fluids panel.

Change the cooling inlet temperature in the Fluids panel to 90°F. Then, click your mouse pointer anywhere inside the Average Block Loads Module. The Average Block Loads module cooling inlet temperature automatically updates itself along with the pump performance characteristics. This connectivity saves designers much time. This feature is especially useful when designers are using the Zone Manager Loads module (Chapter 3 in the User Manual). While this feature is a tremendous time-saver, the new **calculated equipment capacities can lead to changes in selected equipment so the designer must be aware of the changes.** Customized pump values must be manually adjusted.

***Note:** Since solution properties vary considerably and non-linearly with type and percentage of additive, Ground Loop Design does not include detailed automatic antifreeze information. Generalized tables of data may be found in the ‘Fluid Properties’ tables. The data in these tables are from IGSHPA manuals and the CRC engineering handbook. The designer must manually enter the desired values in the input text boxes.*

#### STEP 5.11

For this demo, input the following values into the Fluid panel:

- Cooling Inlet Temperature: **90°F**
  - Heating Inlet Temperature: **50°F**
  - Fluid Type: **10% Methanol**
- Note:** Click on the Check Fluid Properties button found at the bottom of the Fluid panel and select Table I (Densities and Specific Heats for Various Solutions) to find the following values for a 10% methanol solution:
- Specific Heat: **1.022**
  - Density: **56.448**

#### STEP 5.12

We are now ready to perform our initial calculation. Click on the Calculate tab to open the Calculate panel. Then, click on the Calculate button. Your screen should look something like this:

Calculate | Fluid | Soil | U-Tube | Pattern | Extra kW | Information

Calculation of Required Bore Lengths

Calculate

	COOLING	HEATING
Total Length (ft):	<b>10829.0</b>	7934.3
Borehole Number:	<b>20</b>	20
Borehole Length (ft):	<b>541.5</b>	396.7
Ground Temperature Change (°F):	<b>+3.0</b>	+4.1
Unit Inlet (°F):	<b>90.0</b>	50.0
Unit Outlet (°F):	<b>101.2</b>	43.4
Total Unit Capacity (MBtu/Hr):	<b>593.7</b>	624.3
Peak Load (MBtu/Hr):	<b>552.1</b>	410.0
Peak Demand (kW):	<b>50.5</b>	31.5
Heat Pump EER/COP:	<b>11.6</b>	4.2
System EER/COP:	<b>10.9</b>	3.8
System Flow Rate (gpm):	<b>138.0</b>	102.5

Optional Cooling Tower

Condenser Capacity (MBtu/hr):	0.0	0 %
Cooling Tower Flow Rate (gpm):	0.0	
Cooling Range (°F):	10.0	
Annual Operating Hours (hr/yr):	0	Load Balance

The Initial Calculation



All results for both the heating and the cooling calculations can be viewed at any time on the Calculate panel. After all data has been entered or any changes have been made, the user can calculate interim or final results using the Calculate button. The two lists on the Calculate panel are for heating and cooling. Although all of the numbers shown are valid and respond to changes, the side with the longer required length is printed in bold type so that it stands out.

The “Optional Cooling Tower” section is included to assist in the sizing of a cooling tower. This is a convenient tool for hybrid-type designs, which may be desirable when the cooling length exceeds that of heating.

**STEP 5.13**

In this demo, the heat exchanger is cooling dominated (as expected from the loads data). Notice that there are 20 boreholes (in the Pattern panel we specified a 10x2 grid arrangement) and that each borehole is about 550 feet long. We now will quickly optimize the design.

In this demo we do not want to drill deeper than 300 feet and we have access to a large parking lot and field for drilling. Click on the Pattern panel again and change the grid arrangement by modifying the following data:

- Number of Rows Down: **7**
- Number of Rows Down: **4**
- Separation Between Boreholes: **22 ft**

**STEP 5.14**

Now go back to the Calculate panel and click on the Calculate button. The individual borehole length has dropped to about 390 feet. Since we increased the number of boreholes, we cut the individual borehole depth. Furthermore, by increasing the spacing between boreholes, we continue to maintain a long-term ground temperature change of approximately 3°F. However, since we have not reached our 300 foot goal, more optimization is required.

