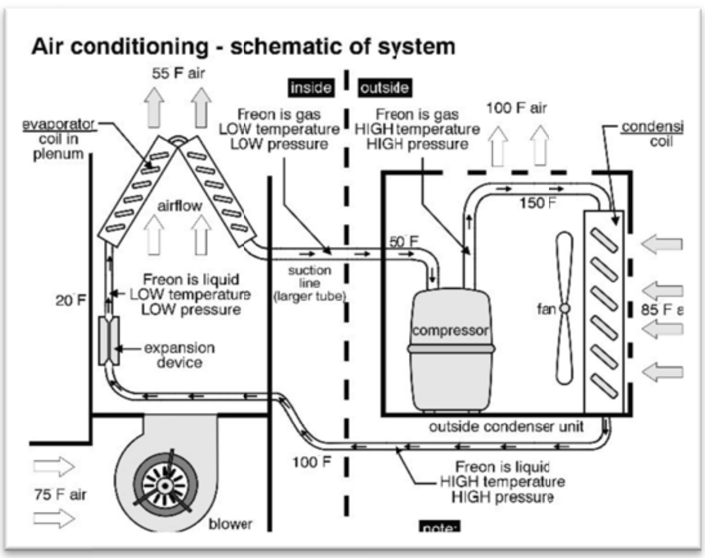
THESIS PROPOSAL [REVISED]

Due Date: January 18, 2011

The Mirenda Center for Sports, Spirituality, and Character Development



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Executive Summary

The purpose of this proposal is to clearly explain the scope of the redesign project of The Mirenda Center – The new sports facility has room for improvement due to electric costs being $150,000 per year. The existing mechanical system has been evaluated and alternatives will be explored.

The Mirenda Center is a 72,000 gross square foot building, and is cooled by the six roof top air handling units. The roof units have a total of (28) ¾ hp fans, which consume up to 30% of the annual electric energy per year. The proposed thesis will investigate a geothermal heat rejection system in place of the air cooled condensing system. This could potentially reduce the yearly electric consumption.

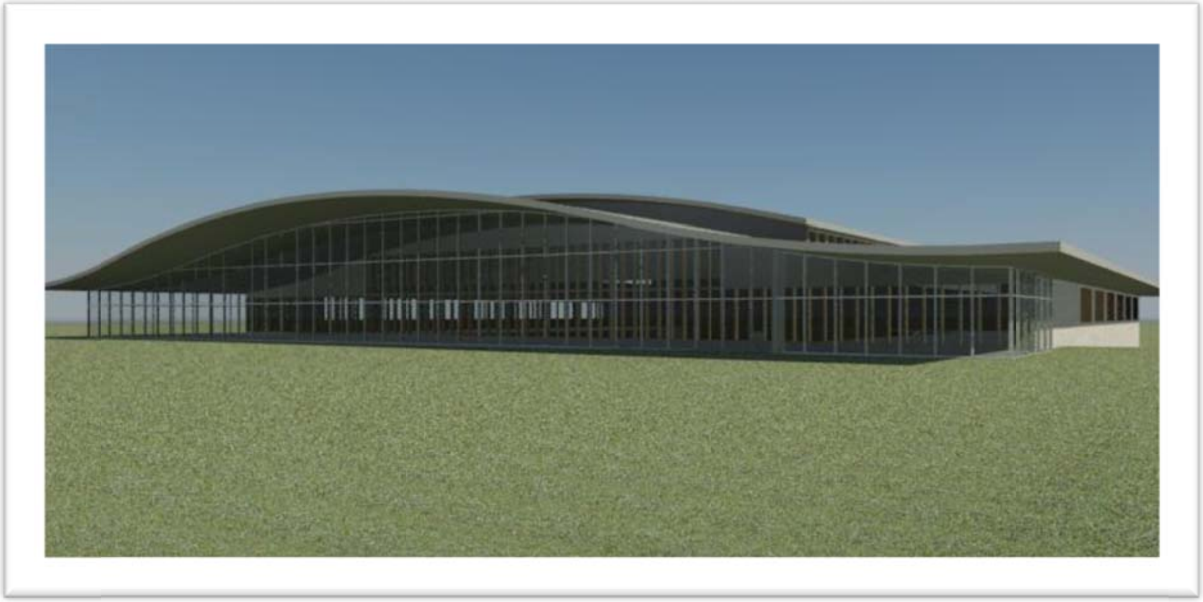
Ground study of the existing soccer field will be calculated to determine the adequacy of the geothermal system. The ground study will determine the length of piping needed to achieve the heating load of 1727.8 MBh and cooling load of 318.5 tons which equates to 3822 MBh.

