Thesis Final Report 2008

Washington-Lee High School
Arlington, Virginia

Matthew Hoerr
The Pennsylvania State University
Construction Management
Advisor: Dr. Messner

Washington-Lee High School

Arlington, Virginia

Project Team

Owner: Arlington Public Schools

Architect: Grimm and Parker Architects

CM: McDough Bolyard Peck

GC: Hess Construction Company

Civil Engineer: ADTEK Engineers, Inc.

MEP Engineer: Mendoza, Ribas, Farinas and Associates

Food Service: Nyikos Associates

Aquatics: Councilman, Hunsaker and Associates

Project Features

Building Type: Educational

Size: 350,000 sq. ft

Dates of Construction: Phase 1 - April 2006 to December 2007
Phase 2 - January 2008 to July 2009
Phase 3 – July 2009 to December 2009

Total Cost: $95.2 Million

Delivery Method: CM advisor

Building Contains: Classrooms to hold over 1600 students, 16 Science labs, 3 Business labs, 8 Computer labs, 3 Music rooms, a cafeteria that opens up to the track, 800 seat auditorium, gym, 2 pools and a diving area.

Structural

Foundation: Shallow spread footings under columns and Strip footings around the building perimeter

Floors: Structural Steel beams typically spanning between 20 and 30 ft. with a composite metal deck with 5 ¼ inch light weight concrete

Roof: Open web steel joists with 1.5 inch deep x 22 gauge metal roof deck

Lateral Force: CMU shear walls

Façade: Red Brick along with metal panels and large southern facing windows

Mechanical & Electrical

Mechanical: (2) 750 GPM 500 Ton Chillers
(11) AHU's ranging from 9000 to 21500 CFM
5000 MBH Gas fired Boiler
Each temperature zone contains own VAV box with reheat coil

Electrical: 8000 Amp 277/480, volt 3-phase 4-wire service with a 277/480 volt 150 KW diesel generator

Indoor lamps are F32W/SP35/T8/RS

*Building trying to get LEED Silver Certification

Matthew Hoerr – Construction Management

www.engr.psu.edu/ae/thesis/portfolios/2008/mjh371

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ACKNOWLEDGEMENTS

HESS
CONSTRUCTION COMPANY

Karen Groppe
Kathy Langan
Andy Hess
Chuck Hess

Arlington Public Schools

Steve Stricker

Dallastown Area
School District

School Board Members

The Pennsylvania State University

Dr. Messner

High Concrete Inc.

Gary Reed

I would also like to thank my friends and family for keeping me motivated.

Executive Summary

This report is the culmination of a semesters worth of research and analysis on Washington-Lee High School. The first part of this report contains information on research on LEED rated schools and why there are not more of them being built. Surveys were sent out to Dallastown area school district school board members and analyzed on why their new intermediate school proposal was not going green. The findings were that they could not justify the extra cost of going for a LEED rating on the new school. The public was already upset about the cost of the new school and adding more cost would not go over well. It was suggested that if the public was educated more on the advantages of having a green school they might be willing to pay the extra tax money. The best way for Dallastown to educate the public would be to put articles and statistics in the pamphlets and community couriers that go out monthly.

The first analysis that was done was to compare the use of architectural precast panels on the façade with the current façade design. Altus Group's Carboncast panels were chosen and were found to be a feasible alternative to the CMU and brick that is currently being used. Using these panels will reduce the schedule by 96 days however will require the use of a crane to erect them. These panels will also provide a reduction in heating and cooling loads. The only downside to using the Carboncast panels is the increase in price compared to the current design. It would cost approximately $2 million dollars more to use the Carboncast panels, however the quality of these precast panels would be better and waste would be reduced.

The second analysis that was done was to value engineer/redesign the lighting in the gymnasium. The current gymnasium design uses 1000 watt metal halide bulbs which are more inefficient when compared to fluorescent lighting. A 6-bulb, 54 watt T5HO luminaire was chosen to take the place of the current metal halide fixtures. It turned out that these fluorescent luminaires could replace the metal halide fixtures 1 for 1 so no extra fixtures would be added. The new design was kept so that the power density met ASHRAE 90.1 standard of 1.1 W/sf for gymnasiums. After the lighting levels were found and renderings were made the energy savings was calculated. The new design would save more than $9500 per year in electricity costs. It would also give the owner more control over the lighting levels in the gymnasium.

PROJECT OVERVIEW

The new Washington-Lee High School is being built on the same site as the current High School is located. The school is surrounded by homes on three sides and is located at 1300 North Quincy Street in Arlington, Virginia. The new school is going to be approximately 362,000 square feet and is going to require the demolition of 225,000 square feet of the existing school. The new school is going for a LEED Silver rating and is very advanced compared to the current school that was originally built in 1924.

The new Washington-Lee High School is going to be a 4-story building that contains a courtyard in the center. The building is designed to hold the more than 1600 students that currently attend school there. The building itself contains sixteen science labs, three business labs, eight computer labs, and 3 music rooms. This building also contains a cafeteria that opens up towards the track. A large auditorium, gym, and natatorium are also going into the building.

The construction of the new school is going to be done in 3 phases. The first phase is the largest part and contains the 4-story section. The second phase includes some of the demolition of the existing school and contains the gym, auditorium, and natatorium. The third and final phase of construction includes the demolition of the rest of the existing school and the creation of 2 new soccer fields. The building is going to be a phased occupancy project with students entering phase 1 of the new school in January 2008. The entire construction is to be completed in December 2009.

Project Team

Owner: Arlington Public Schools
Architect: Grimm and Parker Architects
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Washington-Lee High School

Matthew Hoerr | CM | Messner

Dates of Construction: Phase 1 - April 2006 to December 2007
Phase 2 - January 2008 to July 2009
Phase 3 – July 2009 to December 2009

Client Information

The owner of Washington-Lee High School is Arlington County Public Schools. They are very experienced in building new schools and doing renovations. Washington-Lee was chosen to get a new school because the original school was built in 1924 and it was time for an upgrade. They wanted to update their technology and also give more room to the more than 1600 students that currently attend school there.

Safety is important on every jobsite and that includes this school. The owner does not want anyone to get injured while onsite and also wants to protect pedestrians as well as students and faculty. School is in session during most of construction so it is very important to keep school children out of the construction areas and also to control the amount of noise due to the new construction.

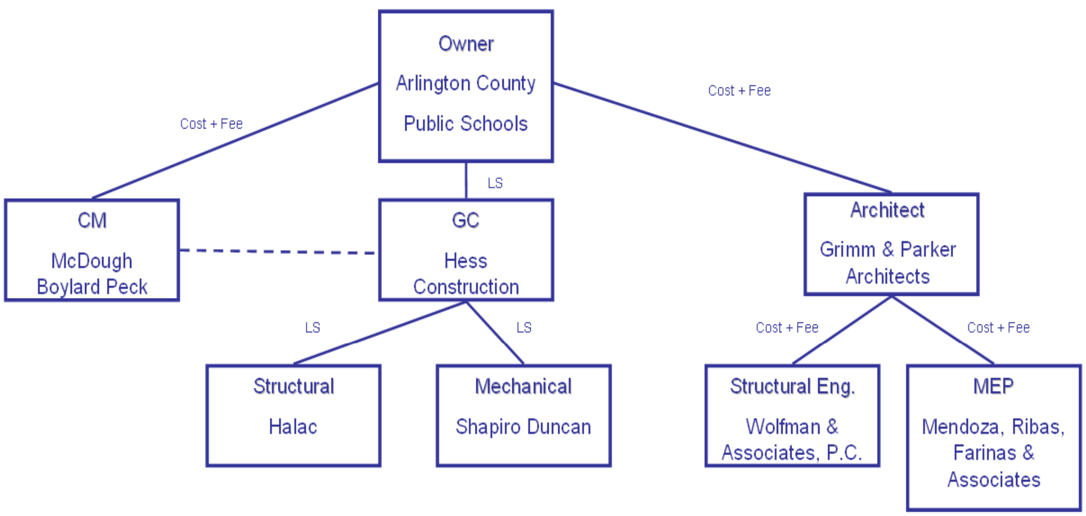
The owner wants to have a good quality building that is going to last a long time. This is demonstrated by the fact that the building is going for a LEED Silver Rating. This shows that the owner is looking towards the future of building and is hoping to save money in the long run by having very efficient equipment in the building.

The schedule is of utmost importance to the owner. The new Washington-Lee High School is a phased occupancy building and is going to be completed in three phases. The first phase is the largest of them all and should be completed by the end of December 2007 so that students can use this facility starting in January of 2008 and phase 2 of construction can begin. It is very important that phase 1 is completed on time so that the students can start immediately after Christmas Break. It is important that the new High School be completed on time, at a high quality, and with minimal safety incidents.

Project Delivery System

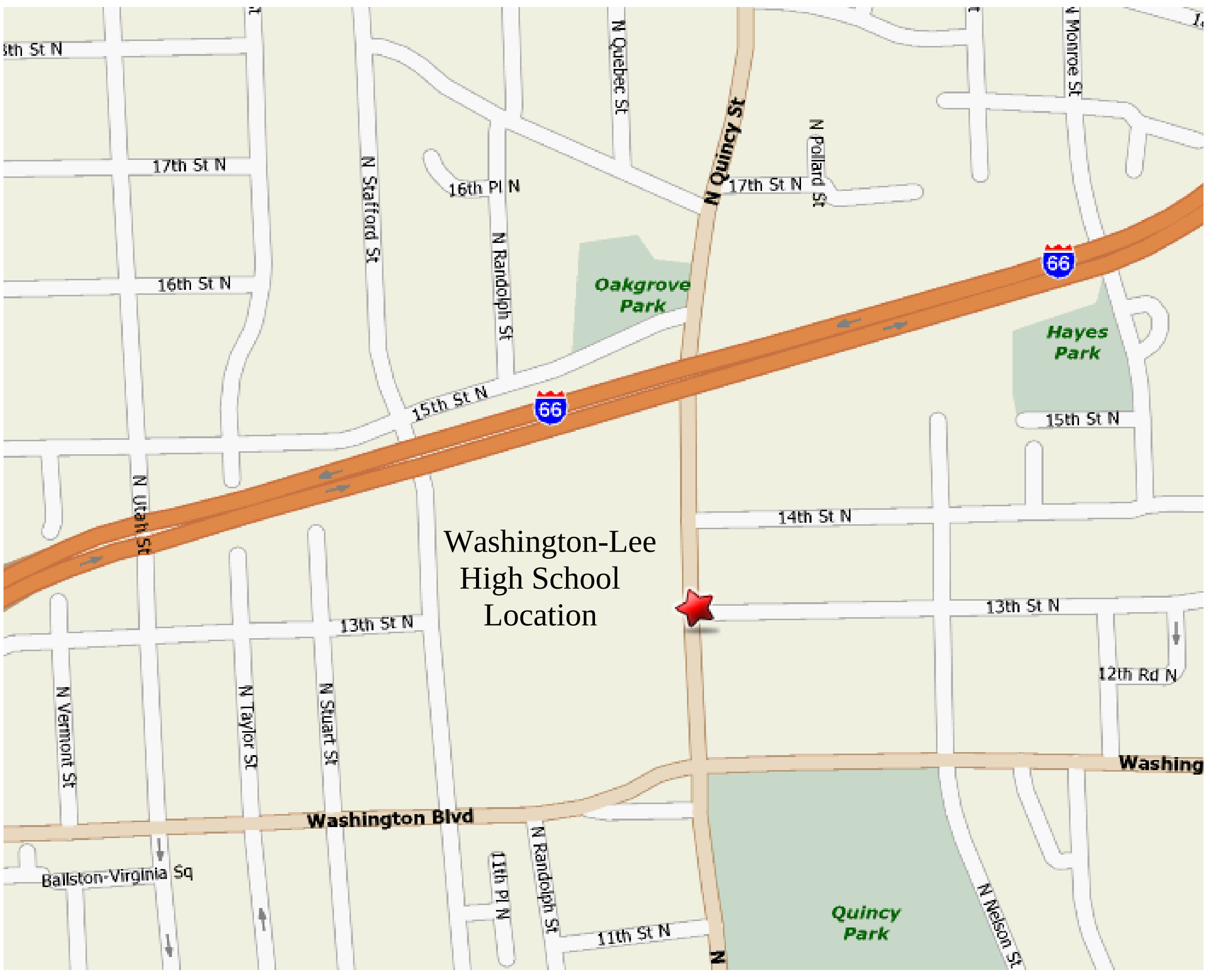
The project delivery method used on Washington-Lee High School was Design-Bid-Build. This method was chosen so that costs could be kept down and the project did not need to be fast tracked. They also wanted the building to be technologically advanced and LEED rated so the design took some time to accomplish. A CM-Advisor was also chosen to assist the owner in decisions and to make sure everything was going smoothly during construction.

