

Mechanical Technical Report 2

Building and Plant Energy Analysis Report



Suburban Wellness Center Germantown, Maryland

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Suburban Wellness Center
Germantown, Maryland

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Executive Summary

This report analyzes the Suburban Wellness Center to determine the number of expected LEED points generated and compliance with ASHRAE Standard 90.1-2004. An analysis of the lost rentable space by the mechanical systems is also performed.

The Suburban Wellness Center was not designed to attain a LEED certification but there were some areas where it did gain points and could easily gain more. Despite none of the prerequisites being met, with better planning in the future, a LEED rating could be achieved.

Overall, Suburban Wellness Center did meet several of the requirements of ASHRAE Standard 90.1-2004. The vertical fenestration percentage and insulation values of the walls were both met. The Prescriptive Building Envelope Option method was conducted to check for compliance based on building location. Another area that had to be met for the standard is lighting. A lighting power density criterion was given in the standard to provide a gauge to how much power must be used to light a space. The two methods used were the Building Area Method and Space by Space Method. The Suburban Wellness Center did not meet either of these methods and so an older version of the standard was used to analyze compliance. The SWC proved to comply with the Building Area Method of ASHRAE Standard 90.1-1999. This was probably due to the building being designed before the standard was revised in 2004.

A building system energy analysis was also performed and showed that the majority of the heat generated from the building is from the occupants. Most of the space in the building is used as exercise space so this makes sense since many of the occupants are giving off a lot of heat because of their workout. It also showed that during the winter months, most of the heat lost to the atmosphere was due to the windows. This was most likely from the U value of the windows being higher than that of the walls.

Building Design Overview

The Suburban Wellness Community Center is a two story 57,200 square foot building which contains a variety of spaces. On the first level is a fitness center and on the second level are conference rooms, offices and private practicing doctor's offices. In the northwest corner of the first floor is the swimming pool area which consists of a large four lane lap pool, a therapy pool, public spa as well as a sauna and steam room. South of this room is the basketball court and racquetball courts which are two stories in height. In the center of the building are the men's and women's lockers rooms and a two story tall atrium with cardiovascular machines and the registration desk. The east side of the first floor holds the free weight rooms in the north and studio spaces for group exercise classes in the south. Figure 1 visually shows the breakdown of each unit coverage.

On the second story (not shown) in the center of the north part of the building are restrooms and conference rooms. The southeast corner of the second story includes an imaging office which can perform X-Rays, MRIs and ultrasounds. The rest of the space on the second floor has yet to be leased out.

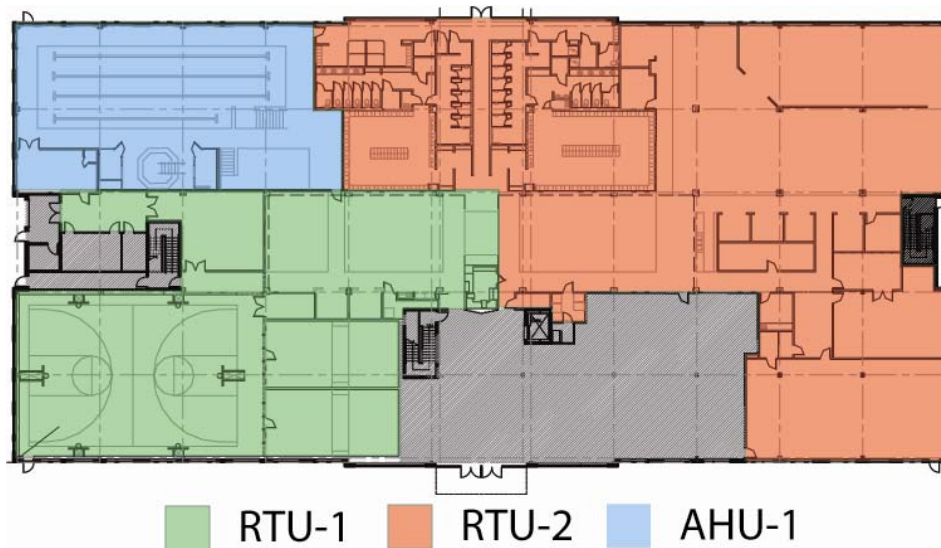


Figure 1 – Overall Mechanical System Load Distribution

Mechanical Systems Summary

Two single packaged combination gas-fired heating and electric, air-cooled cooling units provide conditioned air to most of the building. RTU-1 which is located on the west side of the building supplies to the southwest corner while RTU-2 located on the east side of the building supplies to the east half of the building. A separate air handling unit is used to supply conditioned air strictly to the swimming pool facility. RTU-1 supplies to the basketball court, racquetball courts, group cycling room and the cardiovascular machine room. RTU-2 supplies to the locker rooms, weight training

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area, circuit training area, fitness center offices and group workout studios. Both supplies to the spaces using a VAV box system with electric reheat which ensures sufficient individual space conditioning control. A variable speed fan drive is also used to give even more control over the conditioning of the supply air.

The northwest corner of the building which holds the swimming pool facility is conditioned by a dehumidification unit. This unit is separate from the two rooftop units and was added at a later point in the design. AHU-1 supplies to the swimming pool facility which has a four lane wide lap pool, public spa and a therapy pool. This space needed a separate unit because of the above average humidity ratio and temperature that must be maintained. Aside from the rooftop units and air handling units, the building also utilizes unit heaters and electric ceiling heaters to heat the stairwells.

