Sound Geothermal Corporation

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GEOEXCHANGE
Comfort from the ground up

December 19, 2013

Mr. Jacob Cain
Energy
Manager
Weber State
University 2601
University Circle
Ogden, UT 84408-2601
jacobcain@weber.edu

Re: Weber State University – Thermal Conductivity Test Report

Dear Mr. Cain,

This report contains drilling data, thermal conductivity data, and an analysis of the test boreholes completed on the Weber State University campus in Ogden, Utah. Three test boreholes were drilled on this site: borehole (BH) #1 near the northeast corner of the parking lot W-5, borehole #2 near the southwest corner of parking lot W-5, and borehole #3 near the southern side of parking lot A-2 (see attached map for approximate locations).

Borehole #1 Drilling Summary: BH#1 was drilled through landslide deposits and Lake Bonneville sediments (valley fill) from the surface to 280 feet. The upper zone from the surface to 140 feet included sand, silt, and clay with some gravel; drilling proceeded quickly through this zone. The zone from 140 to 280 feet consisted of layers of clay and gravel. In places the gravel appeared to be weakly cemented. Drilling slowed in this material. At 280 feet solid Tintic Quartzite was encountered; this very hard rock drilled slowly. Since the drilling speeds encountered would not be conducive to economical production drilling, it was decided to stop drilling and load the borehole at 350 feet. No significant lost circulation was noted while drilling. BH#1 was drilled with 5-1/4" carbide button bits. The 1.25" HDPE earthloop was inserted to 338 feet and would not go deeper. It was difficult to run the tremie in this bore, likely due to swelling clay layers. BH#1 was grouted from bottom to surface; it appears that there was minimal grout loss to the formation.

Borehole #2 Drilling Summary: BH#2 was drilled through landslide deposits and Lake Bonneville sediments (valley fill) from the surface to 318 feet. This zone included sandy clay and gravel to 70 feet, clay and silt from 70 to 160 feet, and layers of clay, silt, and gravel from 160 to 318 feet. Drilling proceeded relatively quickly to 318 feet with no issues. At 318 feet hard white Tintic Quartzite pebble gravel was encountered. Drilling in this zone was difficult and slow. It was decided to stop drilling and load the borehole at 355 feet. No significant lost circulation was noted while drilling. BH#2 was drilled with a 5-5/8" carbide button bit. It was difficult to run the loop and tremie in this bore, likely due to swelling clay layers. After multiple attempts, the 1.25" HDPE earthloop was inserted to 354 feet. The tremie would not go past 50 feet. Based on grout volume calculations, it appears that grout went to the bottom of the bore and there was minimal grout lost to the formation, but since the tremie did not go to bottom this cannot be determined with certainty. For this reason it was determined to conduct the TC test for lot W-5 on BH#1.

Thermal Conductivity Testing: Two thermal conductivity tests were conducted on the site from December 10-12, 2013. In Lot W-5 Borehole #1 was selected for testing due to the fact that the grout tremie went to bottom, ensuring proper grout placement. The single borehole in Lot A-2, BH#3, was also tested.

> **BH#1:** The thermal conductivity (TC) was very high for the Wasatch Front, **1.71 btu/hr-ft-°F** (vs. 1.0 btu/hr-ft-°F average). The diffusivity value calculated from the test was **1.20 ft^2/day**. The deep earth temperature range was **55.7°F – 57.4°F**, toward the higher end of the normal range for the Wasatch Front. *Note: if it is decided to optimize bore length to avoid the quartzite, then we suggest using a more conservative TC design value of 1.18 btu/hr-ft-°F for Lot W-5. Without further testing it cannot be determined how much of the higher TC value is due to the quartzite.*
>
> **BH#3:** The thermal conductivity (TC) was above average for the Wasatch Front, **1.18 btu/hr-ft-°F** (vs. 1.0 btu/hr-ft-°F average). The diffusivity value calculated from the test was **0.77 ft^2/day**. The deep earth temperature range was **56.2°F – 57.8°F**, consistent with the first test. The full thermal conductivity analysis for both bores is enclosed.