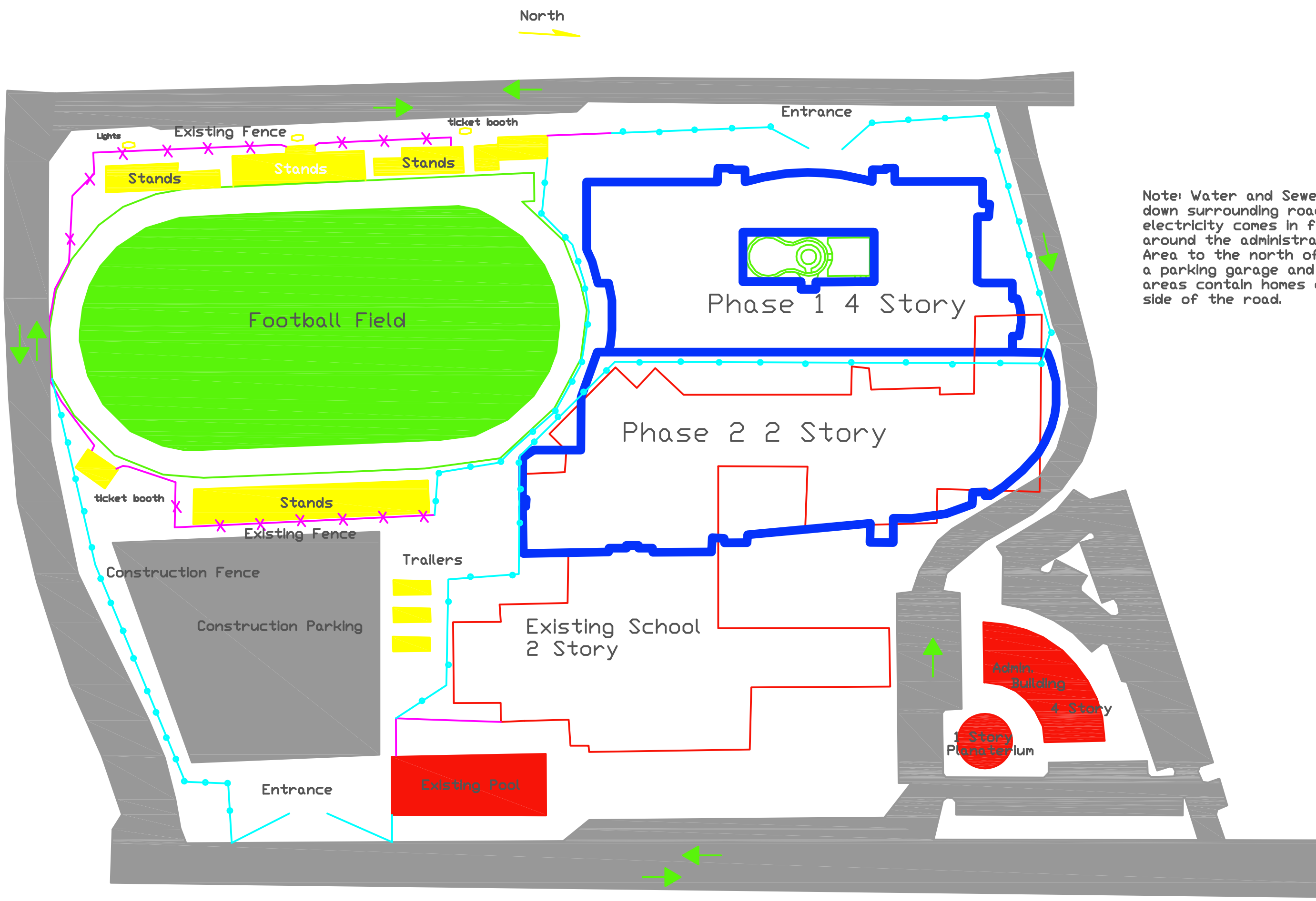
Hess Construction Company was chosen as the contractor from a select list of prequalified bidders. They had the lowest bid. The bonds required on this project were a performance bond and a payment bond that both had to equal 100% of the bid. Certain subcontractors also had to have these bonds. Most of the contract types are lump sum on the contractor side and cost plus fee on the design side. The organizational chart can be seen below.



Site Plan and Existing Conditions

The new Washington-Lee High School has not been given an official address, however the current school is located at 1300 North Quincy Street in Arlington, Virginia.





Note: Water and Sewer run down surrounding roads and electricity comes in from around the administration building. Area to the north of the road has a parking garage and all other areas contain homes on the other side of the road.

Thesis
2008

Matthew Hoerr

CM

Dr. Messner

Existing Conditions Site Plan for Washington-Lee High School

Drawing

C 1.01

Local Conditions

The new Washington-Lee High School is located in an urban environment and is in a very tight area, so there are not a lot of areas to park. The current softball field is being used as a staging area and for contractor parking. At some times during the day cars are triple parked within this area. After taking 29 boring samples it was found that the site contained fat clay, lean clay, silt, silty sand, clayey sand, poorly graded sand, and clayey gravel. About half of the soils located on the site can be used for structural fill.

The location of the new building was already fairly level however they had to be careful of organic materials and other buried items because of the old school. They also had to be careful of localized soft zones of soil. It was found that the new school would not adversely affect the water table at all. The building is going for a LEED Silver rating so recycling is very important and is readily available.

Building Systems Summary

Architecture:

The new Washington-Lee High School is a four-story building that contains a courtyard in the center. It was designed to hold over 1600 students. The building itself contains sixteen science labs, three business labs, eight computer labs, and 3 music rooms. This building also contains a cafeteria that opens up towards the track. A lot of thought was placed into the community access parts of the building which is why it contains an 800 seat auditorium, a large gym including 2 pools and a diving area. Two brand new soccer fields are also going to be created for the community.

The original building was built in 1924 and the design wanted it to be more modern but still maintain the tradition of the school. The building is designed to be a LEED-certified building and should qualify for LEED Silver Certification. Some of the LEED items in the design are a green roof as well as more efficient mechanical equipment.

Demolition

Approximately 225,000 square feet of the existing Washington-Lee High School had to be demolished so that the new High School could be constructed. In phase I, only part of the existing building is going to be demolished. These areas include the auditorium as well as some classrooms and offices. In Phase II, the cafeteria along with several classrooms will be demolished. After phase II is complete the new school building is complete and the rest of the existing school will be demolished.

There will be some trouble with asbestos and lead paint. This is mainly because the original building was constructed in the 1920's. Hess Construction has a separate contractor already scheduled to take care of these items.

Structural Steel

The new Washington-Lee High School is designed to be a mainly steel structure. The typical floor spans of the steel beams are usually between 20 and 30 feet. These beams will carry a 2" deep composite metal deck and have 5 1/4 " light weight concrete on top.

Cast in Place Concrete

The foundation is where most of the cast in place concrete took place on Washington-Lee High School. The foundation system of the school is very basic in that it uses shallow spread footings at each of the columns in the building and a continuous strip footing around the perimeter of the building. The slab on grade and the other floor slabs are reinforced with welded wire fabric. The way the concrete got to the upper floors was by a pump.

Masonry and Curtain Wall

The façade of Washington-Lee High School consists mainly of red brick which is traditionally used in Arlington County. With the building aiming for LEED Silver, large windows and open spaces also take up a significant amount of space on the building façade. These windows are mainly on the south side of the structure and contain shading devices to prevent too much solar gain. Metal panels are also used at several parts of the building so it gives the structure a better sense of scale both up close and from a distance. A different color brick is used to create banding to make the building look aesthetically pleasing and to help the scale when up close to the building. There will also be a lighter colored brick used for the stairwells, entranceways, and the fourth floor to make these areas stand out. Most of the exterior walls are 1'7" thick with CMU being tied in to the face brick.

Mechanical System

In Phase I of the construction of Washington-Lee High School the mechanical systems are located in a ground floor mechanical room and in the mechanical penthouse. On Phase II of the construction the mechanical systems are located in a second floor mechanical room. In total there are three different areas of the building that the equipment will be placed. The two 500 ton chillers are located in the mechanical room on the first floor along with all of the boilers. All of the air handling units serving the phase I areas are located on the roof along with 2 cooling towers. The other air handling units used to serve the second phase of construction will be located in the second floor mechanical room. All of the air handling units in the building range in size from 9000 to 21500 CFM. Each temperature zone in the building contains a VAV box with reheat coils. The science labs in the building will have a 24/7 make-up and exhaust system so that it complies with LEED requirements. The building will have electric direct digital controls and each zone and classroom will have their own temperature sensor.

Electrical System

The electrical service on Washington-Lee High School is an 8000 amp 277/480 volt, 3-phase, 4 wire system. The panels are located throughout the building in electrical closets and in the mechanical rooms. There is also a 277/480 volt 150 KW diesel backup generator for the school.

Lighting System

Almost all parts of the building will use 3 or 4 lamp F32W/SP35/T8/RS lights with electronic ballasts. The system will be designed to be the most efficient at high and low light levels. Motion sensors will be used to make sure unnecessary lights will be turned off. The parking lot will consist of high wattage metal halide fixtures.

Telecommunications System

The telecommunications system is going to consist of one voice/data line located near each of the teacher's desk and one dual data device line for computers located in each classroom. The media room will contain several others and the main networking hub will be located in the communications room.

Project Cost Evaluation

Washington-Lee High School is scheduled to be about 362,000 square feet. The original bid for the school was 84 Million dollars. This gave a cost of $232.04/SF for the building. The total project cost is estimated to be 95.2 Million dollars. This gives a total cost of the project of $262.98/SF. A breakdown of the building systems costs is as follows:

	Cost	**$/SF**
General Requirements	$11,643,515	$32
Site Construction	$6,916,262	$19
Concrete	$3,246,579	$9
Masonry	$7,651,156	$21
Metals	$9,576,874	$26
Wood and Plastics	$1,384,757	$4
Thermal and Moisture Protection	$3,786,623	$10
Doors and Windows	$3,530,137	$10
Finishes	$4,676,255	$13
Specialties	$925,997	$3
Equipment	$864,868	$2
Furnishings	$1,680,152	$5
Special Construction	$1,990,415	$5
Conveying Systems	$157,070	$0
Mechanical	$16,095,340	$44
Electrical	$9,874,000	$27
Total	$84,000,000	

Project Schedule Summary

Introduction

The new Washington-Lee High School is going to be completed in 3 phases. The first phase consists mainly of new classrooms, offices, and a cafeteria and is going to be completed in December of 2007. The students will move into this building in January and some of the old school will be demolished to make room for the phase 2 part of the building. Phase 2 consists of an auditorium, gym, and natatorium. Phase 3 follows and consists of the creation of 2 new soccer fields and demolishing the remaining parts of the old school.