**STEP 5.15**

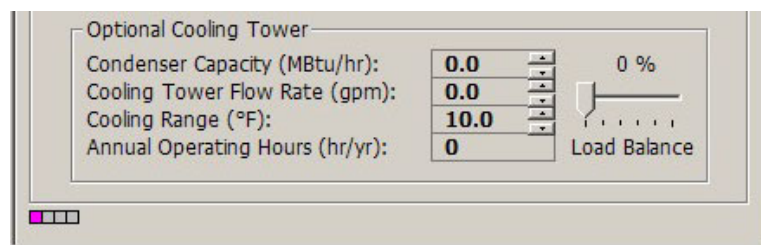
Click on the U-Tube panel. Change the following inputs:

- Radial Pipe Placement: **Along Outer Wall**

Go back to the Calculate panel and calculate again. Each borehole should be down to approximately 350 feet in length.

**STEP 5.16**

From here, there are a number of ways to continue optimizing the system. In the final step of this demonstration, we will assume the designer wants to add a cooling tower. The cooling tower must have a large enough capacity so that individual boreholes are no longer than 300 feet deep. With GLD, this calculation is straightforward. Click on the Calculate panel and look at the bottom of the panel.



### Optimizing the Cooling Tower

On the right side of the Optional Cooling Tower section notice that there is a Load Balance at 0%. Begin dragging the balance to the right. As you do so, notice what happens to the cooling-side length. Keep dragging the

balance to the right until you reach an individual borehole length that is below 300 feet. Your screen will look something like this:

The screenshot shows a software window titled "Borehole Design Project - demo" with a menu bar containing "Calculate", "Fluid", "Soil", "U-Tube", "Pattern", "Extra kW", and "Information". The main area is titled "Calculation of Required Bore Lengths" and contains a "Calculate" button and a table of results for COOLING and HEATING. Below the table is an "Optional Cooling Tower" section with input fields and a slider for "Load Balance".

	COOLING	HEATING
Total Length (ft):	8182.2	7735.1
Borehole Number:	28	28
Borehole Length (ft):	292.2	276.3
Ground Temperature Change (°F):	+3.2	+3.4
Unit Inlet (°F):	90.0	50.0
Unit Outlet (°F):	101.2	43.4
Total Unit Capacity (MBtu/Hr):	593.7	624.3
Peak Load (MBtu/Hr):	552.1	410.0
Peak Demand (kW):	50.5	31.5
Heat Pump EER/COP:	11.6	4.2
System EER/COP:	10.9	3.8
System Flow Rate (gpm):	138.0	102.5

Optional Cooling Tower

Condenser Capacity (MBtu/hr):	143.0	20 %
Cooling Tower Flow Rate (gpm):	30.9	
Cooling Range (°F):	10.0	
Annual Operating Hours (hr/yr):	1559	Load Balance

### Cooling Tower Decreases Drilling Requirements

With a 20% load balance in the cooling tower and 28 boreholes, each borehole is now 292 feet long. The cooling tower performance characteristics also can be found at the bottom of the screen.



Notice that at the 300 ft bore length, the total required pipe lengths for cooling and heating are almost the same. This is also reflected in the similarity of the reported long term ground temperature changes. In a perfectly balanced system, the lengths and ground temperature changes for cooling and heating are identical. This balance point represents the maximum cooling tower capacity that could be added (maximum reduction of pipe length required for cooling) while still having enough installed pipe to fully satisfy the heating requirement. In this example, the actual balance point occurs at a Load Balance of about 22%, with a long term temperature change prediction of about +3.2 degrees Fahrenheit.



The last step now is to incorporate the extra kW requirements for the cooling tower into the design.

