Technical Report Three

Mechanical Systems Existing Conditions Evaluation

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New Castle Center for Delaware Hospice, Inc.

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Mechanical Option

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Executive Summary

The purpose of this report is to provide a summary of the New Castle Center for Delaware Hospice's mechanical system, design requirements, external influences on the design, major hardware components, system configuration, control logic, and operating characteristics. New Castle Center for Delaware Hospice is a two story building of 65,000 SF medical and administration. Image 1 (page 4) shows the location of the site for Google maps. Throughout the report New Castle Center for Delaware Hospice may show as DE Hospice to shorten the name. The DE Hospice is divided into two buildings connected by a Lobby area. Building A is a one story building with the main entrance and patient area facilities for the DE Hospice. The support services and administration are in the two story building B. Building A has patient rooms open to an outside patio and a courtyard for the inner patient rooms. DE Hospice has aluminum curtain wall systems with manufactured stone for the lower part of the exterior wall for the first floor and manufactured stone for some exterior walls. The manufactured stone is also used chimney on the East side of building B. The building is topped with asphalt shingles on the gable roof and cupolas. Windows are cladwood windows with louvers for shading.

This report is to sum up technical report one "ASHREA Standard 62.1-2007 and Standard 90.1-2007 Analysis" and technical report two " Building, Plant Energy and Emission Analysis".

Mechanical System Overview

The DE Hospice is a geothermal based mechanical cooling and heating system. The geothermal wells are under the east parking lot and in to the mechanical room in the basement. Then it is piped up to the attic where heat pump units and energy recovery units are. The water to water geothermal heat pump exchanges the energy from 20% glycol source to the R410A refrigerant. The refrigerant goes to heat pump units throughout the attic and the three ventilation heat pumps. The mechanical system does use two energy recover units that are located in the attic with the heat pumps. There are eight mechanical rooms in the attic. One mechanical room in the attic is not in line with an energy recovery unit or ventilation heat pump unit, it receives outside air directly to a regular heat pump.