Foundation

The foundation used on Washington-Lee High School was concrete. The soil onsite was good, so they used shallow spread footings where there are columns and continuous strip footings around the perimeter walls. They started in the areas closest to the stadium and moved away from it for the first phase of construction. The building was broken up into 5 sections with A and B comprising phase 1 and C, D, and E in phase 2. They basically followed the areas in order. The only areas of the building that needed extra foundation work were the Orchestra pit in phase 2 and the elevator shafts.

Structure

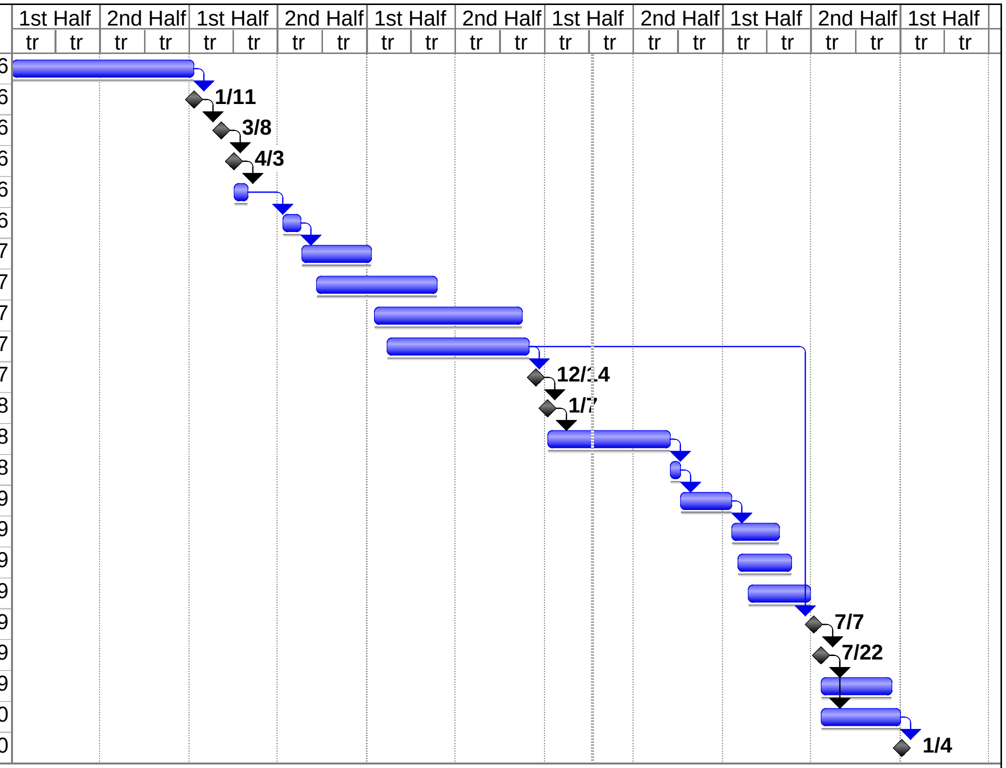
The structure of the building is a basic steel structure that uses beams typically spanning between 20 and 30 feet. The sequencing was done just like that of the foundation. Section A in phase 1 was completed first followed by section B in phase 1. Phase 2 has not yet begun but is going to be done in the same manner starting with Area C and working their way to Area E.

Finishes

The main element in the finishing work on this building is the MEP work. The building is going for a LEED Silver rating so the mechanical and electrical equipment are very large and are highly efficient. Coordinating this work was the most important thing when it came to finishing. All of the other items in finishing followed a typical order starting with framing the walls and ending with the new furniture in the building. The building is done in 2 phases so that the students can occupy phase 1 while phase 2 is being completed.

A one-page Summary Schedule is provided on the next page

ID		Task Name	Duration	Start	Finish
1		Design Phase	267 days?	Mon 1/3/05	Tue 1/10/06
2		Prequalification Packages	1 day?	Wed 1/11/06	Wed 1/11/06
3		Bids Due	1 day?	Wed 3/8/06	Wed 3/8/06
4		Notice to Proceed	1 day?	Mon 4/3/06	Mon 4/3/06
5		Demo for Phase 1	20 days	Tue 4/4/06	Mon 5/1/06
6		Foundation Phase 1	27 days	Thu 7/13/06	Fri 8/18/06
7		Steel Phase 1	103 days?	Mon 8/21/06	Wed 1/10/07
8		Masonry	178 days?	Wed 9/20/06	Fri 5/25/07
9		MEP	218 days?	Wed 1/17/07	Fri 11/16/07
10		Interiors	210 days?	Mon 2/12/07	Fri 11/30/07
11		Building Phase 1 Completed	1 day?	Fri 12/14/07	Fri 12/14/07
12		Startup of Phase 2	1 day?	Mon 1/7/08	Mon 1/7/08
13		Demolition for Phase 2	180 days?	Tue 1/8/08	Mon 9/15/08
14		Foundation Phase 2	15 days?	Tue 9/16/08	Mon 10/6/08
15		Steel Phase 2	75 days?	Tue 10/7/08	Mon 1/19/09
16		Masonry	70 days?	Tue 1/20/09	Mon 4/27/09
17		MEP	80 days?	Mon 2/2/09	Fri 5/22/09
18		Interiors	92 days?	Mon 2/23/09	Tue 6/30/09
19		Building Phase 2 Completed	1 day?	Tue 7/7/09	Tue 7/7/09
20		Phase 3 Startup	1 day?	Wed 7/22/09	Wed 7/22/09
21		Demo of remaining building	103 days?	Thu 7/23/09	Mon 12/14/09
22		Sitework and Soccer Fields	117 days?	Thu 7/23/09	Fri 1/1/10
23		Project Completion	1 day?	Mon 1/4/10	Mon 1/4/10



Project: Washington-Lee High School
Date:4/9/08

Task	Rolled Up Task	External Tasks
Progress	Rolled Up Milestone	Project Summary
Milestone	Rolled Up Progress	Group By Summary
Summary	Split	Deadline

GREEN SCHOOL RESEARCH

Problem

Green building practices and going for a LEED rating is becoming more and more popular. The new Washington-Lee High School is currently going for a LEED Silver rating, however there still is not a lot of school buildings that are going for a LEED rating. Green schools have so many advantages over conventional schools but there are several reasons that there are not more of them being built. It seems that most schools want to keep upfront costs low so that it pleases the tax payers in the area. There needs to be a way to educate tax payers and owners on the LEED system and its advantages so that learning environments in new schools will be better.

Goal

The goal of this research is to find out how much information that school boards know about the advantages of LEED rated schools compared to conventional schools. This will specifically be concentrated on my high school because they are currently in the midst of designing a new intermediate school. The hope is to find a reason why more LEED rated schools are not being built and to find a solution to this problem.

Resources

US Green Building Council
LEED Design for Schools 2007
Surveys to School Board Members
Other LEED websites

Methodology

The first thing that was done was to research the LEED point system. This was done to understand what items were needed to be done for a school to become LEED rated. The next thing that was done was to read the Greening Americas Schools: Costs and Benefits study by Gregory Kats. This item provided case studies and went into great detail on the advantages of having a LEED rated school compared to a conventional school. After the main background research was done, it was time to send surveys out to school board members to determine how much they knew about LEED rated schools. This information was important in determining why new schools are not going for a LEED rating. A solution for this problem was found for Dallastown area school district with the hope that more new schools will become LEED rated so that there is a better learning environment for students.

Research

The construction of new schools is the largest construction sector currently in the United States and costs approximately $80 billion from 2006 to 2008. It is a well known fact that conventional schools typically have a smaller upfront cost and higher operational costs whereas green schools cost more on design and construction and have much lower operational costs. It seems that this upfront cost is one of the main reasons that more new schools are not going for a LEED rating. Private schools are more likely to go green than public schools because they can afford the extra upfront costs and public schools are usually on a very strict budget. Even though the upfront cost of a LEED rated school is higher than conventional schools there are several financial advantages of having a green school.

According to Greening Americas Schools, LEED rated schools typically cost on average 2% more than conventional schools. This is usually an increase of approximately $3 per square foot of building area. The financial savings of having a green school is estimated to be approximately $74 per square foot. This means that in the end, the net financial benefits of constructing a green school is going to be about $71 per square foot. This is due to the significant amount of operational and maintenance cost savings of having a green school. Typical LEED rated schools can save over $100,000 per year on energy costs depending on the size of the school. Even though the upfront costs are higher, the real advantage of having a green school is the impact that it has on the environment.

The LEED rating system for schools emphasizes classroom acoustics, master planning, indoor air quality, mold prevention, energy efficiency, and water conservation. Green schools on average use 30% less energy, 30-50% less water, and reduce carbon dioxide emissions by 40% compared to conventional schools. These savings will help provide a better environment for the future and will also help prevent global warming. There are also several benefits of having a LEED school that are hard to quantify.

Green schools typically have better lighting, temperature control, and improved ventilation. This is because green schools use more efficient lights such as compact fluorescents. Green schools also have more efficient heating and cooling systems. All of these factors produce a better learning environment for students. This results in an increase in test scores. The indoor air quality is better in green schools which helps contribute to a reduction in asthma, colds, and the flu. This means that absenteeism will be decreased and children will be sick less often. There is also a positive correlation between green schools and faculty retention. There are so many advantages of going green that there has to be some reason that more new schools are not going for a LEED rating.

Sources for the statistics and research information found above.

Greening Americas Schools: Costs and Benefits by Gregory Kats, 2006
www.usgbc.org
Turner Green Building Survey, 2005

Survey

The focus of this research is on Dallastown Area School District and is very important to me because I graduated from high school there. While I was in school there, they were always doing renovation work on the High School and other schools in the district. Dallastown is one of the fastest growing areas in the entire country and the newly renovated High School is already overpopulated. They are currently in the process of designing a new intermediate school and I feel like they represent how most school districts would go about deciding on whether or not their new school will go for a LEED rating. Surveys given to the school board can be seen in appendix B.

Survey Results

After doing research on green schools and their advantages, surveys were handed out to Dallastown Area School District school board members. They are currently in the midst of designing a new intermediate school and I wanted to see if they were even considering going for a LEED rating. It turns out that the school board members knew more about green schools than what I had anticipated. Several of them would like the new school to go for a LEED rating however they ran into several problems that are preventing this.

The tax payers in the area were already in disarray and upset over the initial costs of the new intermediate school and that was without going for a LEED rating. The main reason why the new school would not be going green was cost. The school board could not justify spending the extra amount of money to go LEED when the cost was already high and tax payers were already complaining. The school board felt that the public was not educated enough on the advantages of having a green school.

This lack on knowledge contributes to the reason on why the new intermediate school will not be going for a LEED rating. If the public knew all of the advantages that this school would have for their children, then they might be able to be convinced that the extra cost would be well worth it. The survey also revealed that utility and maintenance costs for the school district were very high. If the public could understand that taxes could be reduced in the future because of the energy savings then they may be willing to pay the higher upfront costs for the school.