Also located near the swimming pool facility is the main mechanical room of the Suburban Wellness Center. Two 800 MBH gas fired water heaters have been placed in the mechanical room to supply hot water throughout the building. To heat the three swimming pools, one 400 MBH and two 250 MBH gas fired pool heaters have been installed. Especially during the winter months when temperatures drop below freezing, these pool heaters take some of the loading off of the dehumidification unit.

LEED-NC Version 2.2

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is the nationally accepted benchmark for the design, construction, and operation of energy conscience buildings. The main purpose of this building rating system is to improve public health and the environment as well as reduce operating costs for the building and potentially increase occupant productivity. The five main categories in which points can be attained are sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality.

Since the Suburban Wellness Center was recently constructed, the LEED-NC which is a standard for new construction will be used to analyze the building LEED compliance. The building can attain any of these levels of certification. The point range will be beside the level where the higher the points, the better compliant the building is.

- LEED Certified (26-32 points)
- Silver (33-38 Points)
- Gold (39-51 Points)
- Platinum (51-69 Points)

The construction of my project completed in November 2002. Around that time, saving energy was taken very seriously, however, not as serious as it is taken today. A gallon of gas could be found at the nearby pump for under a dollar whereas now a gallon of gas can't be found under \$3. So with this in mind, I suggest the reason the

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owners of the Suburban Wellness Center didn't go for a LEED certification is because the energy savings over time were not worth the initial costs upfront. Whether it is insufficient research done on implementing energy efficient building systems or the unpopularity of the LEED certification in general, the owners chose not to implement an energy saving scheme.

In my analysis, I inspected the LEED certification checklist to see if a certification was possible for the Suburban Wellness Center. There were three requirements that I thought would be easily counted for and those are reflected on the checklist with a "Y". The requirements with a question mark next to it were requirements which could be gained with a little better planning from the beginning or a little more invested in the technology used. One example would be Credit 4.2 of the sustainable sites category which discusses providing bicycle storage and changing rooms. This would be a very easy credit to attain because locker rooms and showers are already provided in the building. The only addition they would need is bicycle racks. Another example where a LEED point could be attained is in Credit 6.1 of the indoor environmental quality category. This requirement suggests installing occupancy sensors to cut down on the lighting usage in unoccupied spaces. This would be very ideal in the studio spaces when group classes are not in session or the gymnasium and racquetball courts when they aren't in use. The requirements that have an "N" beside it are difficult to acquire for a variety of reasons and wouldn't be logical to utilize when trying to attain the LEED certification. A detailed analysis of the Suburban Wellness Center compliance with LEED-NC 2.2 can be viewed in appendix A.

Building Envelope – ASHRAE Standard 90.1-2004

ASHRAE Standard 90.1-2004 provides minimum requirements for energy-efficient buildings with the exception of low rise residential buildings. Section 5 of the ASHRAE Standard specifically focuses on the requirements for the building envelope.

In the Standard, there are two methods to go about checking for the building envelope compliance. The first is the Prescriptive Building Envelope Option which states that the total vertical fenestration must not exceed 50% of the gross wall area. Another restriction for this method is the total skylight area cannot surpass 5% of the total roof area. The second method is the Building Envelope Trade-Off Option is similar to the Prescriptive Building Envelope Option but says that the envelope performance factor of the proposed building has to be less than or equal to the envelope performance factor of the budget building.

The Suburban Wellness Center which is located in Germantown Maryland falls under the ASHRAE specified 5A climate zone. Table 5.5-5 of ASHRAE Standard 90.1-2004 was used to compare the required values with the installed values to check for compliance. In the table, there are three categories; Nonresidential, Residential and Semiheated. This building was evaluated under the nonresidential section.

Figure 2 shows that compliance for the R-values of the roof and walls has been reached for the Suburban Wellness Center. The R-values for the installed roof and walls materials were both found in the building specifications and the values for the R-values required were looked up in the ASHRAE Standard under Table 5.5-5.

	Roof Insulation Minimum R- Value	Walls Insulation Minimum R- Value	Floors (Slab on Grade) Unheated
Required	R-15 Continuous Insulation	R-7.6	N/A
Installed	R-15	R-20	N/A
Compliance	Yes	Yes	Yes

Figure 2 – R-Value Compliance

Figure 3 and 4 both show the compliance with the standard for vertical fenestration and roof fenestration. The percent total vertical fenestration has to be below 50% and the building meets this with a total vertical fenestration of 39.8%. For the roof, the percent total fenestration has to be below 5% and the Suburban Wellness Center meets this with a total fenestration of 1%. The results are reflected in table 4.2 and Table 4.3.

Total Glass Area (sqft)	Total Wall Area (sqft)	% Total Vertical Fenestration	Compliance
8578	21528	39.8%	Yes

Figure 3 – Glass Area to Wall Area Compliance

Total Skylight Area (sqft)	Total Roof Area (sqft)	% Total Fenestration	Compliance
375	37224	1.0%	Yes

Figure 4 – Skylight Area to Roof Area Compliance

Figure 5 shows the compliance of the window U-values and SHGC values with the standard. Since the values could not be found in the specification or drawings, the manufacturer’s website provided the U-values and SHGC values. The total vertical fenestration was 39.8% which falls under the 30.1-40% range for vertical glazing in Table 5.5-5 in the standard.