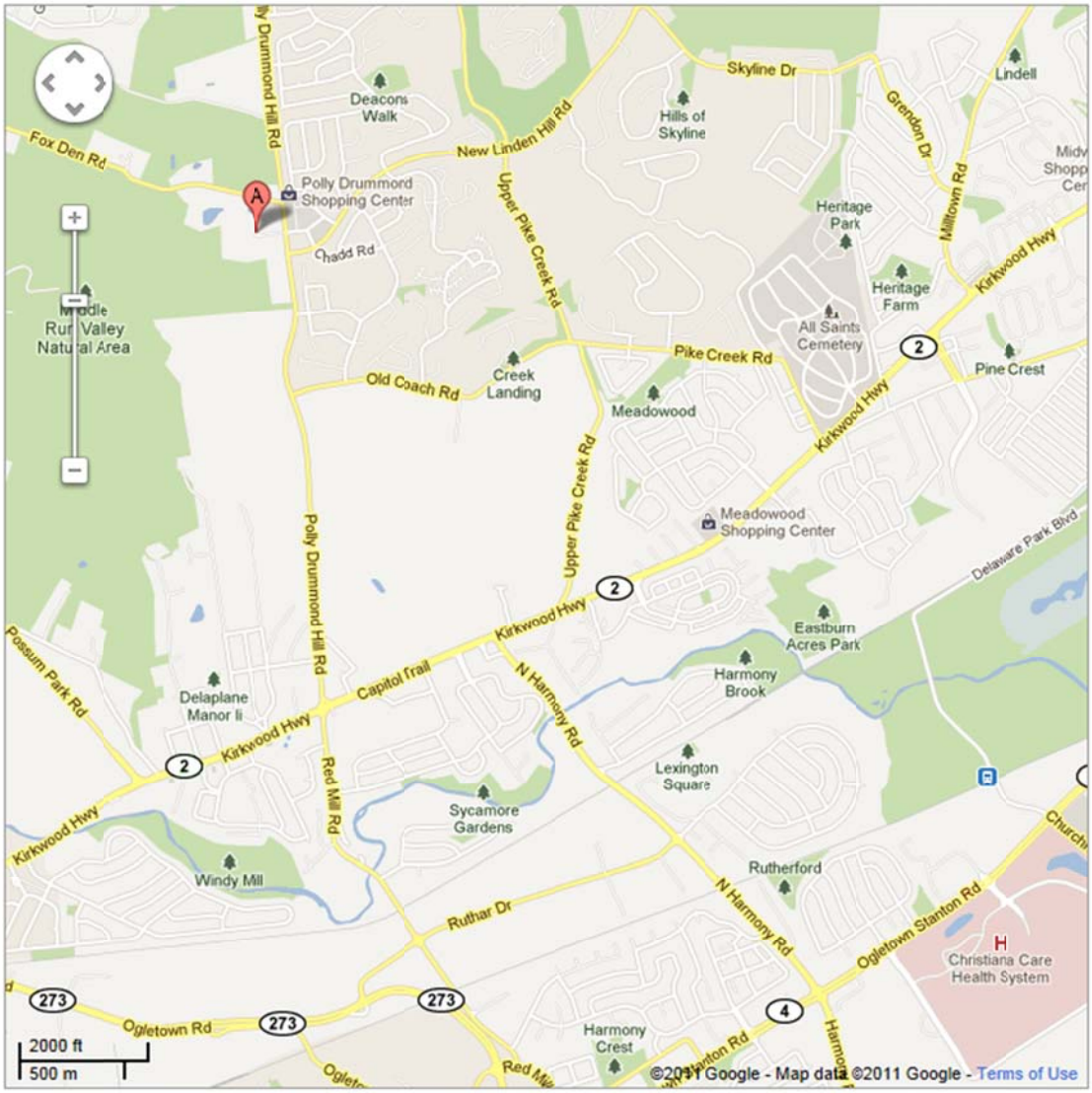

Image 1: A is the location of site, Image by maps.google.com

Design Objectives and Requirements

The Delaware Hospice building most of the heating and cooling system comes from water to water geothermal heat pump. This mean the design is a water to heat pump design and no chillers or boilers.

Energy Sources and Rates for Site

The utility rates were obtained from the EIA averages for Maryland in 2009 for electric and natural gas.

Utility Rates

Unit	Cost
Electricity	$ 0.1141 /kWh
Natural Gas	$ 66.48 / ccf

Table 1: Utility Rates

Site Cost

Using table 1 and table 2 to fine the cost of energy consumed to run the build based on Trace 700 design model. The electric comes out to be $158,900 per year and $49,400 per year for natural gas and for a total of $208,300 per year. Since the building is not complete with construction there no data to compare. Table 3 has the breakdown of annual energy consumption cost of the loads for a year.

Annual Energy Consumption				
Load	Electricity (kWh)	Natural Gas (kWh)		Percent of Total Energy (%)
Heating		21,765		1.5%
Cooling	158,997			11.2%
Supply Fans	448,844			31.7%
Pumps	257,923			18.2%
Lighting	438,502			31%
Receptacle	88,126			6.2%
Total	1,392,391	21,765	1,414,156	100%

Table 2: Annual Energy Consumption

Annual Energy Consumption Cost	
Load	Coat per year
Heating	$49,400
Cooling	$18,141
Supply Fans	$51,213
Pumps	$29,429
Lighting	$50,033
Receptacle	$10,055
Total	$208,300

Table: 3

Design Conditions

The weather data for the DE Hospice building was selected for the Wilmington, Delaware, the closest city on the weather date list of cities. A template for ten typical rooms' types was made for trace 700 modeling. The interior design conditions are uniform throughout the building. Table 3 below is a summary of the summer and winter weather design and interior conditions.

Season	Indoor Design (°F)	Outdoor DB (°F)	Outdoor WB (°F)
Summer (0.4%)	75	91.7	75.2
Winter (99.6%)	70	10.6	-

Table: 3 Indoors and Outdoor Design Conditions

Design Ventilation Requirements

VHP-1 has a ventilation system efficiency of 95% with critical zone being the large conference room. VHP-2 has a ventilation system efficiency of 68% with critical zone being a conference room. VHP-3 has 255% outdoor air as a % of design primary supply air. This shows a low design primary supply fan airflow rate. ERU-1 has 404% outdoor air as a % of design primary supply air. This shows a low design primary supply fan airflow rate. ERU-2 has 510% outdoor air as a % of design primary supply air. This shows a low design primary supply fan airflow rate

	ASHRAE 62.1	
	62.1	62.1 OA
	cfm/sf	cfm
ERU-1	1.43	1555
ERU-2	1.53	1555
VHP-1	0.27	1250
VHP-2	0.23	2140
VHP-3	0.45	2265

Table: 4

Design Loads

Energy Modeling Program Selection

For technical report two of the DE Hospice building, I used Trance Trace for modeling of the building. I chose Trane Trace because I have used it in the past for modeling design loads.