Solution

After reviewing the answers to the survey questions and identifying the reasons why the new intermediate school was not going for a LEED rating a solution to the main problem needed to be found. It seemed that everything stemmed from the lack of knowledge that the public had on the advantages of having a green school. Educating the public on green schools advantages is of the utmost importance for school districts looking to go for a LEED rating.

The best way to do this in the Dallastown area school district would be to put statistics and articles in the pamphlets and community couriers that are distributed monthly to the public. Even if not everyone reads these statistics, if it convinces at least a few people to talk about green schools then it did its job. These statistics can come from the study Greening Americas Schools by Gregory Kats and should reflect the advantages of having a green school. The information contained in these pamphlets should also contain information showing how a green school will produce a better learning environment for their children. It should show how test scores in green schools has gone up and that children are generally healthier and miss less school days in green schools compared to conventional schools. This should convince some people to be willing to pay the extra money in taxes so that their children will be healthier and happier.

In the end, educating the public on the advantages of having a green school will take some time. Having lived in the area all of my life I know that people do not like paying more for taxes and it will take a lot to convince them to be willing to do so.

Conclusion and Recommendations

After doing research on green schools and giving surveys to the Dallastown Area School District school board members it was found that LEED schools have a huge advantage over conventional schools. Green schools have better lighting and more efficient heating and cooling equipment. They concentrate on classroom acoustics, master planning, indoor air quality, mold prevention, energy efficiency, and water conservation.

It was determined that there are several reasons that new schools are not going for a LEED rating. These reasons are cost and lack of knowledge by the public. More private schools are going green because they can afford the upfront costs and public schools are usually on a very tight budget. The public needs to be educated on the advantages of having their children go to a LEED rated school. The best way for the Dallastown area school district to do that is to put statistics and information about green schools in the community courier and the pamphlets that the schools send out monthly. They need to show parents how having a green school will produce a better environment for their children. Their children will achieve better test scores and will be sick less often. They need to show the public that having a green school will not only have an immediate impact on the health of their children now, but will also provide a healthier environment for the future.

ARCHITECTURAL PRECAST FAÇADE
(Mechanical Breadth)

Problem

The new Washington-Lee High School is 4 stories high and the current façade consists of many different elements including masonry, storefront windows, curtain walls, and metal panels. The main element is the traditional Arlington County red brick with CMU backup and insulation. Constructing this façade took many months to complete due to the amount of brick used and could have prevented finishing trades from starting sooner.

Scaffolding around the exterior of the school

Goal

The goal of this analysis is to determine if replacing the current wall system with a precast panel façade system will save schedule time and also raise the thermal resistance of the wall so that heating and cooling loads will be reduced. Whether or not a precast system is even an option because of the small construction site and the proximity of the new school to the current school will also need to be determined.

Resources

High Concrete Inc.
Altus Group
RS Means 2008 Edition
1997 ASHRAE Handbook of Fundamentals

Methodology

The first thing that needed to be done for this analysis was to determine the amount of brick that would need to be replaced using precast masonry panels. After that, a precast system and manufacturer had to be chosen that would be able to be used on Washington-Lee High School. Some requirements for the system were that the manufacturer had to be somewhat close to the job site so LEED credits would not be affected and the system needed to be economical and have a very high R-value so that mechanical loads could be reduced. After the system was chosen, several different impact areas were looked into such as structural, schedule, mechanical load, cost, and constructability. Finally, all of the data was assembled and conclusions were made.

Precast Panel System

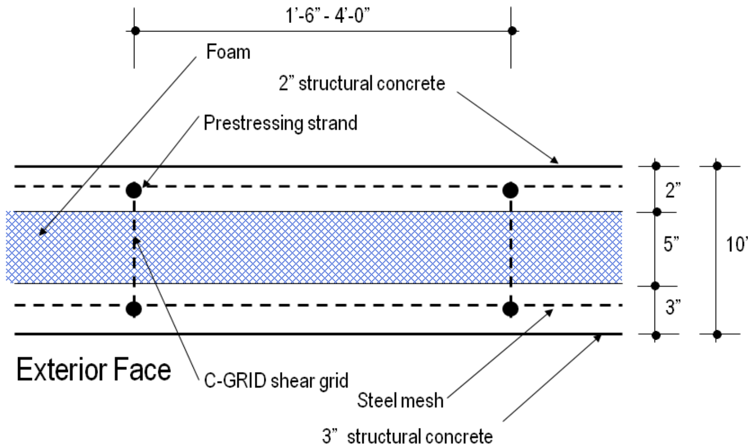
There are several different types of wall panel systems that were available to choose from and would work on Washington-Lee High School. After looking at several of them and researching their advantages it was determined that the Altus Group's Carboncast system would be the best one to use on the new Washington-Lee High School. This system really showed off its ability to get LEED points and also its cost and weight would be kept down compared to other insulated wall panel systems. The exterior of the school would look the same as the current system by using thin brick on the exterior of this panel system.

The Carboncast system was chosen because it uses different technology than most insulated wall panel systems and has many different advantages. The way most Carboncast panels are laid out is with two concrete wythes that are separated by rigid foam insulation boards. The panel designed for Washington-Lee is no different and contains 3 inches of concrete on the exterior, 5 inches of foam insulation board, and then another 2 inches of concrete on the interior. Carboncast panels are innovative in that they replace the conventional steel or fiberglass wythe connectors that typical precast panels use with C-GRID carbon fiber trusses. This 1 mm thick C-GRID is not only stronger than other connectors it is also less thermally conductive. Using C-GRID allows these panels to be lighter in weight and also thinner than other precast panels. It also has the ability to limit hot and cold spots that are common with solid concrete areas or highly conductive steel connectors. Carboncast panels also are very fire resistant and will help to prevent mold growth in the school. These panels are built in a controlled environment so there will be less waste. There will also be no need to worry about efflorescence forming on the exterior of the panels like you will with the current system A picture of how these Carboncast panels are constructed can be seen below.

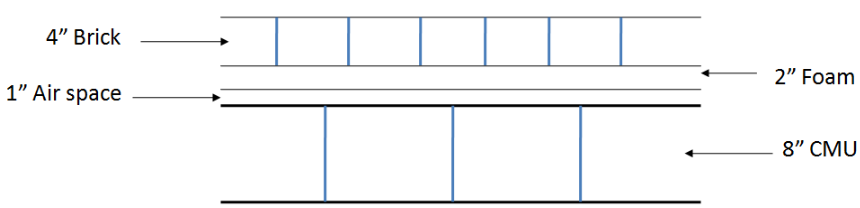

Layout of Carboncast panel

The Carboncast system is also different from other precast panels in that the panel sizes can range from 8’-14’ wide and up to 65’ tall. The specific design for Washington-Lee was designed to be one storey high each and would be 12’ wide. The height of the panels would range from 14’-18’ high. The width of the panels for Washington-Lee was designed to be the most thermally efficient while keeping the weight and cost of the panel down. The width was determined to be 10” thick with thin brick used on the exterior. The width is greatly reduced from the current stick built design which is 15”. A comparison of the two designs can be seen on the next page.

Precast Panel



Current Façade



Structural Impacts

A brick with CMU backup wall is going to have a different weight than the Carboncast insulated panel system. The weight of the Carboncast panel was quoted by Gary Reed of High Concrete Inc. and was found to be approximately 65 lbs/sf. The current system was found to weigh approximately 75 lbs/sf. Both of the systems weigh about the same so the foundation for the school will not have to be increased. The current system is designed to transfer gravity loads to the strip footings around the exterior of the building and the Carboncast system will do the same thing.

Mechanical Impacts (Breadth)

After selecting the Carboncast system, it was known that it was going to have an immediate impact on the mechanical system. The insulated panel was designed so that it would have a fairly high R-value so that the mechanical loads could be reduced in the school and so the mechanical equipment might be able to be reduced in size. The better the exterior wall is at resisting temperature change the more comfortable the learning environment will be on the inside of the school. Tables of the R-value calculations can be seen below.

Current Design			
Component	R-value	Thickness	Total R-value
Outside Air Film	0.17	∞	0.17
Brick	0.11	4	0.44
Extruded Polystyrene Ins.	5	2	10
Air gap	1.68	1	1.68
CMU	0.13875	8	1.11
Inside Air Film	0.68	∞	0.68
		Total	14.08
		U-value	0.0710

Carboncast Panel			
Component	R-value	Thickness	Total R-value
Outside Air Film	0.17	∞	0.17
Concrete	0.08	3	0.24
Extruded Polystyrene Ins.	5	5	25
Concrete	0.08	2	0.16
Inside Air Film	0.68	∞	0.68
		Total	26.25
		U-value	0.0381

After the U-value is found, it is possible to determine how much the mechanical loads will be reduced and if the mechanical equipment can be downsized. The way this is done is by using the heat transfer equation h=A*ΔT*U and then comparing the difference to the total load. Tables for this calculation can be seen below.

Winter Temperature	
To	15
Ti	70
ΔT	55

Summer Temperature	
To	95
Ti	70
ΔT	25

Winter Heat Loss				
System	Area (sf)	U-value	ΔT (F)	Heat Loss (BTU/hr)
Brick w/ CMU backup	120160	0.0728	55	481120.64
Carboncast	120160	0.0381	55	251795.28
			Difference	229325.36
			Boiler Load	4502000
			% Difference	5.10%

Summer Heat Gain					
System	Area (sf)	U-value	ΔT (F)	Heat Gain (BTU/hr)	Heat Gain (Tons)
Brick w/ CMU backup	120160	0.0728	25	218691.2	18.2
Carboncast	120160	0.0381	25	114452.4	9.5
				Difference	8.7
				Chiller Load	847.6
				% Difference	1.02%

Even though the R-value of the Carboncast system is much higher than that of the current design, it is not enough to affect the mechanical equipment sizes. There is only a difference of 1.2% on the chiller load and a difference of 5.1% on that of the boiler load. This means the mechanical equipment can not be reduced like it was hoped to be.

Schedule Impacts

The main advantage of using the Carboncast system or any precast system is the schedule savings that can be achieved. The current exterior façade is scheduled to take approximately 175 days of masonry work to complete. This includes both phase 1 and phase 2 of the project. The Carboncast system will take approximately 79 days to complete which means there is a 96 work day difference between the Carboncast panel system and the current stick built system. The lead time for the panels must also be taken into account. All of the design work on the school must be completed before construction on the panels could be started and no changes can be made once a panel is started. One of the major positives of this schedule reduction is that the school would be enclosed much earlier than originally planned. This means that there is less chance for moisture to get into the school and for mold to start growing. That is very important to all buildings but is especially important because this school is going for a LEED rating. Please see the table below for a schedule comparison between the two systems.