In summary, we would characterize the drilling on this site as favorable. Drilling speeds encountered should enable economical production drilling, provided the Tintic Quartzite and deep gravels are avoided. The thermal conductivity of both tested boreholes is better than average, and native temperature is within the expected range. Our conclusion is that this site is suitable for GeoExchange. We suggest that bore depth be optimized to suit the geologic conditions of each designated borefield, and that the more conservative TC value of **1.18 btu/hr-ft-°F** be used for both sites evaluated. More detailed evaluation of the specific configuration should take place during the ground heat exchanger design process. Due to the significant variations in site geology discovered in these test bores, we recommend that TC test(s) be conducted in each area (parking lot, etc.) considered for future ground heat exchanger installation to confirm optimal depth and thermal performance.

We will e-mail a consolidated report consisting of this cover letter, the drilling logs, and the TC test results. This package should be used as part of the drilling bid package in order to facilitate the bid process. We will also append this consolidated report to the loopfield specifications.

We will be happy to provide electronic or hard copies as needed, or forward this report at your request. If you have any questions, please call. Thank you for using Sound Geothermal testing and design services. We will look forward to working with you as your plans for the campus develop.

Sincerely,

David N. Eckels

Enclosures: TC Bore Map, TC Drilling Logs, FTC Test & Data Analysis

CC: File

WEBER STATE UNIVERSITY – THERMAL CONDUCTIVITY TEST BOREHOLE LOCATIONS

Drilled 11/25/2013 to 12/2/2013, left fusion capped as of 12/12/2013

Approximate Locations (hand held GPS WGS84)	
BH1	41°11'39.16"N, 111°56'17.53"W
BH2	41°11'35.72"N, 111°56'23.98"W
BH3	41°11'39.66"N, 111°56'35.22"W

Sound Geothermal Corporation

DRILLING LOG - Test Borehole

Weber State University
Ogden, UT

Geothermal Soil Analysis

DRILLING LOG - Test Borehole #1
11/25/2013 -
11/26/2013

Location: Legal S3 T5N R1W SLBM
GPS WGS84 41°11'39.16"N, 111°56'17.53"W
Elevation 4756' (GPS)

Approx. Address: Near NE Corner of Parking Lot W-5
Near E3850 & Edvalson St.
Weber State University
Ogden, UT 84403

Driller: Glenn Henderson - Bertram Drilling
State License #: 712
Rig: #84 - Midway
Drilling Fluid: Mud - Cetco Super Gel X
Loop: Centennial 1010' x 1.25" DR-11 HDPE U-Bend
Grout: Geo Pro Thermal Grout Lite & Select 0.88 (1:4 Mix)
SPUD/TD: 11/25/2013 10:50 / 11/26/2013 14:52
Spud with: 5-1/4" Carbide Button Bit - Used, moderate condition (surface bit)
Surface Water: None

Joints on rig: 24 x 20'
1 x 10' stabilizer
Length of Kelly: 20'
Total Reach: 510'

NOTE: Time gaps represent connections or unrelated activity.

Time Start	Time End	Activity	Duration	Depth (Ft.) From	Depth (Ft.) To		Comments
11/25/2013							
10:30	10:50						Rig up, Mix 1.5 sx mud
10:50	10:57	D	0:07	0	10		Asphalt, road base, gravel
							Add 10' stabilizer, change to new 5-1/4" Button Bit
							Ream 0-10'
11:02	11:06	D	0:04	10	20	Silt, Clay, Sand, Gravel	70% coarse tan sand, 30% M angular multicolored gravel
11:06	11:10	D	0:04	20	30		AA
11:13	11:21	D	0:08	30	40		50% tan silty sand, 50% S-M gravel
11:21	11:28	D	0:07	40	50		Layers of fine silt & S gravel
11:30	11:39	D	0:09	50	60		AA
11:39	11:50	D	0:11	60	70		AA more clay
11:52	11:57	D	0:05	70	80		Fine silt, tr clay, tr gravel
11:57	12:02	D	0:05	80	90		AA
12:03	12:07	D	0:04	90	100		Fine silt, 20% clay, tr S gravel
12:07	12:13	D	0:06	100	110		AA
12:14	12:19	D	0:05	110	120		AA
12:19	12:30	D	0:11	120	130		Silty tan clay with coarse sand
12:32	12:43	D	0:11	130	140		AA
12:46	13:06	D	0:20	140	150	Layers of Gravel and Clay	Tan clay, tr silt, crs. Sand; harder 146-150' quartz gravel
13:08	13:28	D	0:20	150	160		150-156: Hard gravel, multicol. quartz, possibly cemented
							156-160: layers tan clay & gravel
13:28	13:46	D	0:18	160	170		Layers tan clay & hard gravel
13:48	14:01	D	0:13	170	180		AA
14:01	14:27	D	0:26	180	190		Tan clay w/ layers hard L gravel
14:30	14:39	D	0:09	190	200		AA more clay
14:39	14:54	D	0:15	200	210		Layers clay & S gravel
14:56	15:14	D	0:18	210	220		AA
15:14	15:35	D	0:21	220	230		AA
15:37	15:54	D	0:17	230	240		AA
15:54	16:20	D	0:26	240	250		AA harder