Assumptions

Building spaces and elements are simplified into block loads.

Design Conditions

The weather data for the DE Hospice building was selected for the Wilmington, Delaware, the closest city on the weather date list of cities. A template for ten typical rooms' types was made for trace 700 modeling (Table 5. Internal Load and Table 6 Construction elements from technical report two). The tenth typical room template is storage, which there is little

information to show on it. Table 2 (table from technical report two) was used for the all of the building's envelope. The rooms are zoned into eight zones (see Fig. 1-8) Zones 2,3, and 4 are mostly hospice areas and zones 1,5,6,7, and 8 are more offices (from technical report two). Internal Loads (table 5) was take from technical report two.

Internal Load					
Space Type	Density(ft^2/pp)	Sensible (Btu/h)	Latent (Btu/h)	Lighting (W/ft^2)	Ventilation (cfm/pp) or (cfm/ft^2)
Conference	20	245	155	1.3	20 pp
Corridor	0	250	250	1.4	.05 ft^2
Dinning	10	275	275	1.4	20 pp
Gen. Hospice Areas	100	250	200	1.0	15pp
Kitchen	75	250	250	1.4	7.5 pp
Lobby	17	250	250	1.4	15 pp
Office	143	250	200	1.1	20 pp
Patient Room	100	250	200	1	25 pp
Restroom	0	250	250	0.7	50 pp

Table 5. Internal Load

Construction	**Description**	**90.1 Zone 4**		**Building**		**Complies**
		U Max	R Min	U-Factor	R-Value	
Roof	Insulation Entirely above Deck	0.048	20	0.020	49	Yes
Walls	Mass	0.104	9.5	0.067	15	Yes
Floors	Mass	0.087	8.3	0.087	8.3	Yes
Fenestration		U Max	SHGC Max	U-Factor	SHGC	
Metal Framing	Windows	0.55	0.4	0.28	0.40	Yes
Metal Framing	Doors	0.85	0.4	0.28	0.40	Yes

Table 6. Construction elements

Design Energy Usage

Trace 700 was used to calculate energy consumption in a year the for Delaware Hospice building. Figure 1 shows the energy consumption for an average year for the building. The Supply fan and lighting both care most of the energy consumption with 31.7% and 31% respectfully. The primary heat is the lowest at 1.5% follow by the receptacles.