Type	Quantity	Unit	Production	Days
CMU + Brick	120,160	SF		175
Carboncast System	120,160	SF	1536	79
Panels	626	Panels	8 Panels/day	
			Total Difference	-96

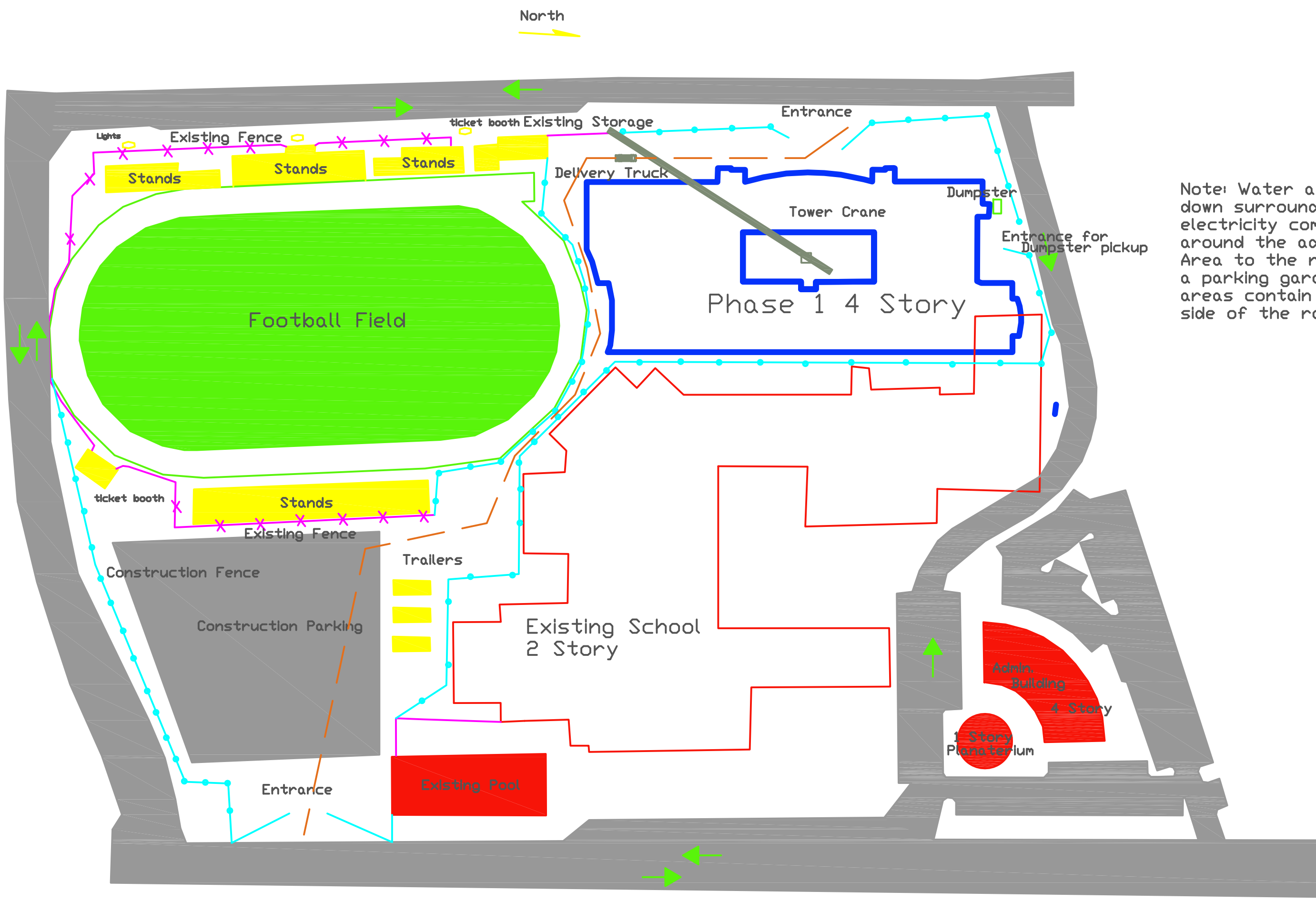
Site Plan Implications

Another important thing to consider when using the Carboncast panels is the amount of space that is going to be saved onsite. There will no longer be large storage areas filled with CMU's and brick around the exterior of the site. There also will be no need for scaffolding which cluttered up the site a lot on this project. The big problem with using the Carboncast panel system is that there now needs to be a crane onsite to lift the panels off of the truck and onto the exterior of the school. A lot of coordination is needed between the deliveries and the installation of the panels. This needs to be done in a timely matter so that the crane can almost always be in use to save money.

Another problem that came about was how to install the Carboncast panels on the courtyard facades. A standard mobile crawler crane would most likely not be able to reach this area from the east and it would also be difficult to reach the area on the eastern side of the school because the existing school is so close to the new school. A picture of this can be seen below.

Picture showing the distance between old and new school which gets even narrower at the southern side

The solution for this problem is to use a tower crane and place it in the center where the courtyard is located. This crane will be able to reach all of the areas needed for phase 1 of construction and can also be used for the steel erection. The sequencing will not have to be changed for the steel erection and more space will be saved for steel staging areas. The drawback of using the tower crane is it is more expensive than using the normal mobile crane. These costs were taken into account in the Cost Impacts section of this report. A new site plan showing the crane and the way the trucks would deliver the materials can be seen on the next page. Specifications for the new tower crane can be seen in Appendix C.



Note: Water and Sewer run down surrounding roads and electricity comes in from around the administration building. Area to the north of the road has a parking garage and all other areas contain homes on the other side of the road.

Thesis
2008

Matthew Hoerr

CM

Dr. Messner

April 9, 2008

Detailed Site Plan for Precast Panel Erection
Washington-Lee High School

Drawing

C 1.01

Cost Impacts

There are several added costs that the Carboncast system will add to the total cost of the school. The panels are slightly more expensive and will take a crane to erect the panels. A cost comparison can be seen in the tables below.

Description	Quantity	Unit Price	Cost
4" Standard Brick, Insulation, and 8" CMU Backup	120,160	$30.70	$3,688,912.00
Arlington Location Modifier		0.924	($280,357.31)
		Total	$3,408,554.69

Description	Quantity	Unit Price	Cost
Carboncast Panel and Delivery	120,160	$50.00	$6,008,000.00
Tower Crane	8	$60,000	$480,000
Mobile Crane	103	$2,600	($267,800)
General Conditions	19 WK	$13,140	($249,660)
Arlington Location Modifier		0.924	($453,761)
		Total	$5,516,779

The cost for the Carboncast panel and delivery was quoted by Gary Reed of High Concrete Inc. As expected, the cost of the Carboncast system is significantly more expensive than the original design. There is a difference of over $2 Million, however the real advantage is the reduction in schedule which will lower the general conditions costs.

Conclusion and Recommendations

When examining the results of this analysis, the Carboncast insulated panel system exceeds the current design in every aspect except for cost. The Carboncast system is constructed in a controlled environment so the quality will be better and the waste will be reduced compared to the current design. The Carboncast system is also going to save approximately 96 days of construction time. This means that there will be no need for scaffolding on the side of the building, site congestion will be kept down, and the building will be enclosed sooner. The weight of the panels will be approximately the same as the current design, so the foundation will not have to be increased in any way. Even though the mechanical equipment cannot be downsized the mechanical loads are reduced because of the high R-value that the Carboncast system provides.

The only downfalls of using the Carboncast system on Washington-Lee High School are the cost and the need to use a tower crane to erect them. The Carboncast system will cost $2,108,224 more than the current design. This represents a 2.51% increase in the overall cost of the school, however more general conditions costs could be saved. Using the Carboncast system will also require the use of a crane to erect the panels. It will have to be done with a tower crane so that the courtyard area and the eastern side of the school could be reached. The steel could also be constructed with the tower crane so some costs of the original mobile crane could be saved.

After taking all of this information into account using the Carboncast system on the new Washington-Lee High School is considered a feasible alternative to the current CMU and brick design that is currently being used. If willing to spend the extra money, this system can prove valuable in providing a higher quality exterior façade.

VALUE ENGINEERING/REDESIGN OF GYMNASIUM LIGHTING

Problem

The new Washington-Lee High School is currently trying to achieve a LEED Silver rating, however the current lighting design in the gymnasium wastes a lot of energy and lighting levels are hard to control. The current design uses pendant style luminaires that contain 1000 watt metal halide bulbs. There are currently 32 of these fixtures in the gymnasium and each of them uses a significant amount of energy. Lighting levels are also hard to control in this space because the fixtures typically take a while to warm up when they are turned on and are left on for significant periods of time even when nobody is occupying that space. Gymnasiums are typically used for several different types of events and different lighting levels are sometimes needed.

Goal

The goal of this gymnasium lighting redesign is to save energy costs and allow for different lighting levels in the gym. The gymnasium is going to be used by community members and it would be beneficial to be able to have more control over when the lights are turned on. A significant amount of energy savings could also result in extra LEED points which could push Washington-Lee High School to a Gold rating.

Resources

Forum Lighting
Sylvania Website
Luxicon Software
Lithonia Website
Microsoft Excel
ASHRAE 90.1

Methodology

The first thing that had to be done was to determine which type of luminaire was going to be taking the place of the current 1000 Watt Metal Halide pendant fixture. After doing some research, it was discovered that several gymnasiums around the country had changed their lighting from Metal Halide fixtures to T5 High Output fluorescent light bulb fixtures and were having a lot of success doing so. A 6-lamp 54 watt T5HO fixture was then found on lithonia’s website and was selected to take the place of the current system.

It was very important that the new system provide an illuminance level of 30 foot candles at a height of 3 feet about the floor. After inputing this information into Luxicon it was found that the T5HO fixtures could replace the Metal Halide fixtures one for one.

Existing Conditions

The existing lighting design contains 32 pendant style 1000 Watt Metal Halide fixtures. This lighting design uses a lot of energy, however provides a significant amount of light to the ground and also showcases the structure of the gymnasium. The current design can be seen in Figure 1, Figure 2, Figure 3, and Figure 4.