DRILLING LOG - Test Borehole

Weber State University
Ogden, UT

Geothermal Soil Analysis

DRILLING LOG - Test Borehole #2
11/27/2013 -
11/29/2013

Location: Legal S3 T5N R1W SLBM
GPS WGS84 41°11'35.72"N, 111°56'23.98"W
Elevation 4747' (GPS)

Approx. Address: SW side of Parking Lot W-5
Near 4004 Taylor Ave.
Weber State University
Ogden, UT 84403

Driller: Glenn Henderson - Bertram Drilling
State License #: 712
Rig: #84 - Midway
Drilling Fluid: Mud - Cetco Super Gel X
Loop: Centennial 810' x 1.25" DR-11 HDPE U-Bend
Grout: Geo Pro Thermal Grout Lite & Select 0.88 (1:4 Mix)
SPUD/TD: 11/27/2013 9:55 / 11/27/2013 15:43
Spud with: 5-5/8" Carbide Button Bit - Used, good condition
Surface Water: None

Joints on rig: 24 x 20'
1 x 10' stabilizer
Length of Kelly: 20'
Total Reach: 510'

NOTE: Time gaps represent connections or unrelated activity.

Time Start	Time End	Activity	Duration	Depth (Ft.) From	Depth (Ft.) To		Comments
11/29/2013							
	9:55						Rig up, Mix 1.5 sx mud
9:55	9:59	D	0:04	0	10		Asphalt, road base (gravel, sandy clay)
9:59	10:05	D	0:06	10	20	Sandy Clay, Gvl	Gravel in tan sandy clay; more gravel 14-15'
10:09	10:15	D	0:06	20	30		70% Red tan sandy clay, 30% S-M angular gravel
10:15	10:21	D	0:06	30	40		AA tr larger gravel
10:23	10:27	D	0:04	40	50		90% red-tan sandy clay, 10% gravel
10:27	10:31	D	0:04	50	60		90% red-tan sandy clay, 10% coarse sand, tr gravel
10:33	10:36	D	0:03	60	70		Red-tan clay, tr sand, large cuttings
10:36	10:40	D	0:04	70	80	Clay, Silt	Gray-brown clay, tr sand
10:44	10:47	D	0:03	80	90		AA
10:49	10:53	D	0:04	90	100		AA
10:55	10:57	D	0:02	100	110		Fine silt, few cuttings
10:57	10:59	D	0:02	110	120		AA
11:01	11:04	D	0:03	120	130		Gray-brown clay, tr gravel
11:04	11:08	D	0:04	130	140		AA
11:10	11:15	D	0:05	140	150		Fine silt, tr clay
11:15	11:19	D	0:04	150	160		AA
11:20	11:26	D	0:06	160	170	Clay, Silt, Gravel	Light brown silty clay, tr S gravel
11:26	11:32	D	0:06	170	180		AA
11:34	11:40	D	0:06	180	190		Silt, tr sandy clay, crs sand
11:40	11:53	D	0:13	190	200		AA
11:55	12:01	D	0:06	200	210		Layers of hard gravel & light brown clay
12:01	12:08	D	0:07	210	220		Silt
12:10	12:15	D	0:05	220	230		AA, tr clay
12:15	12:23	D	0:08	230	240		Layers of gravel & light brown silty & clay
12:25	12:31	D	0:06	240	250		AA

DRILLING LOG - Test Borehole

Weber State University
Ogden, UT

Geothermal Soil Analysis

DRILLING LOG - Test Borehole #3
11/29/2013 -
12/2/2013

Location: Legal S3 T5N R1W SLBM
GPS WGS84 41°11'39.66"N, 111°56'35.22"W
Elevation 4668' (GPS)

Approx. Address: South side of Parking Lot A-2
N of Elizabeth Hall
Weber State University
Ogden, UT 84403

Driller: Glenn Henderson - Bertram Drilling
State License #: 712
Rig: #84 - Midway
Drilling Fluid: Mud - Cetco Super Gel X
Loop: Centennial 810' x 1.25" DR-11 HDPE U-Bend
Grout: Geo Pro Thermal Grout Lite - various sand ratios - see notes below.
SPUD/TD: 11/29/2013 14:44 / 11/30/2013 12:43
Spud with: 5-1/4" Carbide Button Bit - Used, good condition
Surface Water: None

Joints on rig: 24 x 20'
1 x 10' stabilizer
Length of Kelly: 20'
Total Reach: 510'

NOTE: Time gaps represent connections or unrelated activity.