Aside from the Depth of this paper there will be (2) Breadth Studies performed. They will be a combined effort to reclaim the lost space due to the large ceiling heights. A mezzanine level will be designed in the main entryway behind the architectural columns. This space will require a structural analysis, lighting analysis, and inedibility will also require code analysis for conformity. The overall goal will be to increase the square footage of the building to utilize the already conditioned air, which will increase efficiency of the building as a whole.

The actual occupancy use of the building as a whole may be sporadic, however once the building is in occupied mode the mechanical equipment must be in operation at all times. Thus the economics of installing a geothermal system are justified.

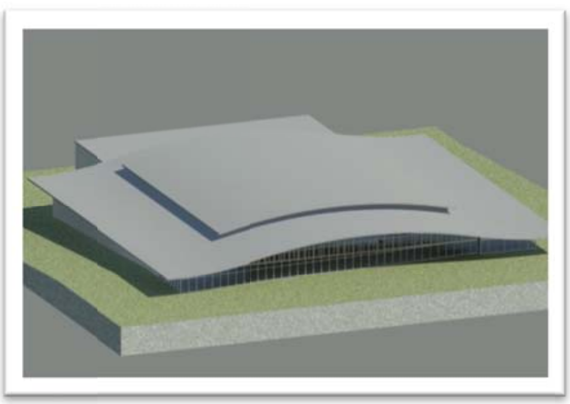
General Building Overview

The Mirenda Center for Sports, Spirituality, and Character Development (CSSCD) is a two story building. The ground floor entrance is at the second level in the front of the building, while the lower level is underground at the front of the building while the sloping topography brings the lower level to exit at ground level in the rear of the building. See Exploded View on following page.