Existing Fixture

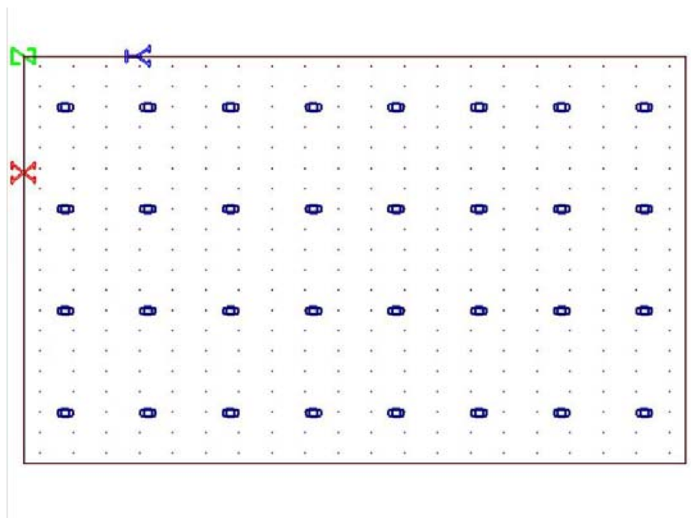


Figure 1 shows the current lighting layout

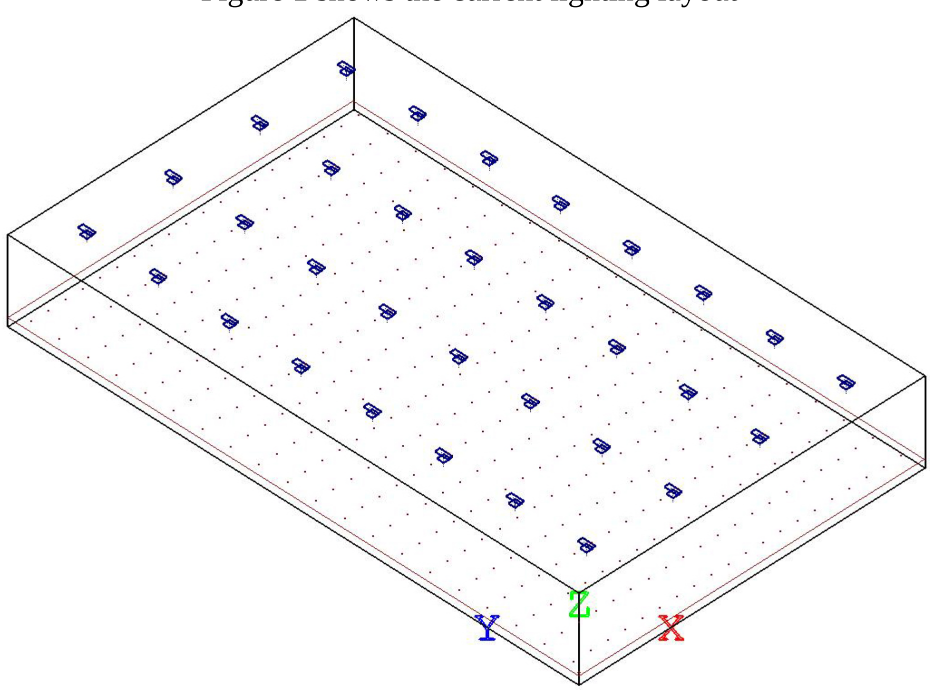


Figure 2 Shows an Orthographic of the current lighting layout

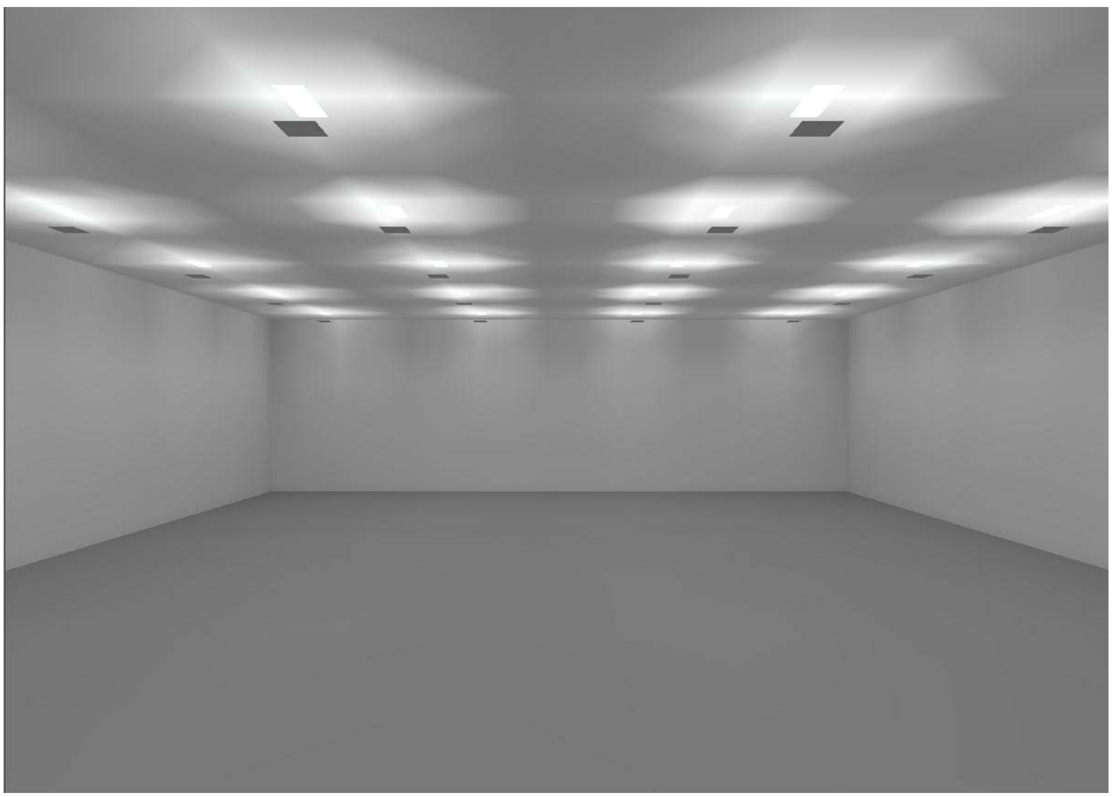


Figure 3 shows a rendering of the current lighting layout

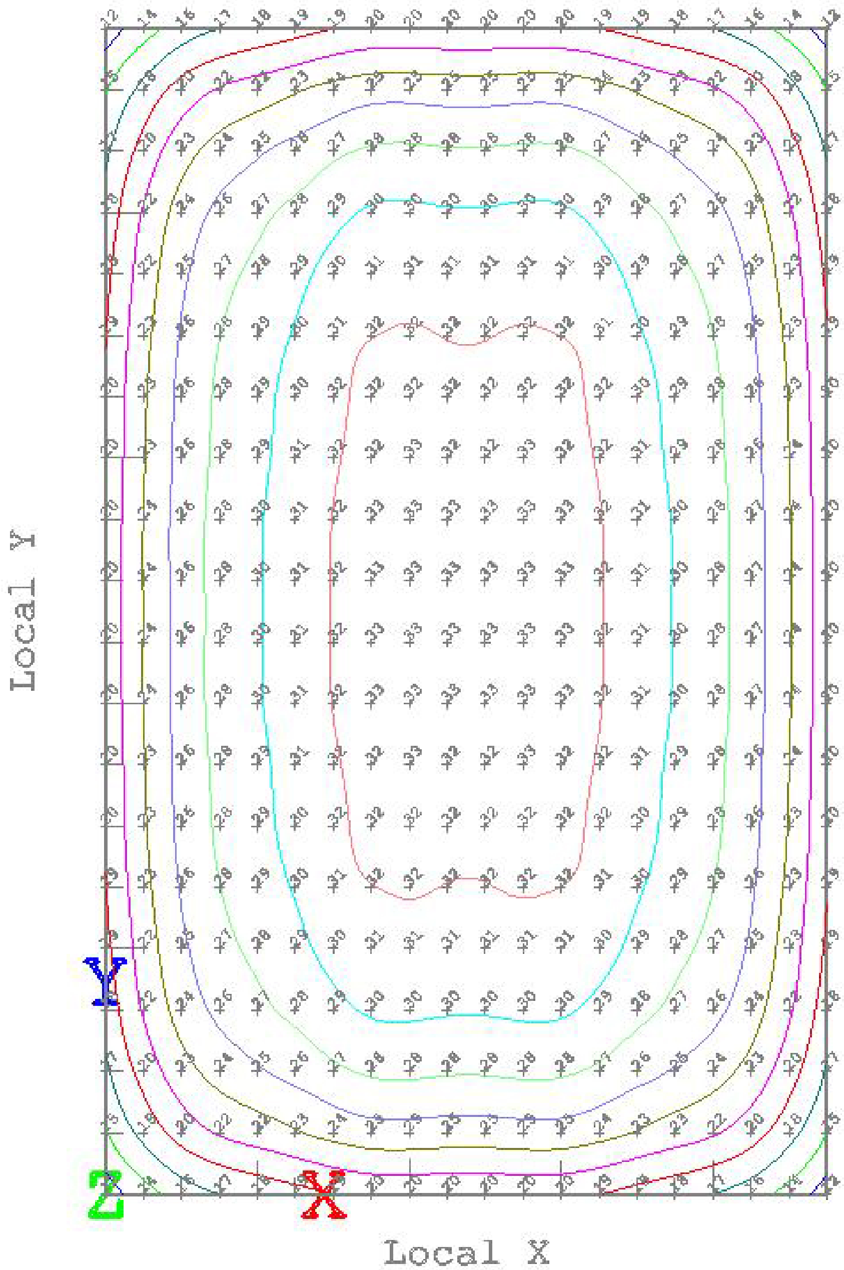


Figure 4 shows the lighting levels in the current design. The average illuminance level is 26.1 fc and the max illuminance level is 32.9 fc.

Redesign Conditions

The redesign of the lighting in the gymnasium contains thirty-two 6-bulb 54 Watt T5HO fixtures. This design meets the illuminance level needed and also uses significantly less energy to achieve it. The new design does not show off the structure of the gymnasium like the current design, however it provides better lighting levels and gives the user more control over when the lights are on or off. The redesign of the lighting in the gymnasium can be seen in Figure 5, Figure 6, Figure 7, and Figure 8.