Time Start	Time End	Activity	Duration	Depth (Ft.) From	Depth (Ft.) To		Comments
11/29/2013							
14:00	14:44						Rig up, Mix 1.5 sx mud
14:44	14:50	D	0:06	0	10		0-5' Roadbase; 5-10' brown clay w/ gravel layers
14:50	14:56	D	0:06	10	20	Clay, Silty Clay	Red-brown clay
							Add 10' stabilizer
15:04	15:08	D	0:04	20	30		Brown clay
15:10	15:12	D	0:02	30	40		AA
15:12	15:19	D	0:07	40	50		AA (add polymer)
15:21	15:24	D	0:03	50	60		AA
15:24	15:28	D	0:04	60	70		AA
15:30	15:34	D	0:04	70	80		AA
15:34	15:38	D	0:04	80	90		AA
15:40	15:44	D	0:04	90	100		Brown silty clay, tr gravel
15:44	15:48	D	0:04	100	110		AA
15:50	15:53	D	0:03	110	120		AA
15:53	15:57	D	0:04	120	130		AA
15:58	16:02	D	0:04	130	140		AA
16:02	16:07	D	0:05	140	150		AA
16:08	16:12	D	0:04	150	160		AA
16:12	16:17	D	0:05	160	170		AA
							POOH - SDFN
11/30/2013							Change to new 5-1/4" Carbide Button Bit
8:30	8:44						RIH - tight from 50' down (swelling clays)
8:44	8:50	D	0:06	170	180		AA (Brown silty clay, tr gravel)
8:50	8:56	D	0:06	180	190	Gravel Layer	AA w/ hard multicolored gravel layer 184-186'
8:59	9:07	D	0:08	190	200		Green silty clay w/ several water-bearing hard gravel layers
9:07	9:24	D	0:17	200	210		Green & tan silty clay w/ gravel layers (b&w granite in gvl)
9:26	9:35	D	0:09	210	220		Green & tan silty clay w/ larger gravel layers (including qtz)
9:35	9:46	D	0:11	220	230		Tan clay tr green, with gravel layers
9:48	9:52	D	0:04	230	240		Fine silt, tr clay & gravel
9:52	9:59	D	0:07	240	250		AA

Geothermal Soil Analysis

LEGEND

Colors:

blk - black
blu - blue
brn - brown
bu - buff
clr - clear
crm - cream
gn - green
gry - gray
pk - pink
rd - red
tn - tan
trnsl - translucent
wh - white
yel - yellow

Descriptors:

ang - angular
cmt - cement
crs - coarse
dk - dark
f - fine
frm - firm
hd - hard
L - Large
lt - light
M - Medium
mtrx - matrix
S - Small
sbang - sub angular
sft - soft
tr - trace
uncons - unconsolidated

Lithology:

bas - basalt
bdl - boulder
cbl - cobble
cche - caliche
cgl - conglomerate
cl - clay
dol - dolomite
grt - granite
grv - gravel
ls - limestone
qtz - quartzite
sd - sand
sh - shale
slt - silt
slts - siltstone
ss - sandstone
volc - volcanics

Drilling:

AA - As Above
PU - Pick Up
POOH - Pull out of hole
RIH - Run in hole
RU - Rig Up
SDFN - Shut down for night
SX - Sack(s)
TD - Total Depth

Executive Summary

A formation thermal conductivity test was performed on Test Borehole #1 at Weber State University in Ogden, Utah with a GPS location of N 41° 11' 39.16" (latitude), W 111° 56' 17.53" (longitude). The vertical bore was completed on November 27, 2013 by Bertram Drilling, Inc. Geothermal Resource Technologies' (GRTI) test unit was attached to the vertical bore on the afternoon of December 10, 2013.

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

Formation Thermal Conductivity = 1.71 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

Formation Thermal Diffusivity = 1.20 ft^2/day

The undisturbed formation temperature for the tested bore was established from the initial loop temperature data collected at startup.