% Vertical Glazing 30.1-40.0%	Required	Installed	Compliance	Comments
Assembly Max U-Value for Fixed Windows	0.57	0.25	Yes	Windows are double pane (1/4" thick glass each) insulating float glass with Low E
Assembly Max SHGC for all orientations	0.39	0.31	Yes	
Assembly Max SHGC for North	0.49	0.31	Yes	

Figure 5 – U-Value and SHGC Compliance

Figure 6 shows the compliance of the skylight U-values and SHGC values with the standard.

0.0-2.0% Skylight	U-Value	SHGC	Compliance
Required	1.17	0.49	Yes
Actual	0.25	0.31	Yes

Figure 6 – U-value and SHGC value Compliance

Lighting - ASHRAE Standard 90.1-2004

The main goal of Section 9 of the ASHRAE Standard 90.1-2004 was to create a standard which optimized energy performance and occupancy comfort. By using this, designers are able to cut down on energy cost yet still provide adequate comfort to the occupants.

Although the Suburban Wellness Center was supposed to be analyzed under the 2004 of the standard, the SWC was designed under the 1999 edition. Both versions of the standard were used in the analysis of this building and so the results can be found below. The difference between the two editions is quite different. The 2004 version became 22% more strict for my building with the allowable lighting power density. Many of the values for the space in the 1999 edition were at least one tenth of a watt per square foot higher if not more. A Comparison of the standard's two editions can be found in Figure 7.

	2004	1999
Active Storage	0.8	1.1
Conference/Meeting/Multipurpose	1.3	1.5
Corridor/Transition	0.5	0.7
Dressing/Locker Room	0.6	0.8
Electrical/Mechanical	1.5	1.3
Exam/Treatment	1.5	1.6
Exercise Area	0.9	1.1
Laundry	0.6	0.7
Lobby	1.3	1.8
Lounge/Recreation	1.2	1.4
Office-Enclosed	1.1	1.5
Patient Room	0.7	1.2
Physical Therapy	0.9	1.9
Playing Area	1.4	1.9
Restroom	0.9	1.0

Figure 7 – Space by Space Method Category Comparison

Two methods were used to meet the compliance of ASHRAE Standard 90.1-2004. The Building Area Method gives a criterion for the entire building based on the majority use. The other method is the Space by Space Method which categorizes each space in the building and finds the allowable lighting power density that way. This way tends to be more precise since it looks at each space in the building instead of generalizing all the space like the Building Area Method.

At first, when the calculations were made, the Suburban Wellness Center did not meet the requirements of ASHRAE Standard 90.1-2004. Since the SWC is a fitness center on the first floor and doctor's office on the second floor, it could be categorized as either an exercise center or clinic according to the standard. The values for both of these categorizes are identical so when the Building Area Method was used, the lighting power density used was 1.00 watt per square foot. SWC did not meet this requirement because its LPD was 1.39 watts per square foot. After this discovery, I was a little surprised so since the building was designed in 2001, I looked at the 1999 version of the standard and found result to be a little different. The older version proved to be more lenient on lighting power density with a required LPD of 1.40. So with this data I concluded that the building was designed according to the 1999 edition of ASHRAE Standard 90.1. The Space by Space Method was also conducted. Since this method looks at each space specifically and doesn't make a generalization like the other method, I didn't expect this to make my argument for compliance any better. Space by Space compliance for was 1.32 W/SF and 1.03 W/SF for 1999 and 2004 respectively. The SWC LPD did not meet either of these and so compliance with the standard using

this method was not met. A more detailed look at both of these calculations can be found in Appendix B.

ASHRAE 90.1 Building Area Method		Compliance
1999 - Exercise Center	1.40	Yes
2004 - Exercise Center	1.00	No
Actual	1.39	

Figure 8 – Building Area Method Comparison

Lost Rentable Space

In the Suburban Wellness Center, the total lost rentable space is very minimal. The first floor contains one mechanical room and two electrical closets. The second floor includes one electrical closet however since part of the floor is not leased to any tenants, this could change in the future. The two rooftop units, air handling unit and compressor which supply the building with conditioned air, are all located outside. These units help decrease the lost rentable space. In the mechanical room, two gas-fired hot water heaters supply hot water to the building and the gas-fired pool water heaters supply water to the pool. Two electrical hot water heaters are located on the second floor of the building however there is no lost rentable space because both of these heaters are suspended from the ceiling.

Lost "Rentable" Space		
Room	Description	Area (SF)
b115	Electrical Closet	42
b132a	Electrical Closet	30
b136	Mechanical Room	350
c108a	Electrical Closet	23
Lost "Rentable" Space (SF)		445
Total Space (SF)		44125
Percent Lost "Rentable" Space		1.0%

Figure 9 – Lost Rentable Space

Table 6.1 displays the breakdown of lost rentable space for the Suburban Wellness Center. The largest lost space is from the mechanical room which is only 350 square feet in area. Overall, only 1% of the space is lost to the mechanical system.

Mechanical and Plumbing System Cost Estimate

The mechanical and plumbing systems in the building are very basic and cost roughly 12% of the overall cost of the building. A breakdown below in Figure 10 shows how

much the cost per square feet is for the Suburban Wellness Center. The mechanical and plumbing system cost would cover everything in the system including labor. A more detailed estimate would have been preferred however resources were not available considering the age of the project.