Redesign Fixture

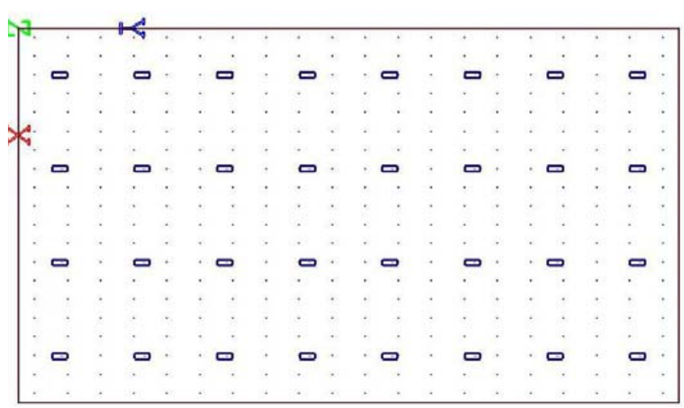


Figure 5 shows redesign layout which happens to be the same as current layout

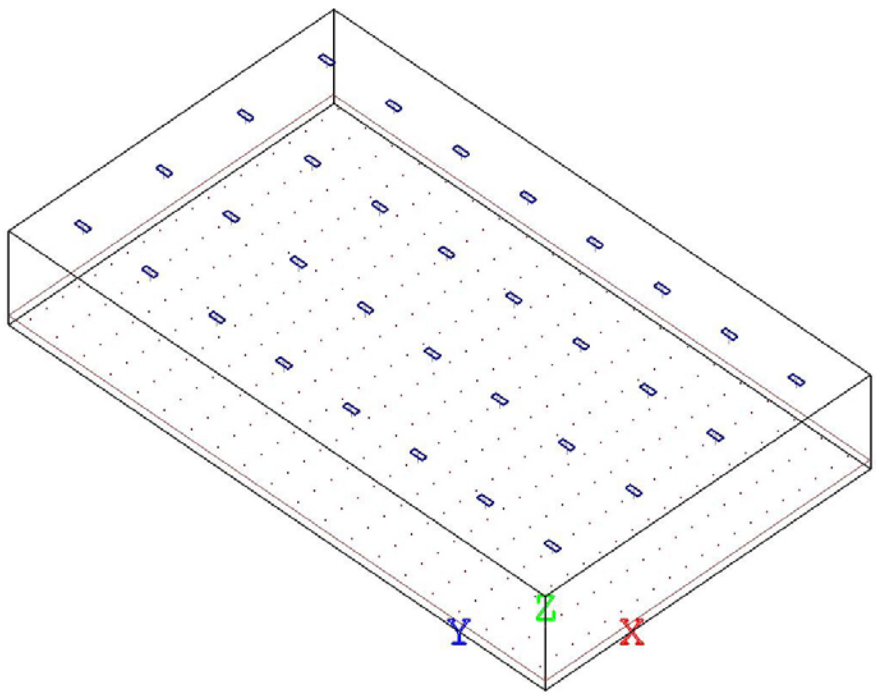


Figure 6 shows an Orthographic of the redesigned layout

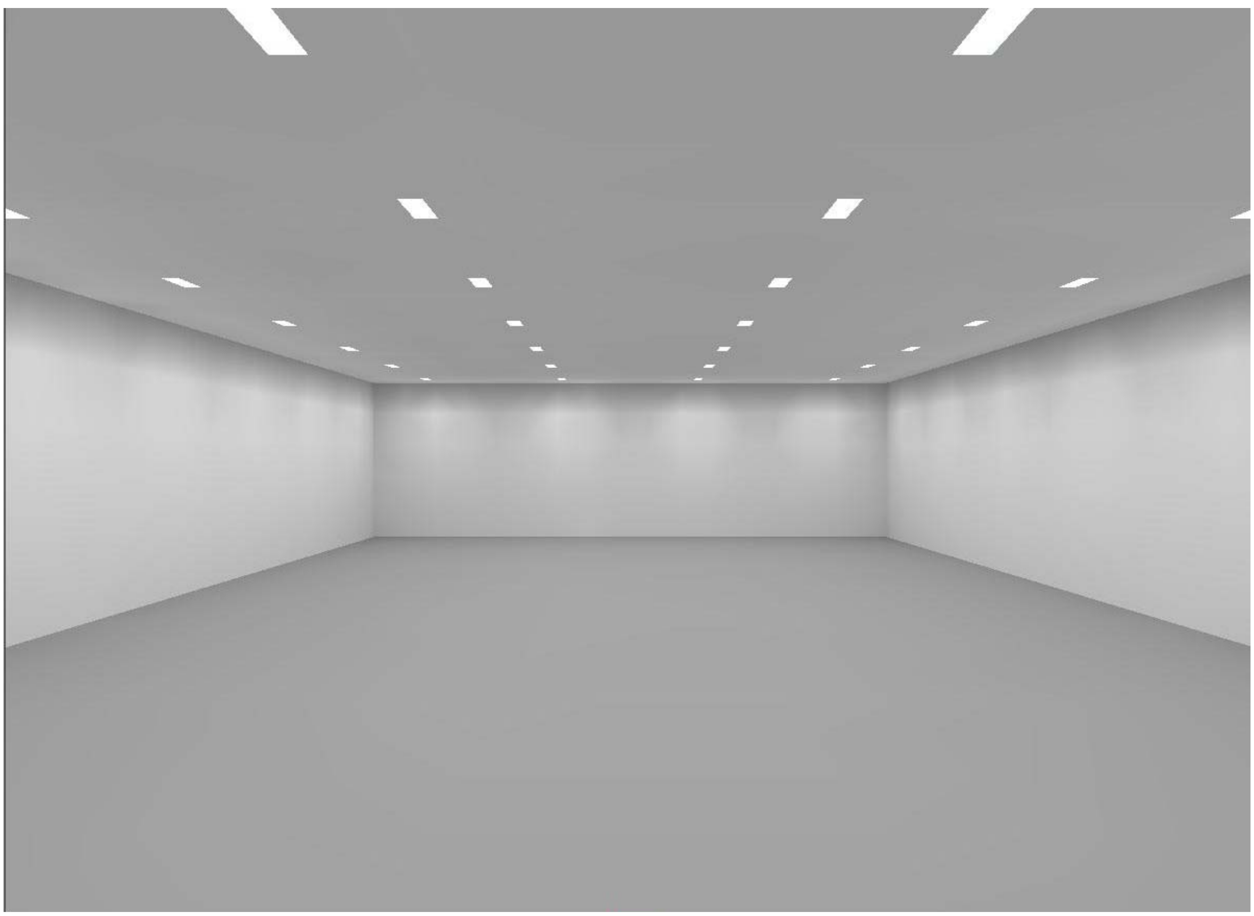


Figure 7 shows a rendering of the redesigned layout

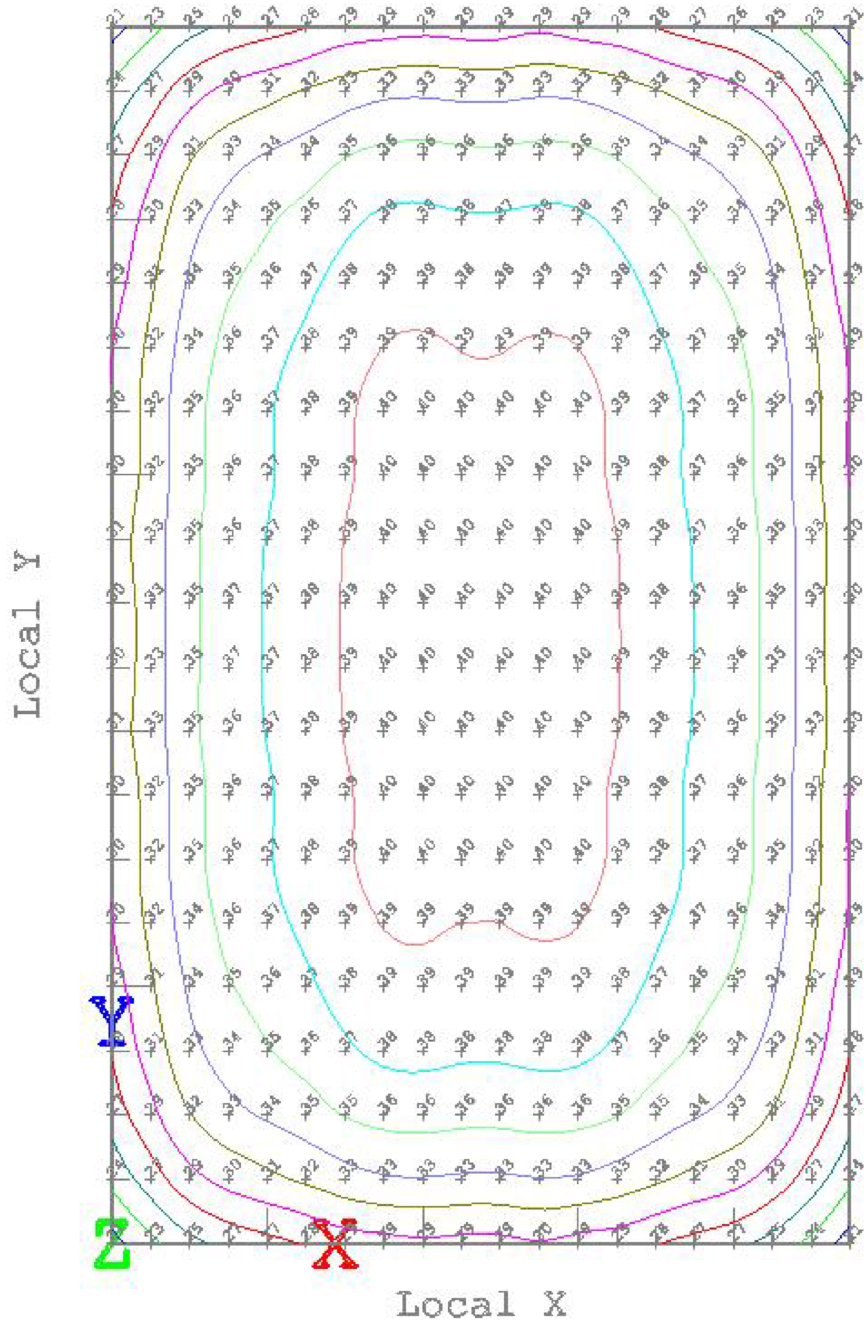


Figure 8 shows the lighting levels of the redesigned gymnasium. The average illuminance level is 34.4 fc and the max illuminance level is 40.2 fc.

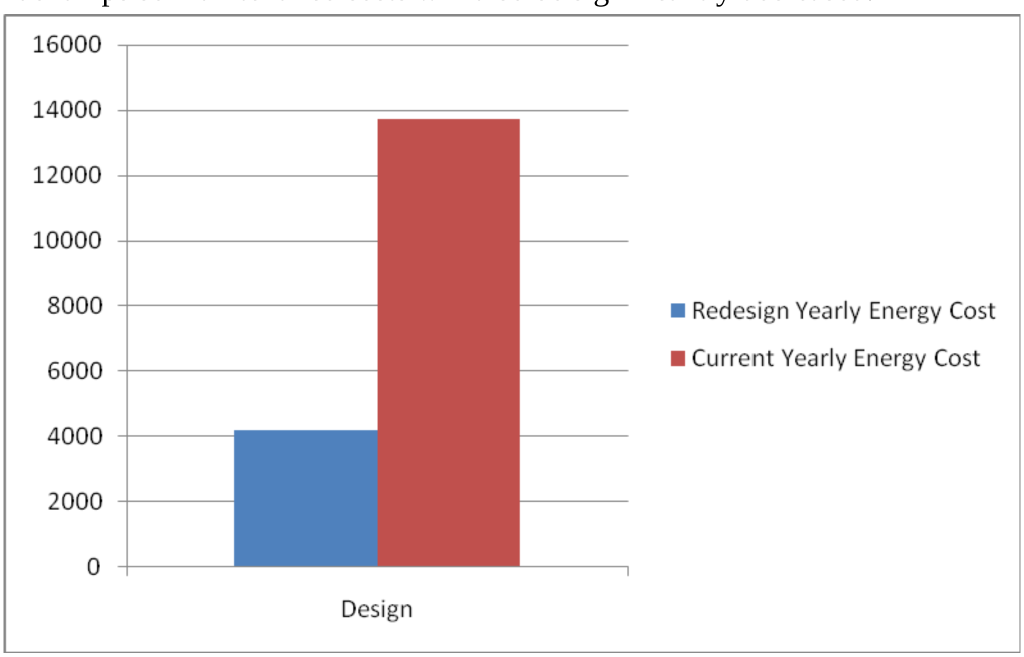
Power Density

ASHRAE 90.1 recommends that the maximum power density allowed in a gymnasium be 1.1 W/sf. The redesigned power density is 0.7 which is well below the requirement. Table 1 shows the calculation of the power density.

Quantity	Watts/Luminaire	Total Watts	Sq. Ft.	Power Density
32	324	10368	16000	0.648

Energy Savings

The redesign of the gymnasium is going to save a significant amount of energy costs compared to the current design. Using the estimating software in Luxicon it was found that the new redesigned gymnasium would save the owner approximately $9500 per year in electrical costs (see graph 1 below). This estimate is also on the low side because the software would not factor in the fact that the new redesigned system could be turned off when the gymnasium was not in use. Fluorescent lights tend to last longer than metal halide lamps so maintenance costs will also be significantly decreased.



Graph 1 Shows Yearly Lighting Cost for Gymnasium

Conclusion and Recommendations

It is recommended that the redesigned lighting system for the gymnasium be utilized rather than the current lighting design. The current lighting system does show off the structure of the gymnasium in a good way and the redesigned system does not, however there are way too many advantages to the redesigned system to pass it over. The redesigned system uses the same number of luminaires as the current system, but is going to save the owner more than $9500 per year in electricity costs. It also contains lights that last longer than the metal halides that the current system uses which will save money on maintenance costs. The redesigned system gives the owner more control so that different lighting levels can be reached inside of the gymnasium. It also exceeds the ASHRAE 90.1 standard on power density for gymnasiums and can help get more LEED credits in the Energy and Atmosphere category. This redesigned system will not require any extra circuits on the panel board and may actually reduce the number of circuits needed in the gymnasium. After looking at all of the advantages the redesigned system has, it is clear that this design will save energy and gives the owner more control over the lighting levels in the gymnasium.

SUMMARY AND CONCLUSIONS

The first part of this report contains information on research on LEED rated schools and why there are not more of them being built. Surveys were sent out to Dallastown area school district school board members and analyzed on why their new intermediate school proposal was not going green. The findings were that they could not justify the extra cost of going for a LEED rating on the new school. The public was already upset about the cost of the new school and adding more cost would not go over well. It was suggested that if the public was educated more on the advantages of having a green school they might be willing to pay the extra tax money. The best way for Dallastown to educate the public would be to put articles and statistics in the pamphlets and community couriers that go out monthly.