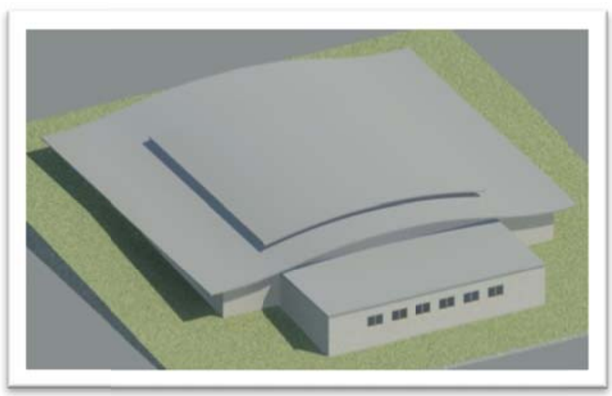


Orthogonal View

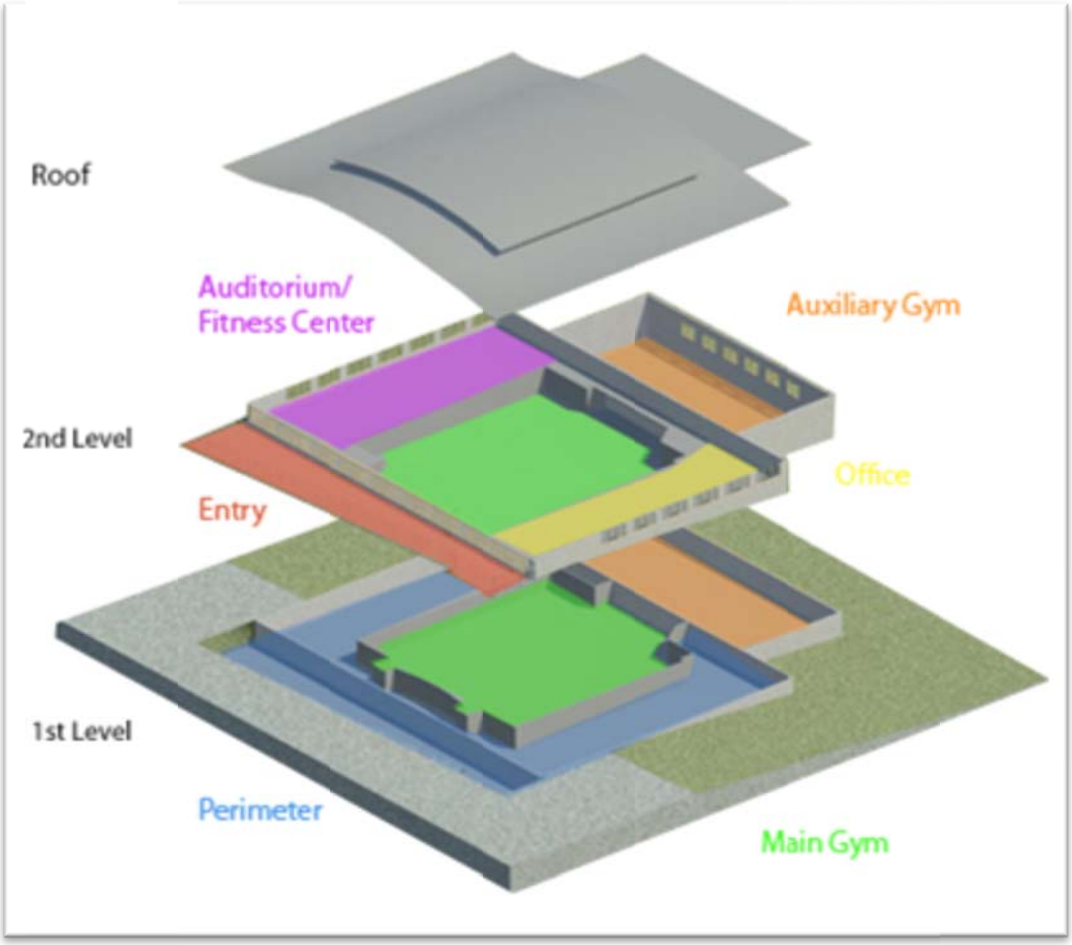
The core of the building is the main gymnasium that seats up to 1450 spectators at the lower level. Wrapped around the main gym at the second level is an indoor running track. The outer most perimeter is as follows: Offices on the east side, Auxiliary gym on the north side, multipurpose and fitness center on the west side, and open glazed atrium on the south side. See Exploded View on following page.



Front View



Rear View



Exploded View

Mechanical System Overview

The Mirenda Center is primarily heated and cooled by 6 roof top air handling units; their location is above the auxiliary gym. RTU-5&6 serve the main gymnasium and the indoor running track in unison. RTU-3 & 4 serve only the auxiliary gym. RTU-1 and 2 serve the remaining perimeter spaces: the auditorium and fitness center, the offices, and entry. There is natural gas burners for heating of the RTU's and reheats for each zone in the constant air volume boxes. There is also electric resistant strip heat around the perimeter of the building. This electric resistance heat is primarily to keep condensation from forming on the glazing. Auxiliary Gym requires 41 tons of cooling, Main gymnasium requires 152.4 tons of cooling, and the perimeter system requires 125.1 tons of cooling. Auxiliary Gym requires 571.0MBh of heating, Main gymnasium requires 575.9 MBh of heating, and the perimeter system requires 580.9MBh of heating.

Statement of the Problem

The annual cost of the DX-Roof Top Air Handling units is significant, approximately $150,000 per year for cooling mode and $7000 per for heating mode. The problem is that the electric utility costs for are expensive, which drive the cost of cooling up. The Mirenda Center could take advantage of the 52 °F ground temperature for free cooling with a geothermal cooling system. This system will be explored.

