

Geo-Connections, Inc.

GSHP Design Report

Project: First LoopLink Project
Prepared: 26-Jul-2010

Prepared By: Doug Carruthers



John Doe
1102 Lincoln Lane
Boston, Massachusetts 02101
888-888-8888

26-Jul-2010

RE: GSHP System Design Report for First LoopLink Project

System Loads

System Loads or Peak Loads are calculated based on a variety of details for an individual residence. Assumed occupancy levels, the number of appliances operating, the number of doors & windows and the tightness of the construction all contribute to the amount of energy required to maintain the thermostat set points given the historical extreme weather conditions in your area.

The peak loads used in this report were provided as listed in the following table.

Zone	Heating Load	Cooling Load (Sensible)	Zone SHF
Entire House	36,000 Btu/hr	32,400 Btu/hr	0.900

Equipment Schedule (Heating)

Based on the provided loads, the recommended heat pump schedule for this system is as follows:

Zone	GSHP	Heating Cap.	% Sizing	Water Flow (GPM)	Air Flow (CFM)
Entire House	Waterfurnace - Envision NS048 (ECM)	37,200	103.3	12.0	1,500
		-	-		

Equipment Schedule (Cooling)

Based on the provided loads, the recommended heat pump schedule for this system is as follows:

Zone	GSHP	Sensible Cap.	% Oversizing	Water Flow (GPM)	Air Flow (CFM)
Entire House	Waterfurnace - Envision NS048 (ECM)	35,475	9.5	12.0	1,500
		-	-		

Entire House

Zone Details

The peak loads for each individual zone are used to calculate the total amount of heating & cooling capacity required for a space based on the set points and the climate data for your area.

Peak Heating Load 36,000 Btu/hr

Peak Cooling Load 36,000 Btu/hr

Heating Set Point 70 °F

Cooling Set Point 75 °F

Space SHF 0.900

GSHP Selection

The ground source heat pump below has been selected to maintain comfortable heating & cooling for this zone.

Manufacturer Waterfurnace

Model Envision NS048 (ECM)

Heat Pump Type Water to Air

Capacity Single

Heat Pumps 1

Installed Capacity Check

The installed capacity check describes the efficiency and total heating/cooling capacity of the selected ground source heat pump system. This information is used to ensure proper sizing of equipment based on the load represented by this zone.

Heating

Heating Capacity 37,200 Btu/hr

% Sizing 103.3%

Installed COP 3.76

Cooling

~~47,300~~ Cooling Capacity 47,300 Btu/hr

Sensible Cooling Capacity 35,475 Btu/hr

% Oversizing 9.5%

Installed EER 15.46

Entire House

Zone Operating Summary

The Zone Operating Summary describes equipment runtime and the total annual power consumption for the GSHP operating in this zone.

Heating

High Capacity Runtime 1,626 hrs
Resistance Heat Runtime 17 hrs

Heat Pump Energy Use 4,909 kWh
Resistance Heat Energy Use 28 kWh
Pumping Energy Use 304 kWh

Cooling

High Capacity Runtime 576 hrs

Heat Pump Energy Use 1,560 kWh
Pumping Energy Use 107 kWh

GSHP Operating Cost Breakdown for Zone Name

Based on the annual power consumption of the system and the price per kilowatt hour in your area the estimated cost to maintain the set points for this zone are as follows:

Heating

HP Operating Cost \$589.14
Resistance Heat Operating Cost \$3.45
Pumping Cost \$36.53

Total Cost \$629.12

Cooling

HP Operating Cost \$187.25
Pumping Cost \$12.94

Total Cost \$200.19

Vertical Bore 1

Earth Temperature Data Location

Deep earth (below 20ft) temperature is a function of the average annual air temperature in your region and remains relatively constant regardless of season.