Initial Mechanical & Plumbing Cost	\$ 877,817.00
Building Area (SF)	44,398
Cost per Square Foot	\$ 19.77

Figure 10 – Mechanical and Plumbing System Initial Cost

Energy Analysis

Trane Trace 700 was used during the energy analysis of the Suburban Wellness Center. The building drawings, specifications, and information taken from the manufacturer’s website were used in the development of this building model. Schedules for the lighting and occupancy were set up based on the hours of operation for the building. A detailed look at this can be found in Appendix C. The building purchases electricity from Pepco Holdings Inc. for \$0.141 per kwh during the summer months from June to October and \$0.122 per kwh during the winter months from November to May. A similar energy analysis was performed for this building however these files were not archived. Occupancy densities were calculated based on ASHRAE Standard 62.1-2007 number of people per 1000 square feet.

Cooling Load By Source					
Envelope Loads (Btus/Hr)	AHU-1	RTU-1	RTU-2	Total	% of Total Load
Roof	0	9,868	10,055	19,923	1.44%
Glass Solar	25,469	27,244	83,938	136,652	9.90%
Internal Loads (Btus/Hr)					
Lights	24,669	51,407	128,085	204,161	14.79%
People	208,314	374,879	436,710	1,019,903	73.87%
Total (Btus/Hr)	258,453	463,398	658,788	1,380,639	100.00%

Figure 11 – Cooling Load by Source

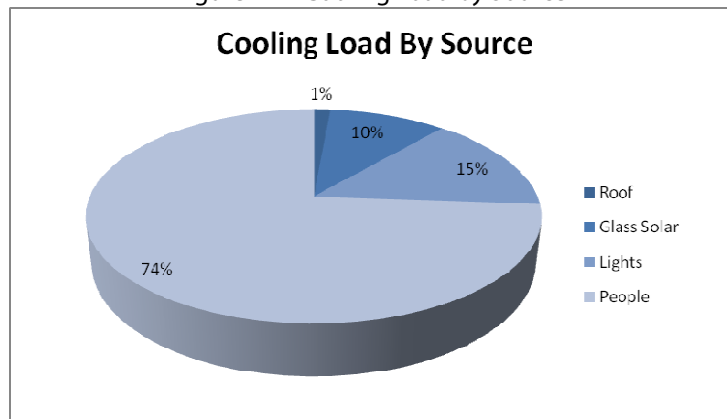


Figure 12 – Cooling Load By Source

Heating Load By Source					
Envelope Loads (Btus/Hr)	AHU-1	RTU-1	RTU-2	Total	% of Total Load
Skylite Cond	0	6015	0	6,015	4.02%
Roof Cond	0	24731	26962	51,693	34.53%
Glass Cond	10,310	12,618	50,692	73,620	49.17%
Wall Cond	2,101	9,591	6,695	18,387	12.28%
Total (Btus/Hr)	12,411	52,955	84,349	149,715	100.00%

Figure 13 – Heating Load By Source

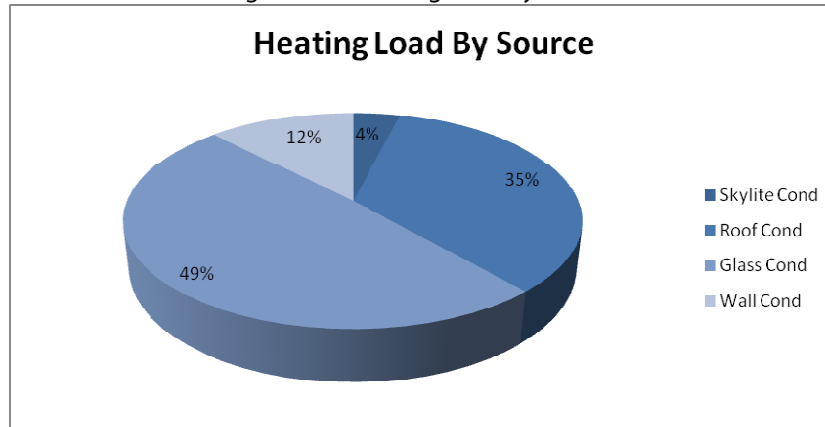


Figure 14 – Heating Load By Source

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Appendix A – LEED-NC Version 2.2 Evaluation



LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

Suburban Wellness Center
 Germantown, Maryland

Yes ? No

1	7	6	Sustainable Sites	14 Points
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N					
Y			Prereq 1	Construction Activity Pollution Prevention	Required
			Credit 1	Site Selection	1
		N	Credit 2	Development Density & Community Connectivity	1
		N	Credit 3	Brownfield Redevelopment	1
		N	Credit 4.1	Alternative Transportation, Public Transportation Access	1
	?		Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
	?		Credit 4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles	1
	?		Credit 4.4	Alternative Transportation, Parking Capacity	1
		N	Credit 5.1	Site Development, Protect or Restore Habitat	1
	?		Credit 5.2	Site Development, Maximize Open Space	1
	?		Credit 6.1	Stormwater Design, Quantity Control	1
		N	Credit 6.2	Stormwater Design, Quality Control	1
	?		Credit 7.1	Heat Island Effect, Non-Roof	1
	?		Credit 7.2	Heat Island Effect, Roof	1
		N	Credit 8	Light Pollution Reduction	1

Yes ? No

	1	4	Water Efficiency	5 Points
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	?		Credit 1.1	Water Efficient Landscaping, Reduce by 50%	1
		N	Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	1
		N	Credit 2	Innovative Wastewater Technologies	1
		N	Credit 3.1	Water Use Reduction, 20% Reduction	1
		N	Credit 3.2	Water Use Reduction, 30% Reduction	1