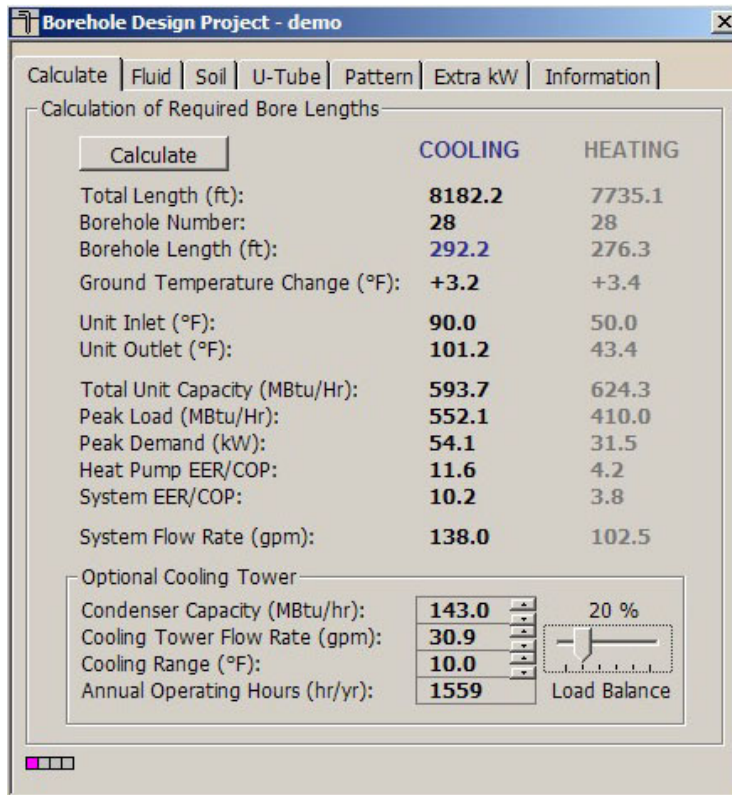
**STEP 5.17**

Click on the Extra kW panel and modify the Optional Cooling Tower pump and fan power requirements. These values will be used to calculate overall system COP (which can be found on the Calculate panel). Modify the following values:

- Cooling Tower Pump Power: **2.0hP**
- Cooling Tower Pump Motor Efficiency: **85%**
- Cooling Tower Fan Power: **2.0hP**
- Cooling Tower Fan Motor Efficiency: **85%**

**STEP 5.18**

This is the final step. Go back to the Calculate screen and calculate the updated results. You will notice when you hit the calculate button, the Cooling Tower load balance returns to 0%. Find a load balance that brings each borehole down to a 300 ft depth. After you do that, your design is complete. Congratulations! Your calculate screen should look like this now:



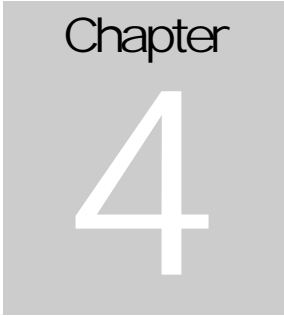
demo continues on page 39

The Design is Complete



**Note:** Notice that the System EER (COP) is adjusted to reflect the additional energy required by the cooling tower pumps

**Summary:** In this chapter, we learned how to link the loads and heat exchanger modules, how to input heat exchanger design parameters and how to optimize a design by modifying parameters (including hybrid cooling tower parameters). GLD also contains Horizontal and Surface Water Design modules (explained in Chapters 5 and 6 in the User Manual) which you can use in the same way as the Vertical Borehole module. In the next chapter we will show you how to print reports and email project files as well as how to begin taking advantage of some of the more powerful GLD features.



# Reports And Design Tips

Whether you have finished your design and want to send customized reports to vendors, clients and colleagues or need to collaborate on a design with a coworker halfway around the world, GLD offers a variety of communication tools to help you work effectively. In this final chapter, we will show you how to choose and print reports, how to email project files so that colleagues can review, modify or approve designs, and how to take advantage of a few of the many other features that GLD offers.



## Reports

At any step in the design process, you can choose to print out a variety of reports including five types of loads/zone reports and two types of heat exchanger reports.

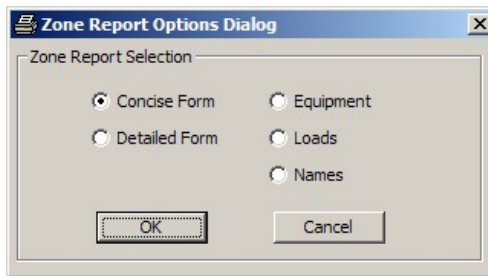


Step 6

**STEP 6.0**

## Zone Reports

You should still have the Average Block Loads module open. At the top of the module you will see a print icon. Click on it and a dialog box will open that looks like this:



Loads Report Choices

Zone (or loads) reports include only the project information and data from the zones. Five different zone reports exist, containing complete or specific information about the zones. Zone reports are representative of the actual installation rather than the heat exchanger portion of the system. There five different zone report choices include:

- **Concise Form:** Contains important info about loads and operational parameters of equipment
- **Detailed Form:** Contains all info for every zone and a full explanation of the listed parameters
- **Equipment List:** Contains the equipment for each zone. This report is ideal for engineers or contractors who require only equipment details
- **Loads List:** Contains the loads at different times in the day for each zone.
- **Names List:** Contains the full reference names of every zone, the zone number and pump information. This report is useful for when a project has many zones

**STEP 6.1**

Explore the different reports and print one out. Notice that the project information you entered in the Information panel of the Borehole Design module appears in all the reports.