Deep Earth Temp (T_G) 52.0 °F

Formation Details

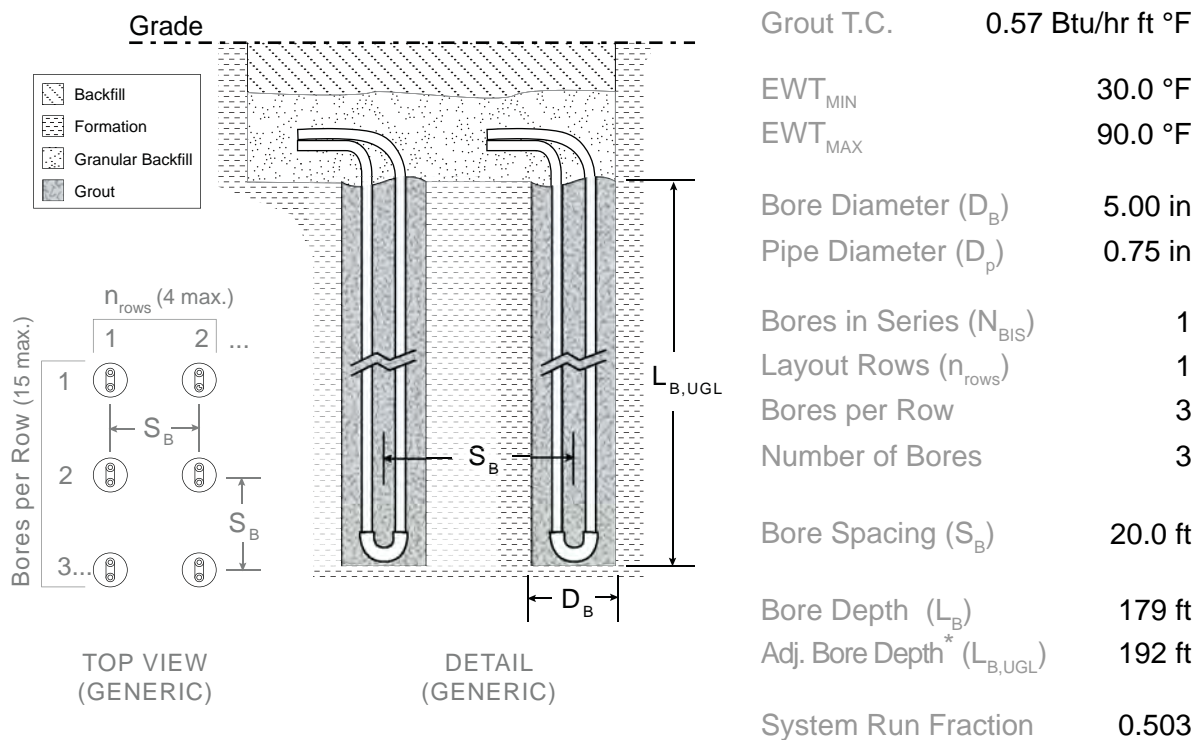
The thermal properties of your formation are based on the formation's composition and have a direct impact on the scale of your loopfield.

Thermal Conductivity 1.30 Btu/hr ft °F

GHEX Summary

Heating is dominant

Grout is used inside of all bores in order to protect the deep earth environment from surface contaminants and to provide a more effective contact surface with GHEX piping that optimizes heat transfer between the fluid pumped through your GSHP and the earth.