Undisturbed Formation Temperature = 55.7-57.4°F

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length. Additional questions concerning the use of these results are discussed in the frequently asked question (FAQ) section at www.grti.com.

Data Analysis

Geothermal Resource Technologies, Inc. (GRTI) uses the "line source" method of data analysis to determine the thermal conductivity of the formation. The line source method assumes an infinitely thin line source of heat in a continuous medium. A plot of the late-time temperature rise of the line source temperature versus the natural log of elapsed time will follow a linear trend. The linear slope is inversely proportional to the thermal conductivity of the medium. If a u-bend grouted in a borehole is used to inject heat into the ground at a constant rate in order to determine the average formation thermal conductivity, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that approximately ten hours is required to allow the error of early test times and the effects of finite borehole dimensions to become insignificant.

In order to analyze real data from a formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger is plotted versus the natural log of elapsed testing time. Using the Method of Least Squares, linear equation coefficients to produce a line that fits the data are calculated. This procedure is normally repeated for various time intervals to ensure that variations in the power or other effects are not producing inaccurate results.

The calculated results are based on test bore information submitted by the driller/testing agency. GRTI is not responsible for inaccuracies in the results due to erroneous bore information. All data analysis is performed by personnel that have an engineering degree from an accredited university with a background in heat transfer and experience with line source theory. The test results apply specifically to the tested bore. Additional bores at the site may have significantly different results depending upon variations in geology and hydrology.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. If desired, please contact GRTI and a copy of the data will be made available in either a hard copy or electronic format.

Contact: Galen Streich
Regional Managing
Engineer Elkton, SD
(605) 692-9069
gstreich@grti.com

Thermal Conductivity Test Data

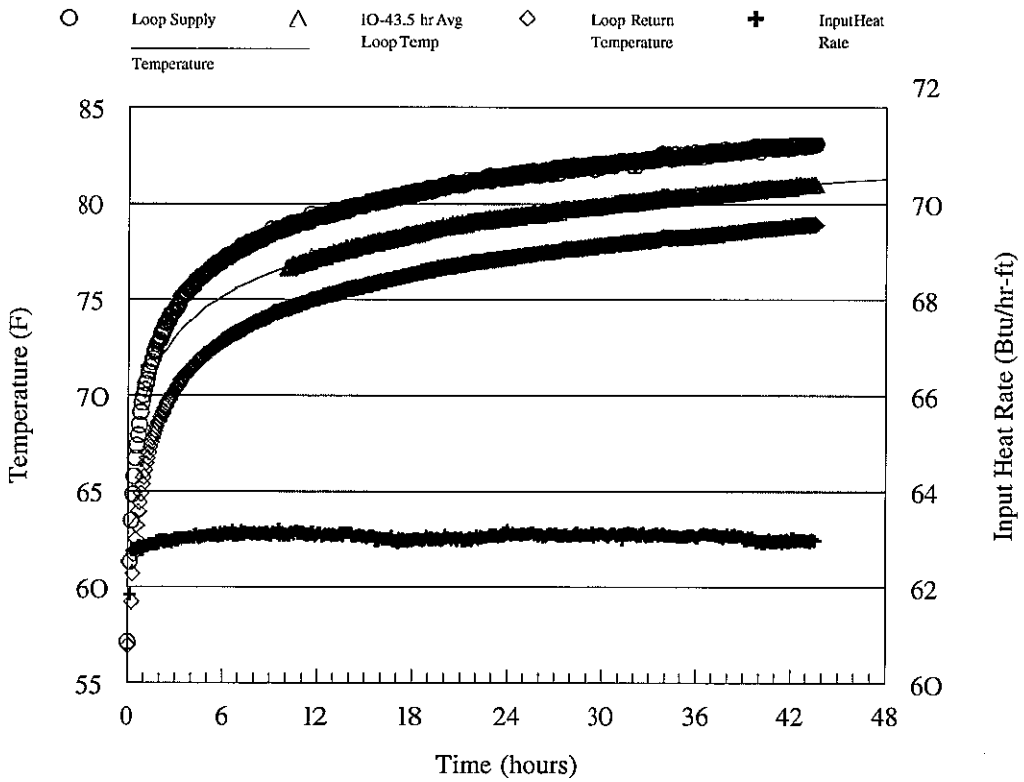

Fig. 1" Temperature & Heat Rate vs Time

Figure 1 above shows the loop temperature and heat input rate data versus the elapsed time of the test. The temperature of the fluid supplied to and returning from the U-bend are plotted on theleft axis, while the amount of heat supplied to the fluid is plotted on the right axis on a per foot of bore basis. In the test statistics below, calculations on the power data were performed over the analysis time period listed in the Line Source Data Analysis section.