Actual Building Utility Bills				
Dates -Period		Gas	Elect	Total
Begin	End			
9-Oct	9-Nov			$ -
9-Nov	9-Dec	$ 1,243.05	$ 16,233.99	$ 17,477.04
9-Dec	10-Jan	$ 2,689.61	$ 19,324.49	$ 22,014.10
10-Jan	10-Feb			$ -
10-Feb	10-Mar	$ 1,604.17	$ 19,914.08	$ 21,518.25
10-Mar	10-Apr	$ 496.22	$ 15,785.64	$ 16,281.86
10-Apr	10-May	$ 381.76	$ 16,102.70	$ 16,484.46
10-May	10-Jun			$ -
10-Jun	10-Jul	$ 135.66	$ 23,146.23	$ 23,281.89
10-Jul	10-Aug	$ 137.94	$ 21,885.70	$ 22,023.64
10-Aug	10-Sep			$ -
10-Sep	10-Oct	$ 279.69	$ 18,036.99	$ 18,316.68
	Totals	$ 6,968.10	$ 150,429.82	$ 157,397.92

Proposed Solution(s) of the Problem

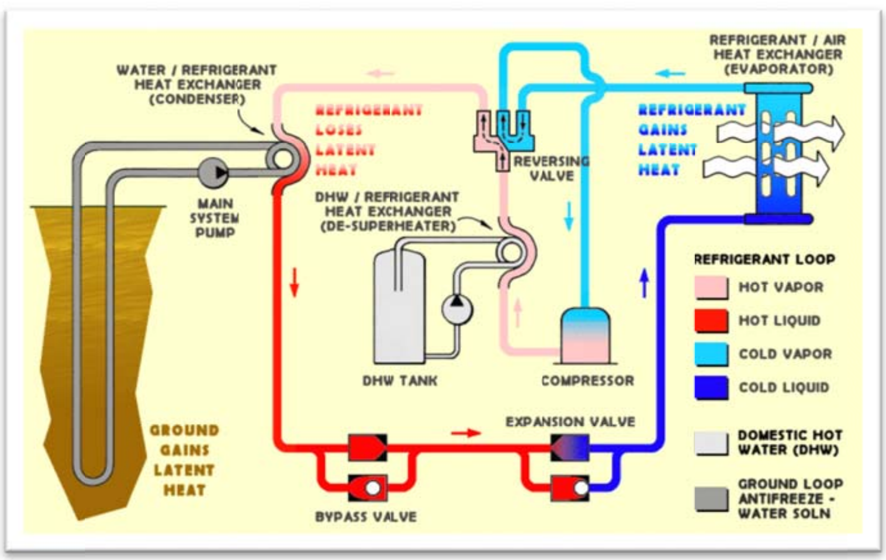
This proposal will study the effects of converting the 6 roof top air handling units from refrigerant to air heat rejection to refrigerant to earth heat rejection. (Geothermal earth-sink heat rejection system) The goal of this proposal is to design a geothermal system of The Mirenda Center, and compare a life cycle cost of geothermal to a life cycle cost the installed existing refrigerant to air system. The total building cooling load is approximately 3500 Mbh, and the total heating load is approximately 1150 Mbh.

A significant amount of square footage need to be available for a geothermal system to installed. The location underneath the soccer field could be an optimum spot. This location will be considered for the geothermal field installation.

Solution Method

There is two large advantage of having geothermal. The first is decrease cooling costs, and the seconded is decreased heating costs.