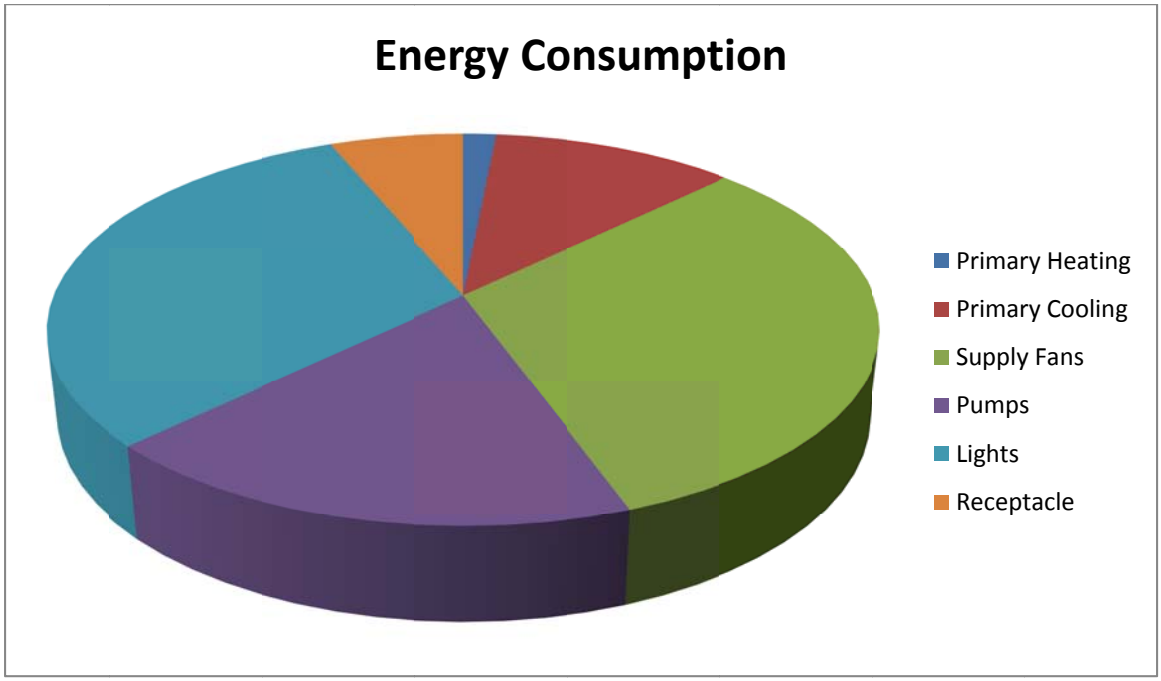

Figure 1: Energy Consumption

Mechanical Equipment/ System Operation

The mechanical system for the Delaware Hospice building is designed around a water to water geothermal heat pump that provides most of the heating and cooling load to treat the building. About ninety geothermal earth wells under the parking lot supplies the geothermal heat pump by two thirty horsepower pumps (Table 7: Pump Schedule). The water to water geothermal heat pump (Table 9: Water to Water Geothermal Heat Pump Schedule) supplies three variable heat pumps and many smaller heat pumps (Table 11: Geothermal Water Source Heat Pump Schedule). The smaller heat pumps are supply outside air by either a variable heat pump, energy recovery unit (Table 10: Energy Recovery Unit Schedule) or direct outside. The variable

heat pumps only condition outside air and exhaust the exhaust air from the building, it does not handle any return air in the mechanical system. The return air is handled by the smaller heat pump and energy recovery units. The room controls are in line with the smaller heat pump units. The energy recovery unit handles the inpatient zones of the building. The variable heat pumps cover everything else, which is mostly office space.

Pump Schedule					
Unit No.	System	Location	Capacity (GPM)	Head (ft)	Motor (HP)
P-1	Heat Pump Loop	Basement	820	90	30
P-2	Heat Pump Loop	Basement	820	90	30
P-3	Data RM Chilled Water	Basement	36	40	1
P-4	Data RM Chilled Water	Basement	36	40	1

Table 7: Pump Schedule

Expansion Tank Schedule				
Unit No.	System	Location	Ave. Water Temp. (F)	Tank Vol. (Gal)
ET-1	Heat Pump Loop	Basement	75	158

Table 8: Expansion Tank Schedule

Water to Water Geothermal Heat Pump Schedule							
					Load Side	Source Side	
Unit No.	System	Location	Cooling Capacity (MBH)	Flow (GPM)	EWT/LWT (F)	Summer EWT/LWT (F)	Winter EWT/LWT (F)
WWHP-1	Heating and Cooling	Attic M107	180	42	54/44	85/95	40/50

Table 9: Water to Water Geothermal Heat Pump Schedule

Energy Recovery Unit Schedule											
Unit No.	Service	SA cfm	EA (cfm)	Energy wheel							
				Summer				Winter			
				OA DB/WB (F)	SA DB/WB (F)	RA DB/WB (F)	EA DB/WB (F)	OA DB (F)	SA DB/WB (F)	RA DB/WB (F)	EA DB/WB (F)
ERU-1	Inpatient Area	1555	1500	91/75	79/66	75/63	87/72	10	55/44	75/54	25/21
ERU-2	Inpatient Area	1825	2100	91/75	79/66	75/63	86/71	10	58/46	72/54	30/25

Table 10: Energy Recovery Unit Schedule

Geothermal Water Source Heat Pump Schedule						
Unit No.	Service	Total (cfm)	OA (cfm)	Suppy Fan (HP)	Cooling Capacity (MBH)	Heating Capacity (MBH)
VHP-1		1250	1250	1	105	42
VHP-2		2140	2140	2	150	63
VHP-3		2265	2265	2	154	63
HP-1		260		1/10	5.9	5.2
HP-2		330		1/10	10.3	9.7
HP-3		430		1/10	13.3	11.6
HP-4		530		¼	17.7	15.3
HP-5		710		¼	23.9	30.1
HP-6		940		½	28.7	24.6
HP-7		1150		½	35.4	31.6
HP-8		1260		½	40.2	36.6
HP-9		1710		¾	48.4	42.0

Table 11: Geothermal Water Source Heat Pump Schedule

Schematics

The schematic (Diagram 1: Water/Air Mechanical System) below combines the water and air sides of the mechanical system for the Delaware Hospice building.