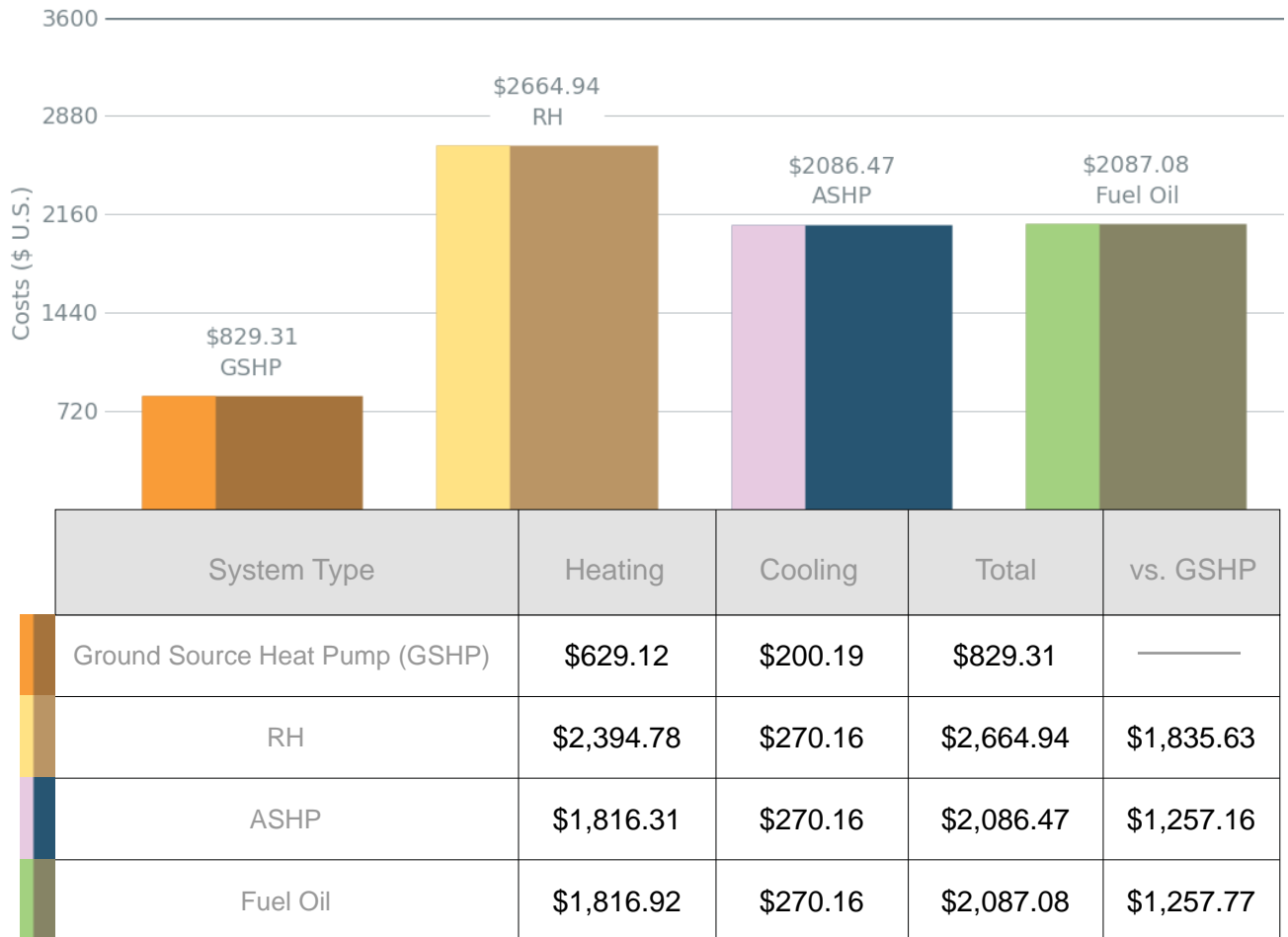


*Adj. Bore Depth is the adjusted bore depth. This is the depth of bore that should be used to accommodate unbalanced ground loads over time.

Economics: Operating Cost Summary

Actual costs and savings may vary from those reported. The methods of calculation and the data used are designed to approximate the total cost and savings of the GSHP system based on the weather conditions for an average year in your area. Additionally, the assumed rates of inflation and the unit prices for energy are subject to change according to the economy and your energy provider.