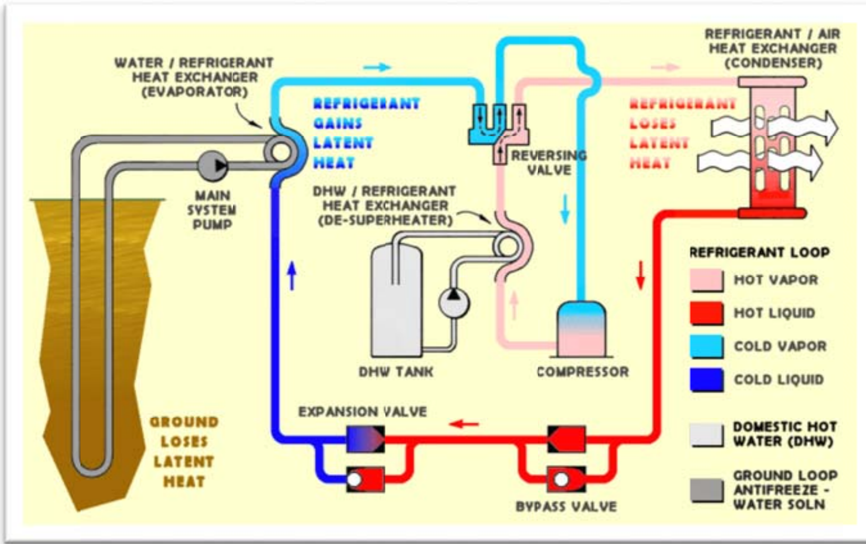
Operation of a GeoThermal Unit in Cooling Mode



Generic Geothermal Cooling System

The Geothermal Unit operates normally in Cooling Mode as a normal air-conditioner. The Heat Pump uses the indoor coil as an evaporator and the outdoor coil as a condenser in the Cooling Mode. The reversing valve is energized or de-energized based on the manufacturer's specification to direct the flow of refrigerant to the appropriate coils.

Operation of a GeoThermal Unit in Heating Mode



Generic Geothermal Heating System

The Geothermal Unit operates in a reverse cycle in the Heating Mode. The Heat Pump uses the indoor coil as a condenser and the outdoor coil as an evaporator in the Heating Mode. The reversing valve is energized or de-energized based on the manufacturer's specification to direct the flow of refrigerant to the appropriate coils. Whenever the outdoor coil, or evaporator section in the Heating Mode, detects ice formed on the coil, blockage of air through the coil, or senses a temperature usually around 42 degrees Fahrenheit or below - the Heat Pump will switch into Defrost Mode every 30, 60, or 90 minutes based on the settings on the Defrost Board. In the Defrost Mode - the Geothermal Unit will reverse cycle which will allow hot gas to enter the outdoor coil and defrost the coil. This will also make the indoor coil become cold and in turn to offset this temperature - the electric heat strips or auxiliary heat will come on. Also, the outdoor fan motor will stop during the Defrost Mode.

Rejected Alternative

There were multiple geothermal configurations that were considered. The Ground-Coupled Heat Pump (GCHP), ground water GWHP, and Surface Water Heat Pump are types that were considered. Due to the large size, capacity, and consistency needed any surface techniques were rules out. The surface heat exchange would be too inconsistent of a source due to the large fluctuation of ambient air conditions. With the Ground-Coupled Heat Pump the advantages apply because of the following: A small plot of land is need and available with The Mirenda Center. The soccer field is an excellent size plot that could be used for geothermal field. Having a vertical well will allow for very little change in temperature and thermal properties. This is a great advantage for predicting thermal load exchange. GCHP also requires the least amount of pipe and pumping energy, which will result to be the most efficient system compared to the alternative geothermal systems. The two disadvantages are the first costs associated with drilling the boreholes, and the skilled labor that can do the work. However, the State of Pennsylvania has recently found a surplus of natural gas that is being extracted from marcellus shale. Extracting gas from this shale require extensive amounts of drilling and skilled labor. Thus the labor is become more available in the Pennsylvania region.