Yes ? No

	4	13	Energy & Atmosphere	17 Points
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N			Prereq 1	Fundamental Commissioning of the Building Energy Systems	Required
N			Prereq 2	Minimum Energy Performance	Required
N			Prereq 3	Fundamental Refrigerant Management	Required
	2		Credit 1	Optimize Energy Performance	1 to 10
		N	Credit 2	On-Site Renewable Energy	1 to 3
	?		Credit 3	Enhanced Commissioning	1
	?		Credit 4	Enhanced Refrigerant Management	1
		N	Credit 5	Measurement & Verification	1
		N	Credit 6	Green Power	1

Yes ? No

	5	8	Materials & Resources	13 Points
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N			Prereq 1	Storage & Collection of Recyclables	Required
		N	Credit 1.1	Building Reuse , Maintain 75% of Existing Walls, Floors & Roof	1
		N	Credit 1.2	Building Reuse , Maintain 100% of Existing Walls, Floors & Roof	1
		N	Credit 1.3	Building Reuse , Maintain 50% of Interior Non-Structural Elements	1
	?		Credit 2.1	Construction Waste Management , Divert 50% from Disposal	1
	?		Credit 2.2	Construction Waste Management , Divert 75% from Disposal	1
		N	Credit 3.1	Materials Reuse , 5%	1
		N	Credit 3.2	Materials Reuse , 10%	1
		N	Credit 4.1	Recycled Content , 10% (post-consumer + ½ pre-consumer)	1
		N	Credit 4.2	Recycled Content , 20% (post-consumer + ½ pre-consumer)	1
	?		Credit 5.1	Regional Materials , 10% Extracted, Processed & Manufactured Regionally	1
	?		Credit 5.2	Regional Materials , 20% Extracted, Processed & Manufactured Regionally	1
	?		Credit 6	Rapidly Renewable Materials	1
		N	Credit 7	Certified Wood	1

Yes ? No

	12	2	Indoor Environmental Quality	15 Points
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N			Prereq 1	Minimum IAQ Performance	Required
N			Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
	?		Credit 1	Outdoor Air Delivery Monitoring	1
	?		Credit 2	Increased Ventilation	1
	?		Credit 3.1	Construction IAQ Management Plan, During Construction	1
Y			Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
	?		Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1
	?		Credit 4.2	Low-Emitting Materials, Paints & Coatings	1
	?		Credit 4.3	Low-Emitting Materials, Carpet Systems	1
	?		Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	1
	?		Credit 5	Indoor Chemical & Pollutant Source Control	1
	?		Credit 6.1	Controllability of Systems, Lighting	1
	?		Credit 6.2	Controllability of Systems, Thermal Comfort	1
	?		Credit 7.1	Thermal Comfort, Design	1
	?		Credit 7.2	Thermal Comfort, Verification	1
		N	Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1
		N	Credit 8.2	Daylight & Views, Views for 90% of Spaces	1

Yes ? No

1		4	Innovation & Design Process	5 Points
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		N	Credit 1.1	Innovation in Design: Provide Specific Title	1
		N	Credit 1.2	Innovation in Design: Provide Specific Title	1
		N	Credit 1.3	Innovation in Design: Provide Specific Title	1
		N	Credit 1.4	Innovation in Design: Provide Specific Title	1
Y			Credit 2	LEED® Accredited Professional	1

Yes ? No

3	29	37	Project Totals (pre-certification estimates)	69 Points
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Certified 26-32 points Silver 33-38 points Gold 39-51 points Platinum 52-69 points