Annual Operating Cost by Technology



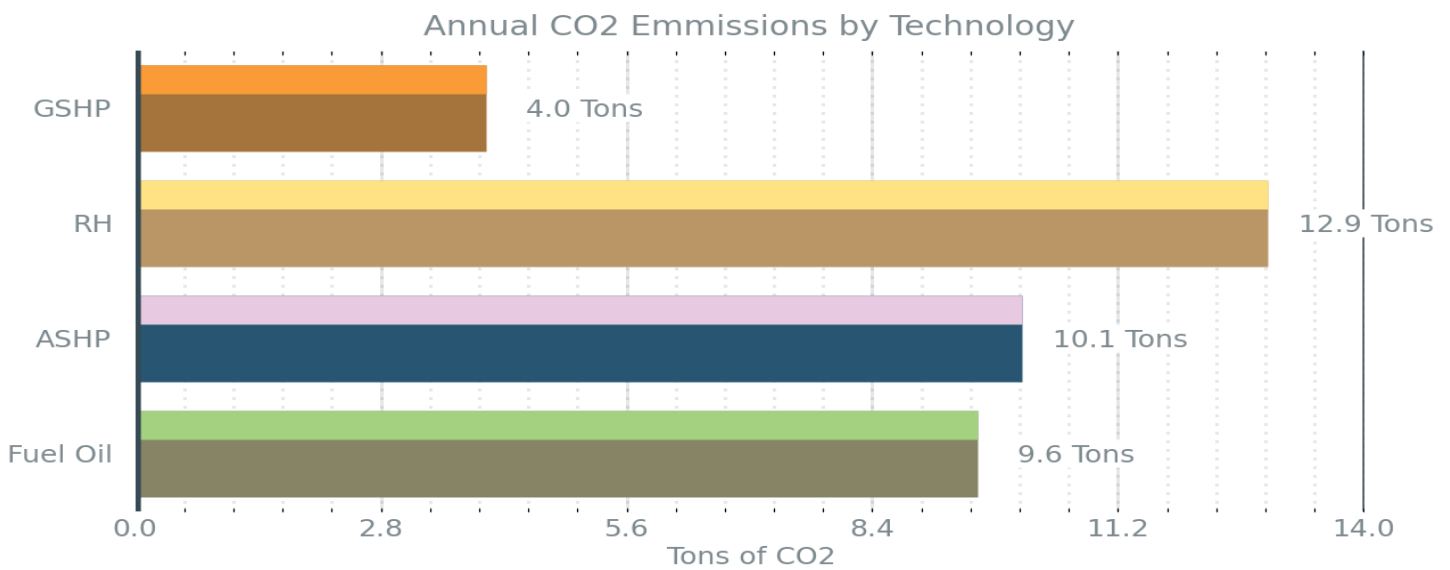
Economics: Operating Cost Summary

Annual CO2 Emissions by Technology

Geothermal heat pumps generate NO DIRECT EMISSIONS however, even “green” heating and cooling technologies like GSHPs produce “upstream” carbon emissions. The amount of these emissions depends on the power generation method in your area.

In areas where the primary power generation technology is nuclear, hydroelectric, wind turbine or solar, the upstream carbon emissions are minimal. However, the majority of the power in the United States is generated by coal fired power plants which emit a relatively higher volume of CO₂.

The emissions shown in the graph below are adjusted based on the mix of power generation methods in your region. Note that for natural gas, propane and fuel oil, only the point of use carbon emissions from the combustion of the fuel is considered not the upstream emissions resulting from their production.



Economics: Cost of Ownership

Actual costs and savings may vary from those reported. The methods of calculation and the data used are designed to approximate the total cost and savings of the GSHP system based on the weather conditions for an average year in your area. Additionally, the assumed rates of inflation and the unit prices for energy are subject to change according to the economy and your energy provider.

Comparative System

Conventional Heating & Cooling System Fuel Oil Furnace w/ A/C

Mortgage Details

Home Purchase Price \$450,000.00

Mortgage Interest Rate 5.000%

Down Payment \$90,000.00

Term 30 years

Conventional vs. GSHP

Based on the details of your mortgage, a reasonable operating cost comparison between a properly sized and installed GSHP system and a conventional system may be made.

Fuel Oil Furnace w/ A/C

Total Mortgage \$360,000.00

Monthly Payment \$1,932.56
(P&I only)

Fuel Inflation Rate 4.5%

Installation Cost \$15,000.00

Incentives \$0.00

Actual Cost \$15,000.00

AFUE 80.00

SEER 12.00

GSHP

Total Mortgage \$376,500.00

Monthly Payment \$2,021.13
(P&I only)

Electric Inflation Rate 3.0%

Installation Cost \$45,000.00

Incentives \$13,500.00

Actual Cost \$31,500.00

Avg. COP 3.81

Avg. EER 16.19

Economics: Cost of Ownership

GSHP Savings Overview

Monthly Operating Cost Savings \$104.81

Incremental Mortgage Payment \$88.58

Monthly Savings from GSHP \$16.24

Total Savings (After 30 Years) \$58,915.31

Simple Payback

GSHP Install Cost \$31,500.00	—	Conventional Install Cost \$15,000.00
Conventional Operating Cost \$2,087.08	—	GSHP Operating Cost \$829.31

⇒ $\frac{\$16,500.00}{\$1,257.72} =$ Simple Payback Period 13.1 years

Life Cycle Cost

Using the information in this section, the cost of replacing a system according to its estimated life cycle has been added to the calculation of the system cost. In other words, the cost of purchasing and installing new equipment each time an old system has reached the end of its life is compounded in to the overall cost. This is why the price spikes on the cost of ownership graph.