Summary Test Results

Test Date_____December 10-12, 2013 Undisturbed Formation Temperature_Approx. 55.7-57.4°F
Duration_____43.5 hr
Average Voltage_____240.5 V
Average Heat Input Rate_____21,307 Btu/hr (6,243 W) Avg Heat Input Rate per Foot of Bore_63.0 Btu/hr-ft (18.5 W/ft) Calculated Circulator Flow Rate___10.1 gpm
Standard Deviation of Power_____0.09%
Maximum Variation in Power_____0.22%

Thermal Diffusivity

The reported drilling log for this test borehole indicated that the formation consisted of clay, silt, sand, gravel and quartzite. A heat capacity value for quartzite was calculated from specific heat and density values listed by Kavanaugh and Rafferty (Ground-Source Heat Pumps - Design of Geothermal Systems for Commercial and Institutional Buildings, ASHRAE, 1997). A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 34.2 Btu/ft^3-°F for the formation. A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be **1.20 ft^2/day**.

FORMATION THERMAL CONDUCTIVITY
TEST & DATA ANALYSIS

Test Location

Weber State University
Test Borehole #3 Ogden, UT
Near South Side of
Parking Lot A-2

Test Date

December 10-12, 2013

Analysis For

Sound Geothermal Corporation
3962 East Alpine Valley Circle
Sandy, UT84O92
Phone,, 8O1-942-6lOO
Fax,, 8O1-942-6127

Test Performed by

Sound Geothermal Corporation

Test Procedures

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published recommended procedures for performing formation thermal conductivity tests in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter. The International Ground Source Heat Pump Association (IGSHPA) also lists test procedures in their Design and Installation Standards. GRTI's test procedures meet or exceed those recommended by ASHRAE and IGSHPA, with the specific procedures described below,,

Grouting Procedure for Test Loops – To ensure against bridging and voids, it is recommended that the bore annulus is uniformly grouted from the bottom to the top via tremie pipe.

Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended for bores that are air drilled, and a minimum waiting period of two days for mud rotary drilling.

Undisturbed Formation Temperature Measurement – The undisturbed formation temperature should be determined by recording the loop temperature as the water returns from the u-bend at test startup.

Required Test Duration – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours.

Data Acquisition Frequency - Test data is recorded at five minute intervals.

Equipment Calibration/Accuracy – Transducers and datalogger are calibrated permanufacturer recommendations. Manufacturer stated accuracy of power transducers is less than ±2%. Temperature sensor accuracy is periodically checked via ice water bath.

Power Quality – The standard deviation of the power should be less than or equal to 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power.

Input Heat Rate – The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of installed bore depth to best simulate the expected peak loads on the u-bend.

Insulation – GRTI's equipment has 1 inch of foam insulation on the FTC unit and 1/2 inch of insulation on the hose kit connection. An additional 2 inches of insulation is provided for both the FTC unit and loop connections by insulating blankets.

Retesting in the Event of Failure – In the event that a test fails prematurely, a retest may not be performed until the bore temperature is within 0.5°F of the original undisturbed formation temperature or until a period of 14 days has elapsed.

Test Bore Details

(As Provided by Sound Geothermal Corporation)

Site Name	Test Borehole #3 Weber State
University Location	Ogden, UT
Driller	Bertram Drilling,
Inc. Installed Date	December 3, 2013
Borehole Diameter	5 1/4 inches
U-Bend Size	1 1/4 inch DR-11
HDPE U-Bend Depth Below Grade	401 ft
Grout Type	GeoPro Thermal Grout Lite
Grout Solids	2 units at 4:1 sand to bentonite ratio 6 units at 2:1 sand to bentonite ratio 27 units with no sand