Appendix B – Space by Space Lighting Power Density Calculations

Room #	Room	Area (sq.ft.)	Table 9.6.1 Category	Overhead Lighting (W)	Allowable Overhead Lighting (W)	Lighting Power Density (W/SF)	Allowable Lighting Density (W/SF)	Compliance	ASHRAE Standard 90.1-1999		
									Allowable Lighting Density (W/SF)	Compliance	
a100	Vestibule	225	Corridor/Transition	348	112.5	1.55	0.5	No	0.7	157.5	No
a101	Hall	260	Corridor/Transition	218	130	0.84	0.5	No	0.7	182	No
a102	Lobby	520	Lobby	416	676	0.80	1.3	Yes	1.8	936	Yes
a103	Waiting	190	Lobby	218	247	1.15	1.3	Yes	1.8	342	Yes
a105	Party Room	336	Conference/Meeting/Multipurpose	532	436.8	1.58	1.3	No	1.5	504	No
a106	Activity Center	953	Conference/Meeting/Multipurpose	1248	1238.9	1.31	1.3	No	1.5	1429.5	Yes
a110	Storage	45	Active Storage	96	36	2.13	0.8	No	1.1	49.5	No
a111	Toilet	45	Restroom	96	40.5	2.13	0.9	No	1.0	45	No
a112	2nd Floor Corridor	627	Corridor/Transition	1450	313.5	2.31	0.5	No	0.7	438.9	No
a113	2nd Floor Corridor	1609	Corridor/Transition	2915	804.5	1.81	0.5	No	0.7	1126.3	No
b100	Reception	355	Lobby	792	461.5	2.23	1.3	No	1.8	639	No
b101	Lounge	472	Lounge/Recreation	384	566.4	0.81	1.2	Yes	1.4	660.8	Yes
b103	Sound Room	50	Electrical/Mechanical	160	75	3.20	1.5	No	1.3	65	No
b104	Program	75	Office-Enclosed	96	82.5	1.28	1.1	No	1.5	112.5	Yes
b105	Program	75	Office-Enclosed	96	82.5	1.28	1.1	No	1.5	112.5	Yes
b106	Storage	115	Active Storage	192	92	1.67	0.8	No	1.1	126.5	No
b107	Hall	300	Corridor/Transition	0	150	0.00	0.5	Yes	0.7	210	Yes
b108	Fitness	1338	Exercise Area	2200	1204.2	1.64	0.9	No	1.1	1471.8	No
b109	Group Cycling	691	Exercise Area	1152	621.9	1.67	0.9	No	1.1	760.1	No
b110	Service Area	305	Active Storage	288	244	0.94	0.8	No	1.1	335.5	Yes
b111	Hall	170	Corridor/Transition	192	85	1.13	0.5	No	0.7	119	No
b112	Gymnasium	3621	Playing Area	6000	5069.4	1.66	1.4	No	1.9	6879.9	Yes
b113	Racquetball Court	795	Playing Area	864	1113	1.09	1.4	Yes	1.9	1510.5	Yes
b114	Racquetball Court	795	Playing Area	864	1113	1.09	1.4	Yes	1.9	1510.5	Yes
b115	Storage	42	Electrical/Mechanical	96	63	2.29	1.5	No	1.3	54.6	No
b116	Laundry	83	Laundry	192	49.8	2.31	0.6	No	0.7	58.1	No
b117	Hall	320	Corridor/Transition	0	160	0.00	0.5	Yes	0.7	224	Yes
b118	Fitness	987	Exercise Area	1200	888.3	1.22	0.9	No	1.1	1085.7	No
b119	Sign In	284	Lobby	800	369.2	2.82	1.3	No	1.8	511.2	No
b120	Fitness Desk	155	Lobby	0	201.5	0.00	1.3	Yes	1.8	279	Yes
b121	Hall	339	Corridor/Transition	192	169.5	0.57	0.5	No	0.7	237.3	Yes
b122	Fitness Testing	97	Patient Room	192	67.9	1.98	0.7	No	1.2	116.4	No
b123	Intrafit	97	Patient Room	192	67.9	1.98	0.7	No	1.2	116.4	No
b124	Office Suite	275	Office-Enclosed	576	302.5	2.09	1.1	No	1.5	412.5	No
b125	Hall	120	Corridor/Transition	192	60	1.60	0.5	No	0.7	84	No
b126	Marketing	123	Conference/Meeting/Multipurpose	288	159.9	2.34	1.3	No	1.5	184.5	No
b127	Office	101	Office-Enclosed	192	111.1	1.90	1.1	No	1.5	151.5	No
b128	Hall	215	Corridor/Transition	192	107.5	0.89	0.5	No	0.7	150.5	No
b129	Pilates	223	Exercise Area	384	200.7	1.72	0.9	No	1.1	245.3	No
b130	Storage	66	Active Storage	96	52.8	1.45	0.8	No	1.1	72.6	No
b131	Studio B	670	Exercise Area	1056	603	1.58	0.9	No	1.1	737	No
b132	Warm-up	256	Corridor/Transition	192	128	0.75	0.5	No	0.7	179.2	No
b132a	Electrical Closet	30	Electrical/Mechanical	96	45	3.20	1.5	No	1.3	39	No
b133	Staff Room	110	Lounge/Recreation	192	132	1.75	1.2	No	1.4	154	No
b133a	Storage	45	Active Storage	96	36	2.13	0.8	No	1.1	33	No
b134	Studio A	1801	Exercise Area	2400	1620.9	1.33	0.9	No	1.1	121	No
b135	Pool	4850	Playing Area	2688	6790	0.55	1.4	Yes	1.9	85.5	Yes
b136	Mechanical Room	350	Electrical/Mechanical	384	525	1.10	1.5	Yes	1.3	2341.3	Yes
b137	Steam Room	77	Playing Area	124	107.8	1.61	1.4	No	1.9	921.5	Yes
b138	Sauna	75	Playing Area	124	105	1.65	1.4	No	1.9	665	Yes
b139	Family Changing	754	Dressing/Locker Room	920	452.4	1.22	0.6	No	0.8	61.6	No