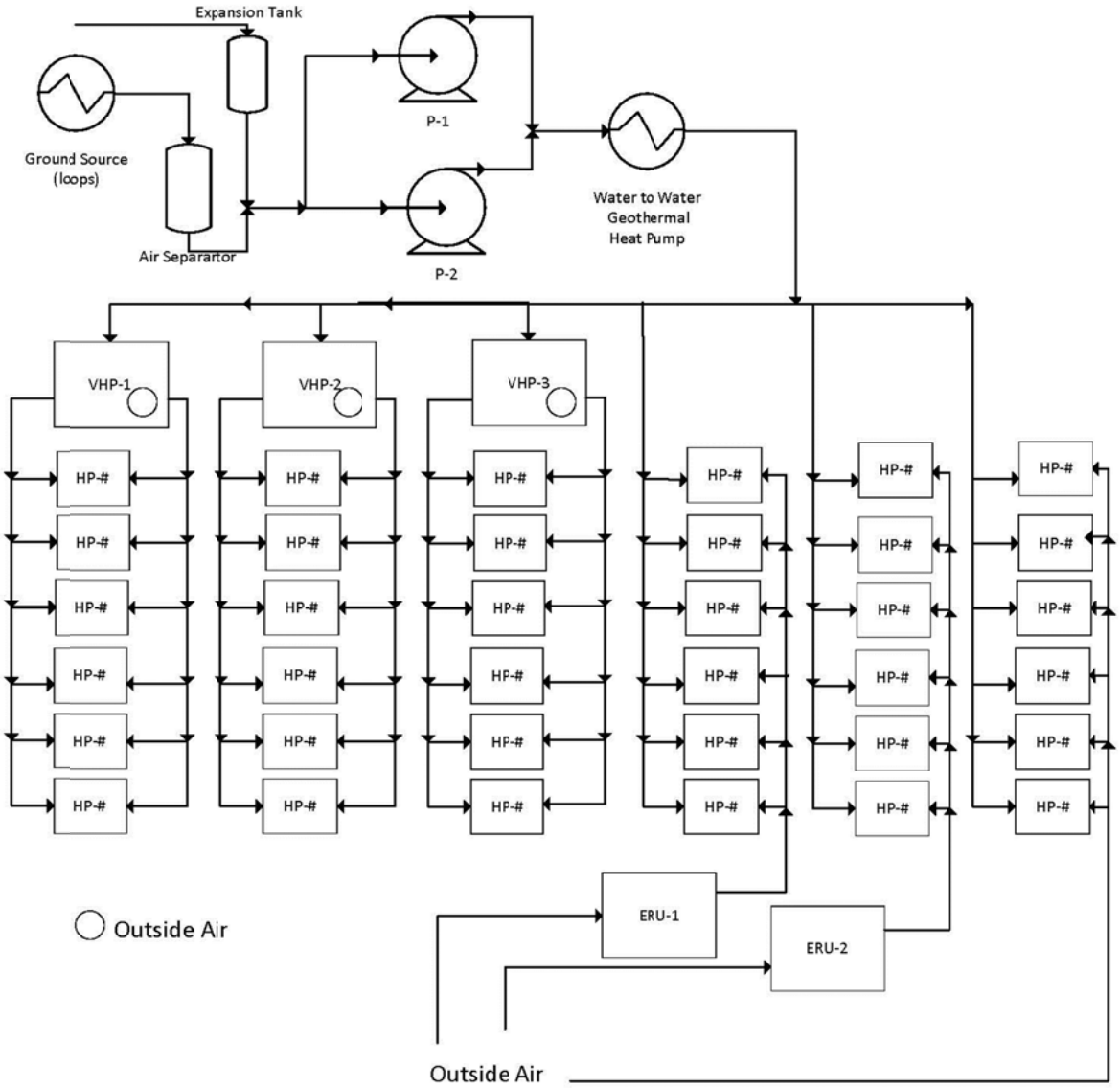

Diagram 1: Water/Air Mechanical System

Space Used by Mechanical System

Table 12 shows and tabulates the total area lost to the mechanical system. The Attic contains most of the mechanical system. The main equipment in the basement is pumps for the mechanical system. The total lost space to the building by the mechanical system is 6,182 SF.

Space Used by Mechanical System		
Room	Area (SF)	Location
Mech. B006	273	Basement
Mech. 101	423	Attic
Mech. 102	405	Attic
Mech. 103	342	Attic
Mech. 104	252	Attic
Mech. 105	342	Attic
Mech. 106	405	Attic
Mech. 107	988	Attic
Mech. 108	2,752	Attic
Total	6,182	

Table 12: Space Used by Mechanical System

LEED

Energy and Atmosphere

EA Prerequisite 1: Fundamental Commissioning of Building Energy

LEED analysis for this building was not obtained. I feel it is safe to assume that this building meet EA Prerequisite 1 since the building is going for accreditation.