Drill Log

Formation Description	Depth (FT)
Road base	0'-5'
Brown clay with gravel layers	5'-10'
Red-brown clay	L0'-20'
Brown clay	20'-90'
Brown silty clay, trace gravel	90'-184'
Hard gravel layer	184'-186'
Silty clay w/several water bearing hard gravel layers	186'-200'
Silty clay with gravel layers	200'-210'
Silty clay with larger gravel layers	210'-220'
Tan clay with gravel layers	220'-230'
Fine silt, trace clay and gravel	230'-260'
Fine silt, less clay, more gravel	260'-406'
Multicolored gravel	406'-410'
Mostly black gravel, thin green clay layers	410'-428'

Line Source Data Analysis

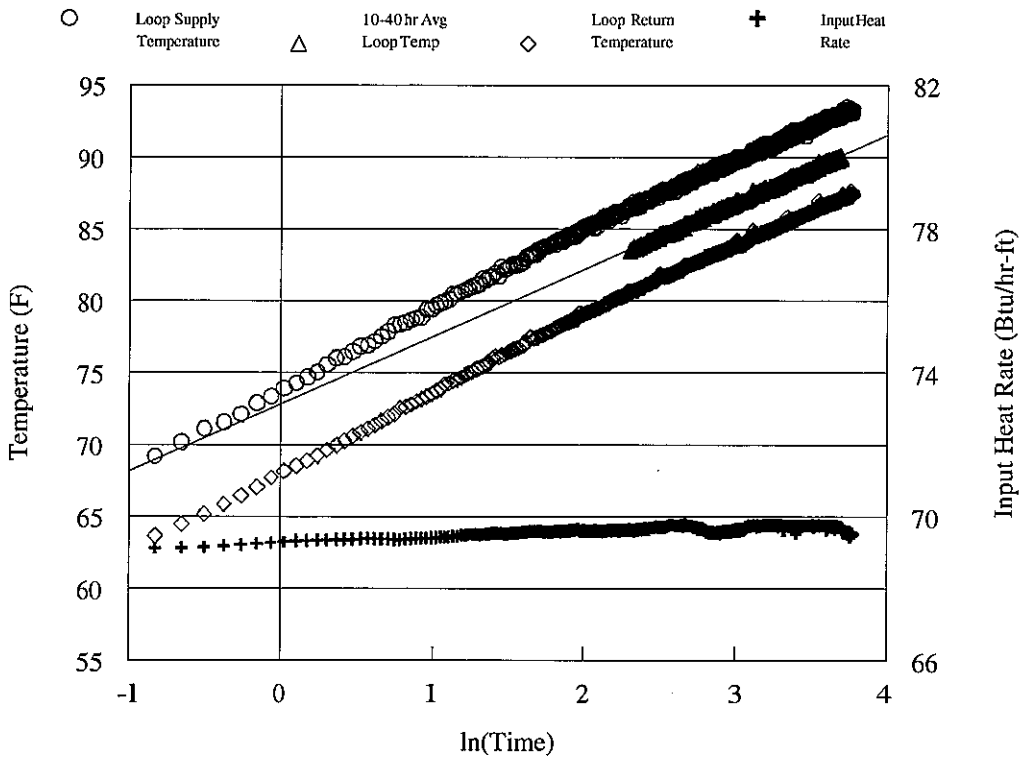

Fig. 2: Temperature & Heat Rate vs Natural Log of Time

The loop temperature and input heat rate data versus the natural log of elapsed time are shown above in Figure 2. The temperature versus time data was analyzed using the line source method (see page 3) in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 40.0 hr.
The slope of the curve fit was found to be 4.69. The resulting thermal conductivity was found to be **1.18 Btu/hr-ft-ºF**.

Certificate of Calibration

GRTI maintains calibration of the datalogger, current transducer and voltage transducer on a biannual schedule per the manufacturers recommendations. The components are calibrated bythe manufacturer using recognized national or international measurement standards such as those maintained by the National Institute of Standards and Technology (NIST).

FTC Unit 226

DA Unit 42

Primary Equipment		
Component	Last Calibration Date	Calibration Due Date
Datalogger	6/5/2013	6/5/2015
Current Transducer	6/10/2013	6/10/2015
Voltage Transducer	6/10/2013	6/10/2015

GRTI periodically verifies the combined temperature sensor/datalogger accuracy via a water bath. Temperature readings are simultaneously taken with a digital thermometer that has been calibrated using instruments traceable to NIST.

[illegible]	7/22/2013			
[illegible]	31.7 31.7 31.8			
[illegible]	31.9 31.9 31.9			
[illegible]	31.8 31.8 31.9			
[illegible]	31.9 31.9 31.9			
[illegible]	32.0 32.0 32.0			