Room #	Room	Area (sq.ft.)	Table 9.6.1 Category	Overhead Lighting (W)	Allowable Overhead Lighting (W)	Lighting Power Density (W/SF)	Allowable Lighting Power Density (W/SF)	Compliance	ASHRAE Standard 90.1-1999		
									Allowable Lighting Power Density (W/SF)	Allowable Overhead Lighting (W)	
b140	Changing Room	28	Dressing/Locker Room	62	16.8	2.21	0.6	No	60	No	
b141	Janitor Closet	12	Active Storage	62	9.6	5.17	0.8	No	829.4	No	
b142	Changing Room	40	Dressing/Locker Room	138	24	3.45	0.6	No	22.4	No	
b143	Changing Room	40	Dressing/Locker Room	138	24	3.45	0.6	No	9.6	No	
b144	Toilet Room	68	Restroom	96	61.2	1.41	0.9	No	40	No	
b145	Hall	206	Corridor/Transition	192	103	0.93	0.5	No	28	No	
b146	Locker Entry	100	Lobby	39	130	0.39	1.3	Yes	1.8	122.4	Yes
b147	Entry	110	Lobby	96	143	0.87	1.3	Yes	0.8	370.8	Yes
b148	Women's Locker Room	680	Dressing/Locker Room	1280	408	1.88	0.6	No	80	No	
b149	Women's Hall	132	Corridor/Transition	1396	66	10.58	0.5	No	0.7	77	No
b150	Janitor Closet	17	Active Storage	62	13.6	3.65	0.8	No	1.1	748	No
b151	Changing Room	30	Dressing/Locker Room	62	18	2.07	0.6	No	0.8	105.6	No
b152	Changing Room	30	Dressing/Locker Room	62	18	2.07	0.6	No	0.8	13.6	No
b153	Women's Toilet	235	Restroom	888	211.5	3.78	0.9	No	1.0	30	No
b154	Women's Shower	309	Restroom	712	278.1	2.30	0.9	No	1.0	30	No
b155	Entry	110	Lobby	96	143	0.87	1.3	Yes	1.8	423	Yes
b156	Men's Locker Room	935	Dressing/Locker Room	1664	561	1.78	0.6	No	0.8	247.2	No
b157	Men's Hall	139	Corridor/Transition	0	69.5	0.00	0.5	Yes	0.7	77	Yes
b158	Janitor Closet	15	Active Storage	62	12	4.13	0.8	No	1.1	1028.5	No
b159	Men's Toilet	165	Restroom	384	148.5	2.33	0.9	No	1.0	139	No
b160	Men's Shower	365	Restroom	736	328.5	2.02	0.9	No	1.0	15	No
b161	Office	129	Office-Enclosed	192	141.9	1.49	1.1	No	1.5	247.5	Yes
b162	Meeting Room	129	Conference/Meeting/Multipurpose	192	167.7	1.49	1.3	No	1.5	547.5	Yes
b163	Fitness	800	Exercise Area	864	720	1.08	0.9	No	1.1	141.9	Yes
b164	Free Weights	1445	Exercise Area	1914	1300.5	1.32	0.9	No	1.1	141.9	No
b165	Fitness	2231	Exercise Area	2880	2007.9	1.29	0.9	No	1.1	880	No
c100	Waiting	92	Corridor/Transition	96	46	1.04	0.5	No	0.7	1011.5	No
c101	Reception	186	Lobby	384	241.8	2.06	1.3	No	1.8	4015.8	No
c102	Hall	73	Corridor/Transition	62	36.5	0.85	0.5	No	0.7	64.4	No
c103	Toilet	48	Restroom	96	43.2	2.00	0.9	No	1.0	186	No
c104	Soiled Utility	46	Laundry	96	27.6	2.09	0.6	No	0.7	51.1	No
c106	Hydro	80	Exam/Treatment	192	120	2.40	1.5	No	1.6	76.8	No
c107	Office	150	Office-Enclosed	384	165	2.56	1.1	No	1.5	69	No
c108	Storage	26	Active Storage	62	20.8	2.38	0.8	No	1.1	88	No
c108a	Electrical	23	Electrical/Mechanical	62	34.5	2.70	1.5	No	1.3	195	No
c109	Exam	105	Exam/Treatment	196	157.5	1.87	1.5	No	1.6	41.6	No
c110	Rehab Floor	791	Physical Therapy	1152	711.9	1.46	0.9	No	1.9	43.7	Yes
e200	Vestibule	420	Corridor/Transition	124	210	0.30	0.5	Yes	0.7	73.5	Yes
e201	Men's Toilet	160	Restroom	220	144	1.38	0.9	No	1.0	791	No
e202	Women's Toilet	160	Restroom	220	144	1.38	0.9	No	1.0	420	No
e203	Misc. Room	118	Active Storage	192	94.4	1.63	0.8	No	1.1	176	No
e204	Conference Room	627	Conference/Meeting/Multipurpose	1160	815.1	1.85	1.3	No	1.5	240	No
e205	Storage	38	Active Storage	0	30.4	0.00	0.8	Yes	1.1	129.8	Yes
e207	Conference Room	425	Conference/Meeting/Multipurpose	532	552.5	1.25	1.3	Yes	1.5	940.5	Yes
e208	Storage	27	Active Storage	0	21.6	0.00	0.8	Yes	1.1	41.8	Yes
f200	Waiting	283	Corridor/Transition	348	141.5	1.23	0.5	No	0.7	297.5	No
f201	Reception	143	Lobby	258	185.9	1.80	1.3	No	1.8	48.6	No
f201a	Anteroom	49	Corridor/Transition	0	24.5	0.00	0.5	Yes	0.7	198.1	Yes
f202	Staff Room	142	Lounge/Recreation	384	170.4	2.70	1.2	No	1.4	200.2	No