Tasks and Tools

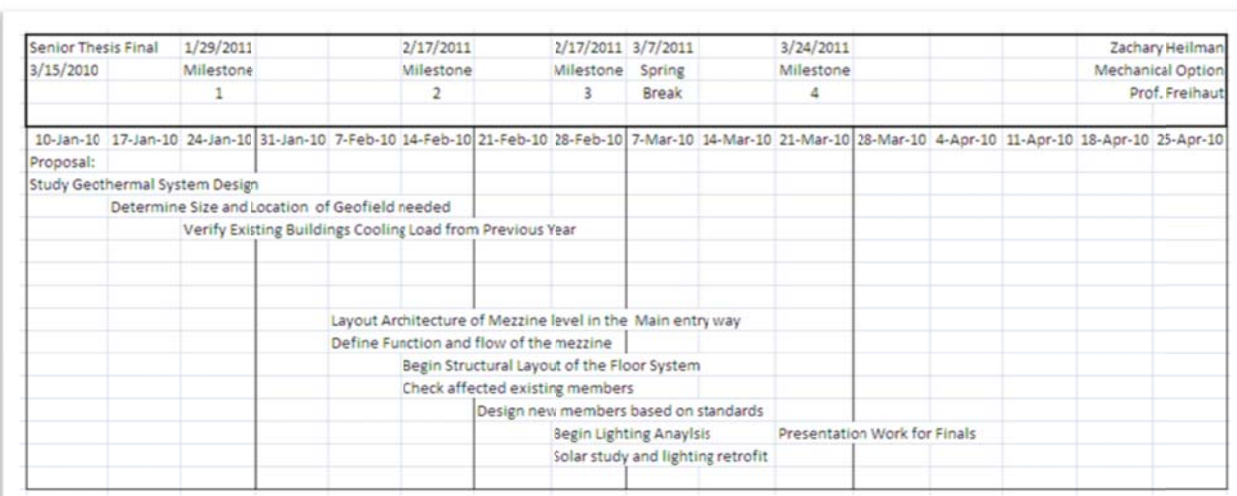
Several different standards and computer programs will be used to determine the benefits of the alternative systems described above. ASHRAE standards describing methods of designing those systems as well as Trane Trace for modeling will be used to determine the performance as well as the energy savings for each different system as well as a combination of those systems with the breadth proposals.

A soils calculation will be performed to determine the soil temperature variation throughout the course of a year. This calculation comes directly out of the ASHRAE Standards Handbooks. Once the soils calculation is performed, a length of borehole calculation can also be performed. The second calculation will determine the length of pipe need to achieve the necessary heat exchange with the earth.

Trane Trace will be the primary program used to determine the performance of the alternatives. This program is capable of modeling any kind of equipment configuration and an energy model can be used to compare the alternatives to the current system design. From this model a detailed report of the energy savings can be constructed and the benefits as well as the drawbacks of the different systems can be directly compared.

Microsoft Excel will be used to perform necessary calculations as well as create graphical comparisons of the different system performances. Any complex engineering calculations above the capabilities of Excel will be performed in Engineering Equation Solver which is programmed specifically for mechanical calculations.

Timetable



Schedule

Thesis Breadth

A major concern with The Mirenda Center is the high ceiling heights and the unusable same associated with it. Specifically on the second floor level, which is the ground level at the main front entry way. This space stands 30 feet tall it is heated and cooled, and is unusable. This space could be reclaimed by adding a mezzanine level where students could gather.

Structural Breadth

I will perform the necessary structural analysis to add a mezzanine level. I will most likely have steel framed members, spaced as necessary. I will consider suspending the mezzanine level from the existing trusses via the purlins supporting the roof.

I will begin to check the purlins to see if there is enough capacity to support the concrete structure. Secondly I will confirm the location of the columns that will be used to from under Truss-3. There will mostly need to be local thickening of the foundation wall under the beams that will be placed along Truss-3.

Lighting Breadth

I will perform the necessary lighting analysis to achieve the required lighting levels per code. This area will have a significant amount of natural day lighting available, thus a solar study will performed to ensure that sufficient naturally day light is adequate when available and other means of lighting will be provided when needed. Solara is a product that will be considered during the day lighting portion of this analysis.

List of Figures

Reference

ASHRAE Fundamentals
ASHRAE Systems and Equipment
ASHRAE Applications