EA Prerequisite 2: Minimum Energy Performance

This building meets Sections 5.4, 5.5, 6.4, 6.5, 7.4, 7.5, 8.4, 9.4, 9.5 and 10.4 or section 11 of ASHRAE/IESNA

EA Prerequisite 3: Fundamental Refrigerant Management

There are zero use of CFC-based refrigerants.

EA Credit 1: Optimize Energy Performance (option 1)

The total building mechanical system will save 32% on overall energy compared to baseline case and attaining **7 points**

EA Credit 2: On-site Renewable Energy

The building has geothermal for heating and cooling load. **3 points**

EA Credit 3: Enhanced Commissioning

Information was not obtained, but follow the assumption from EA Prerequisite 1. **1 point**

EA Credit 4: Enhanced Refrigerant Management

No points, use to much refrigerant in building

EA Credit 5: Measurement and Verification

The Delaware Hospice plan on the ability to continue to monitor. **1 Point**

EA Credit 6: Green Power

No points

Indoor Environment Quality

EQ Prerequisite 1: Minimum IAQ Performance

Meet the minimum IAQ requirements of sections 4 through 7 of ASHRAE Standard 62.1-2007.

EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

Option 1: Prohibit smoking in the building and smoking area at least 25 feet away from entries.

EQ Credit 1: Outdoor Air Delivery Monitoring

No Points

EQ Credit 2: Increased Ventilation

No Points

EQ Credit 3.1: Construction IAQ Management Plan: During Construction

It is assumed for this report that this is credit. **1 Point**

EQ Credit 3.2: Construction IAQ Management Plan: Before Occupancy

It is assumed for this report that this is credit. **1 Point**

EQ Credit 4.1: Low-Emitting Materials: Adhesives and Sealants

It is assumed for this report that this is credit. **1 Point**

EQ Credit 4.2: Low-Emitting Materials: Paints and Coatings

It is assumed for this report that this is credit. **1 Point**

EQ Credit 4.3: Low-Emitting Materials: Carpet Systems

It is assumed for this report that this is credit. **1 Point**

EQ Credit 4.4: Low-Emitting Materials: Composite Wood and Agrifiber Products

It is assumed for this report that this is credit. **1 Point**

EQ Credit 5: Indoor Chemical and Pollutant Source Control

All room with pollutant sources are negatively pressured and have a room exhaust fan. **1 Point**

EQ Credit 6.1: Controllability of Systems: Lighting

No Points

EQ Credit 6.2: Controllability of Systems: Thermal Comfort

No Points

EQ Credit 7.1: Thermal Comfort: Design

Design of the heating, ventilation and air conditioning systems with building envelope was based on ASHRAE Standard 55-2004. **1 Point**

EQ Credit 7.2: Thermal Comfort: Verification

It is assumed for this report that this is credit. **1 Point**

EQ Credit 8.1: Daylight and Views: Daylight 75% of Spaces

This building meets minimum glazing factor of 2% in a minimum of 75% of all regularly occupied areas. **1 Point**

EQ Credit 8.2: Daylight and Views: Views for 90% of Space

NO Points

The Delaware Hospice building obtain 22 points out of 32 points for "Energy and Atmosphere" and "Indoor Environmental Quality"

Executive Summary

The building types are split into hospice and low-rise office buildings with geothermal design for heating and cooling loads. The geothermal system has saved a lot of energy on the heating load. It has all so has saved energy on the cooling load. With the geothermal systems can be must commonly compare to a boiler and cooling tower. The geothermal saves on space compared to the boiler and cooling tower. Supply fans and lighting has most of the energy consumed at about 60% of the annual total. This would be the area to look into finding improvement in energy consumption. The building is in good shape to receive LEED accreditation based on "Energy and Atmosphere", "Indoor Environmental Quality" and working with the Delaware Hospice building the past three technical reports.

Reference

ASHREA, 2007, ANSI/ASHARE, Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality. American Sociaty of Heating, Refrigerating, and Air Conditioning Engineers, Inc. Atlanta, GA

ASHREA, 2007, ANSI/ASHARE, Standard 90.1-2007, Energy Standard for Buildings Except Low-rise Residenrial Buildings. American Sociaty of Heating, Refrigerating, and Air Conditioning Engineers, Inc. Atlanta, GA

LEED-NC, Green Building Rating System For New Constructio & Major Renovations. U.S. Green Building Council, Oct 2005. U.S.