Room #	Room	Area (sq.ft.)	Table 9.6.1 Category	Overhead Lighting (W)	Allowable Overhead Lighting (W)	Lighting Power Density (W/SF)	Allowable Lighting Density (W/SF)	ASHRAE Standard 90.1-1999		
								Allowable Lighting Density (W/SF)	Allowable Overhead Lighting (W)	Compliance
f203	Toilet	45	Restroom	96	40.5	2.13	0.9	1.0	49	No
f204	Manager Office	120	Office-Enclosed	192	132	1.60	1.1	1.5	213	No
f205	R&F examination room	300	Exam/Treatment	576	450	1.92	1.5	1.6	72	No
f206a	Corridor	175	Corridor/Transition	124	87.5	0.71	0.5	0.7	84	No
f207	Technicians	90	Lounge/Recreation	196	108	2.18	1.2	1.4	420	No
f208	Radiology Reading	83	Exam/Treatment	96	124.5	1.16	1.5	1.6	280	Yes
f209	Toilet	56	Restroom	96	50.4	1.71	0.9	1.0	90	No
f210	Corridor	130	Corridor/Transition	96	65	0.74	0.5	0.7	58.1	No
f211	Files	41	Office-Enclosed	96	45.1	2.34	1.1	1.5	84	No
f212	Transcript	30	Office-Enclosed	96	33	3.20	1.1	1.5	195	No
f213	S. Linen	46	Office-Enclosed	96	50.6	2.09	1.1	1.5	61.5	No
f213a	Corridor	152	Corridor/Transition	124	76	0.82	0.5	0.7	21	No
f214	Toilet	49	Restroom	96	44.1	1.96	0.9	1.0	46	No
f215	Patient Dressing	274	Exam/Treatment	686	411	2.50	1.5	1.6	243.2	No
f215a	Vestibule	48	Corridor/Transition	124	24	2.58	0.5	0.7	34.3	No
f216	Conference Room	62	Conference/Meeting/Multipurpose	96	80.6	1.55	1.3	1.5	411	No
f217	Telecommunications/Data	45	Electrical/Mechanical	64	67.5	1.42	1.5	1.3	62.4	No
f218	X-Ray Room	210	Exam/Treatment	28	315	0.13	1.5	1.6	99.2	Yes
f219	MRI Computer Room	285	Exam/Treatment	576	427.5	2.02	1.5	1.6	72	No
f220	MRI Examination Room	395	Exam/Treatment	500	592.5	1.27	1.5	1.6	336	Yes
f222	CT Room	430	Exam/Treatment	576	645	1.34	1.5	1.6	456	Yes
f223	Ultrasound Room	152	Exam/Treatment	384	228	2.53	1.5	1.6	632	No
f223a	Corridor	74	Corridor/Transition	62	37	0.84	0.5	0.7	301	No
f224	Dexa Examination Room	90	Exam/Treatment	192	135	2.13	1.5	1.6	243.2	No
f225	Corridor	173	Corridor/Transition	186	86.5	1.08	0.5	0.7	51.8	No
f225a	Corridor	166	Corridor/Transition	62	83	0.37	0.5	0.7	63	Yes
f226	Mammogram Examination Room	133	Exam/Treatment	192	199.5	1.44	1.5	1.6	276.8	Yes
f227	Dark Room	48	Patient Room	62	33.6	1.29	0.7	1.2	199.2	No
f228	Storage	33	Active Storage	96	26.4	2.91	0.8	1.1	146.3	No
f228a	Corridor	70	Corridor/Transition	62	35	0.89	0.5	0.7	33.6	No
				43229	60290	1.39	1.03			

Appendix C – Schedules

Gym - People Occupancy					
Weekday			Weekend		
Start Time	End Time	Occupancy Percentage	Start Time	End Time	Occupancy Percentage
12:00 AM	4:00 AM	0%	12:00 AM	7:00 AM	0%
4:00 AM	6:00 AM	10%	7:00 AM	10:00 AM	30%
6:00 AM	9:00 AM	40%	10:00 AM	4:00 PM	80%
9:00 AM	12:00 PM	100%	4:00 PM	7:00 PM	30%
12:00 PM	4:00 PM	50%	7:00 PM	12:00 AM	0%
4:00 PM	8:00 PM	100%			
8:00 PM	10:00 PM	20%			
10:00 PM	11:00 PM	10%			
11:00 PM	12:00 AM	0%			

Gym - Lighting					
Weekday			Weekend		
Start Time	End Time	Occupancy Percentage	Start Time	End Time	Occupancy Percentage
12:00 AM	4:00 AM	5%	12:00 AM	6:00 AM	5%
4:00 AM	11:00 PM	100%	6:00 AM	8:00 PM	100%
11:00 PM	12:00 AM	5%	8:00 PM	12:00 AM	5%

Doctor's Offices - People Occupancy					
Weekday			Weekend		
Start Time	End Time	Occupancy Percentage	Start Time	End Time	Occupancy Percentage
12:00 AM	7:00 AM	0%	12:00 AM	12:00 AM	0%
7:00 AM	6:00 PM	100%			
6:00 PM	12:00 AM	0%			

Doctor's Offices - Lighting					
Weekday			Weekend		
Start Time	End Time	Occupancy Percentage	Start Time	End Time	Occupancy Percentage
12:00 AM	7:00 AM	5%	12:00 AM	12:00 AM	5%
7:00 AM	6:00 PM	100%			
6:00 PM	12:00 AM	5%			

Appendix D – Energy and Cost Analysis

	Cooling SF/Ton	Cooling CFM/Ton	Cooling CFM/SF	Heating CFM/SF
AHU-1	241.93	225.54	0.93	0.93
RTU-1	273.99	252.44	0.92	0.28
RTU-2	479.12	164.83	0.34	0.12

Month	Monthly Utility Costs
January	\$3,851.91
February	\$3,484.18
March	\$4,216.34
April	\$4,395.77
May	\$5,348.48
June	\$6,516.09
July	\$6,066.27
August	\$6,784.41
September	\$5,691.33
October	\$5,527.86
November	\$4,547.29
December	\$3,668.14
Total	\$60,098.07