Fuel Oil Furnace w/ A/C

Service Life 14 years

Equipment Cost 65%
(% of Original)

Loan Interest Rate 8.000%

Loan Term 0 years

Down Payment

GSHP

Service Life 28 years

Equipment Cost 35%
(% of Original)

Loan Interest Rate 8.000%

Loan Term 0 years

Down Payment

30 Year Cost of Ownership: GSHP

Year	Purchase Price	+	Operating Cost	=	Ownership Cost	Year	Purchase Price	+	Operating Cost	=	Ownership Cost
1	\$7,714.87		\$829.31		\$8,544.18	16	\$1,637.70		\$1,292.04		\$2,929.74
2	\$1,637.70		\$854.19		\$2,491.89	17	\$1,637.70		\$1,330.80		\$2,968.50
3	\$1,637.70		\$879.81		\$2,517.52	18	\$1,637.70		\$1,370.72		\$3,008.42
4	\$1,637.70		\$906.21		\$2,543.91	19	\$1,637.70		\$1,411.84		\$3,049.54
5	\$1,637.70		\$933.40		\$2,571.10	20	\$1,637.70		\$1,454.20		\$3,091.90
6	\$1,637.70		\$961.40		\$2,599.10	21	\$1,637.70		\$1,497.83		\$3,135.53
7	\$1,637.70		\$990.24		\$2,627.94	22	\$1,637.70		\$1,542.76		\$3,180.46
8	\$1,637.70		\$1,019.95		\$2,657.65	23	\$1,637.70		\$1,589.04		\$3,226.74
9	\$1,637.70		\$1,050.55		\$2,688.25	24	\$1,637.70		\$1,636.72		\$3,274.42
10	\$1,637.70		\$1,082.06		\$2,719.76	25	\$1,637.70		\$1,685.82		\$3,323.52
11	\$1,637.70		\$1,114.52		\$2,752.22	26	\$1,637.70		\$1,736.39		\$3,374.09
12	\$1,637.70		\$1,147.96		\$2,785.66	27	\$1,637.70		\$1,788.48		\$3,426.18
13	\$1,637.70		\$1,182.40		\$2,820.10	28	\$1,637.70		\$1,842.14		\$3,479.84
14	\$1,637.70		\$1,217.87		\$2,855.57	29	\$42,905.41		\$1,897.40		\$44,802.81
15	\$1,637.70		\$1,254.41		\$2,892.11	30	\$1,637.70		\$1,954.32		\$3,592.02
Total Cost Over 30 Years											\$135,930.65

30 Year Cost of Ownership: Fuel Oil Furnace w/ A/C

Year	Purchase Price	+	Operating Cost	=	Ownership Cost	Year	Purchase Price	+	Operating Cost	=	Ownership Cost
1	\$3,773.02		\$2,087.08		\$5,860.10	16	\$773.02		\$4,039.09		\$4,812.11
2	\$773.02		\$2,181.00		\$2,954.02	17	\$773.02		\$4,220.85		\$4,993.87
3	\$773.02		\$2,279.14		\$3,052.17	18	\$773.02		\$4,410.79		\$5,183.81
4	\$773.02		\$2,381.70		\$3,154.73	19	\$773.02		\$4,609.27		\$5,382.30
5	\$773.02		\$2,488.88		\$3,261.91	20	\$773.02		\$4,816.69		\$5,589.71
6	\$773.02		\$2,600.88		\$3,373.91	21	\$773.02		\$5,033.44		\$5,806.46
7	\$773.02		\$2,717.92		\$3,490.95	22	\$773.02		\$5,259.94		\$6,032.97
8	\$773.02		\$2,840.23		\$3,613.25	23	\$773.02		\$5,496.64		\$6,269.67
9	\$773.02		\$2,968.04		\$3,741.06	24	\$773.02		\$5,743.99		\$6,517.02
10	\$773.02		\$3,101.60		\$3,874.62	25	\$773.02		\$6,002.47		\$6,775.49
11	\$773.02		\$3,241.17		\$4,014.20	26	\$773.02		\$6,272.58		\$7,045.61
12	\$773.02		\$3,387.02		\$4,160.05	27	\$773.02		\$6,554.85		\$7,327.87
13	\$773.02		\$3,539.44		\$4,312.46	28	\$773.02		\$6,849.82		\$7,622.84
14	\$773.02		\$3,698.72		\$4,471.74	29	\$26,319.70		\$7,158.06		\$33,477.76
15	\$16,555.30		\$3,865.16		\$20,420.45	30	\$773.02		\$7,480.17		\$8,253.19
Total Cost Over 30 Years											\$194,846.30

Economics: Cost of Ownership

Cost of Ownership: Conventional vs. GSHP

The cost of ownership is a sum of operating costs and loan payments over the estimated 30 year life of a GSHP system including initial costs and fuel inflation rates. The figures represented in the graph below and the following tables assume that both systems are running at their peak efficiency throughout the full 30 year span.