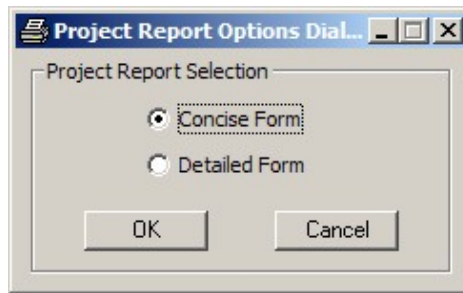


Step 7

**STEP 7.0**

## Project Reports

Now look at the row of icons at the top of the GLD program. Find the print icon and press it (if you cannot click on the print icon, first click the mouse within the Borehole Design module window). This is what you will see:



Project Report Options

The two different project reports include:

- **Concise Form:** Contains essential project info while excluding comments
- **Detailed Form:** Contains full project info

**STEP 7.1**

Choose to print a detailed form and take a look at it.

## Sharing Project Files With Colleagues

GLD saves **zone** files (from the Loads modules) and **project** files (from the heat exchanger files) separately. Colleagues that use GLD can receive these files as email attachments and view/modify the project designs and/or the loads data. Below is a brief description of the two types of files.

### Zone Files

Zone (loads) files are stored as \*.zon files in the Ground Loop Design ‘zones’ directory. They have a general format that can be read into any loads module, and they **can be used simultaneously** in different design modules.

### Project Files

GLD saves project files as \*.gld files in the Ground Loop Design ‘work files’ directory. Each project file type (vertical borehole, horizontal, surface water) has a specific format that GLD automatically recognizes.

### Sharing Files

GLD expects to find the files in the following folders:

**Zone files:** Program Files/Gaia Geothermal/Ground Loop Design/Zones

**Project Files:** Program Files/Gaia Geothermal/Ground Loop Design/Work Files

When you send or receive files, confirm that the files are in the appropriate directories before trying to open them within the program.

**Note:** GLD is available in foreign languages (contact your distributor for more information). If you are working with clients or coworkers in other countries, you can just email your files to them and they will be able to read the files in their native language. Geexchange designs can be complex. In our increasingly interconnected world, you can use GLD to

minimize the risk of communication problems while working in multiple languages.

## Design Tips

Congratulations! You now know enough about GLD to begin designing world-class projects with efficiency and ease. Below you will find a list of suggestions for further exploration and design success:

- After inputting loads and selecting pumps in a loads module, open up two new heat exchanger design modules. Click on one design module to activate it and then click on the link button. Then, click on the other design module to activate it and once again click on the link button. Now, both design modules are linked to the same loads data. Now you can compare two designs at the same time.
- If you have data in only metric units, but want to work in English units (or vice versa), click the English/metric units conversion button. Enter the data in the units you have and when you are done, click the conversion button again. Now all your data is in the format with which you want to work. You can also print out reports in different units following the same procedure.
- With the Zone Manager Loads module (see the User Manual, chapter 3) you choose heat pumps in several different ways: a) select a manufacturer and let GLD do the sizing work for every zone; b) select different manufacturers for each zone and let GLD size them; c) manually select manufacturers and pumps for non-standard applications; d) combine methods a, b and c.
- Compare and contrast different manufacturers and heat pumps. Finish a complete design, print out a report, and then change which manufacturer(s)/pump(s) you are using. Print out another report and compare.
- Using the Heat Pump Module (User Manual, chapter 2), input data for a brand new heat pump, confirm that you input the data properly via the test function and then create a design with the new pump.
- In the Zone Manager Loads module there is a summary view button that allows users to quickly look at all the zone data simultaneously. The summary button looks like this:



and can be found in the middle of the row of icons at the top of the Zone Manager. This is useful when you want to quickly review all the work you have done on a multi-zone installation.

- GLD comes complete with a full set of reference files including Fluid Properties, Soil Properties, Pipe Properties and Unit Conversions. These files can be accessed from the Tables dropdown menu found at the top of GLD. These files are HTML-based and can be modified, customized or added to by the user using a text editor or HTML editor. More information about customizing these files can be found in Chapter 7 of the User Manual.
- GLD contains a searchable database of information about the program. Click on the Help dropdown menu and choose help.
- GLD stores and models heat pump information in the Heat Pumps module. This can be accessed via the HeatPumps drop down menu found at the top of the program. GLD stores individual heat pump data in \*.**hpd** files. If you enter data for a new heat pump, it will be saved in the Ground Loop Design '**pumps**' directory. You can email these small \*.**hpd** files to coworkers or other users of GLD. They can then put the file in their '**pumps**' folder and begin using the pumps. More information can be found in the Preface and Chapter 2 of the User Manual.

## Concluding Remarks

If you have questions about or suggestions for the program, please contact your distributor. Do you need a particular design feature that GLD does not currently offer? Let us know and we will do our best to include it in future versions. Thank you for choosing Ground Loop Design.