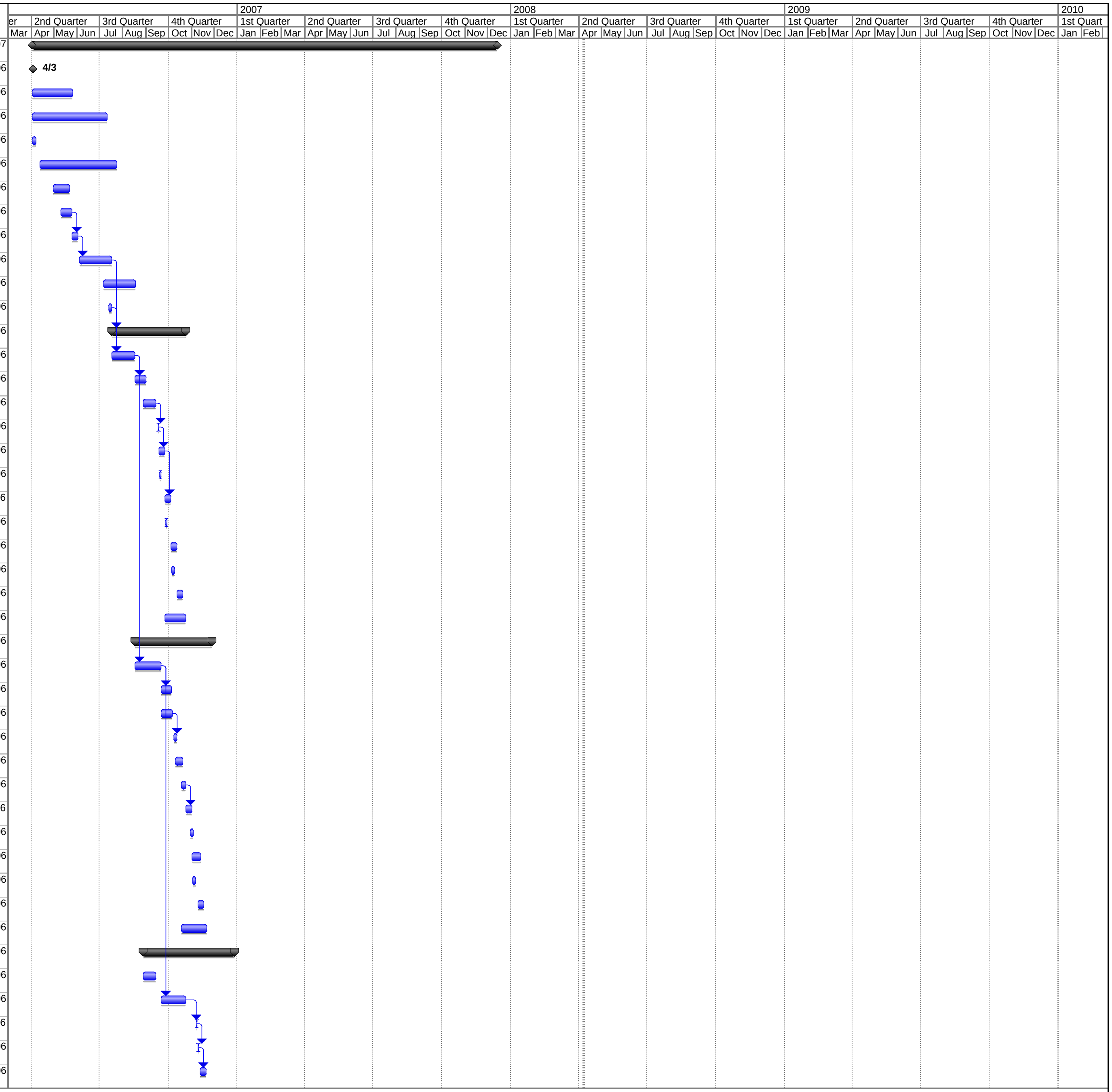
The first analysis that was done was to compare the use of architectural precast panels on the façade with the current façade design. Altus Group’s Carboncast panels were chosen and were found to be a feasible alternative to the CMU and brick that is currently being used. Using these panels will reduce the schedule by 96 days however will require the use of a crane to erect them. These panels will also provide a reduction in heating and cooling loads. The only downside to using the Carboncast panels is the increase in price compared to the current design. It would cost approximately $2 million dollars more to use the Carboncast panels, however the quality of these precast panels would be better and waste would be reduced. In the end, the Carboncast panels were found to be a feasible alternative to the current design if the owner was willing to pay the extra money.

The second analysis that was done was to value engineer/redesign the lighting in the gymnasium. The current gymnasium design uses 1000 watt metal halide bulbs which are more inefficient when compared to fluorescent lighting. A 6-bulb, 54 watt T5HO luminaire was chosen to take the place of the current metal halide fixtures. It turned out that these fluorescent luminaires could replace the metal halide fixtures 1 for 1 so no extra fixtures would be added. The new design was kept so that the power density met ASHRAE 90.1 standard of 1.1 W/sf for gymnasiums. After the lighting levels were found and renderings were made the energy savings was calculated. The new design would save more than $9500 per year in electricity costs. It would also give the owner more control over the lighting levels in the gymnasium. The redesigned gymnasium was found to be a better option than the current design.

Appendix A

Detailed Project Schedule

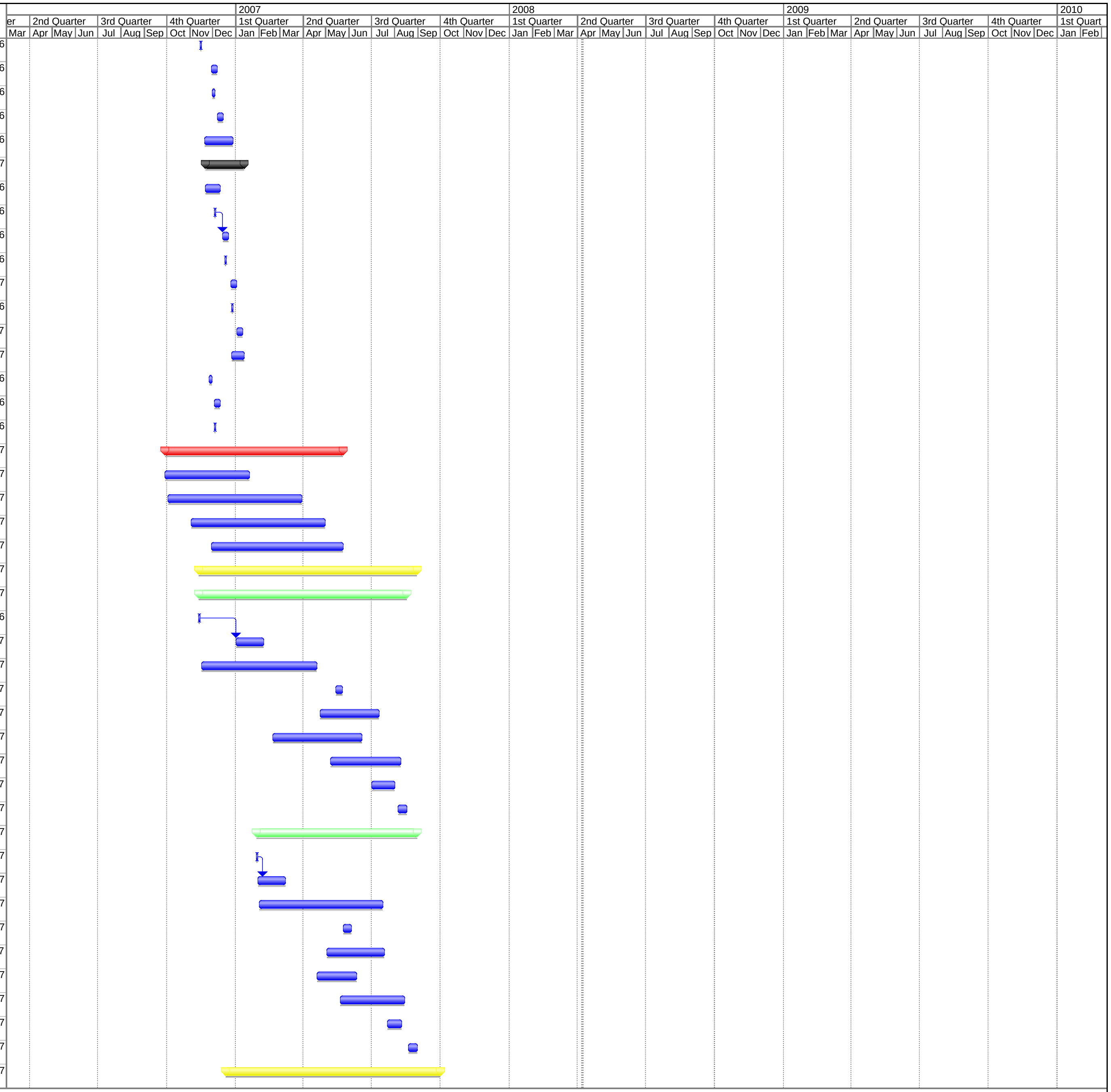
ID	Task Name	Duration	Start	Finish
1	Washington-Lee Phase 1	445 days?	Mon 4/3/06	Fri 12/14/07
2	Notice to Proceed	1 day?	Mon 4/3/06	Mon 4/3/06
3	Steel Procurement	40 days?	Mon 4/3/06	Fri 5/26/06
4	MEP Procurement	72 days?	Mon 4/3/06	Tue 7/11/06
5	Locate and Disconnect utilities	5 days?	Mon 4/3/06	Fri 4/7/06
6	Site work	73 days?	Thu 4/13/06	Mon 7/24/06
7	Asbestos Removal	16 days?	Mon 5/1/06	Mon 5/22/06
8	Demo Existing Auditorium	11 days?	Thu 5/11/06	Thu 5/25/06
9	Demo Existing Classroom	6 days?	Fri 5/26/06	Fri 6/2/06
10	Footings Area A	31 days?	Mon 6/5/06	Mon 7/17/06
11	Footings Area B	31 days?	Fri 7/7/06	Fri 8/18/06
12	Mobilze Crane	2 days?	Fri 7/14/06	Mon 7/17/06
13	Sequence 1	71 days?	Tue 7/18/06	Tue 10/24/06
14	Erect Structural Steel	23 days?	Tue 7/18/06	Thu 8/17/06
15	Erect Detailed Steel	11 days?	Fri 8/18/06	Fri 9/1/06
16	Pour Slab on Grade	13 days?	Tue 8/29/06	Thu 9/14/06
17	Shore LV2	1 day?	Mon 9/18/06	Mon 9/18/06
18	Pour and Cure LV2 SOD	6 days?	Tue 9/19/06	Tue 9/26/06
19	Shore LV3	2 days?	Wed 9/20/06	Thu 9/21/06
20	Pour and Cure LV3 SOD	6 days?	Wed 9/27/06	Wed 10/4/06
21	Shore LV4	2 days?	Thu 9/28/06	Fri 9/29/06
22	Pour and Cure LV4 SOD	6 days?	Thu 10/5/06	Thu 10/12/06
23	Shore Roof	2 days?	Fri 10/6/06	Mon 10/9/06
24	Pour and Cure Roof	6 days?	Fri 10/13/06	Fri 10/20/06
25	Remove Shoring	20 days?	Wed 9/27/06	Tue 10/24/06
26	Sequence 2	73 days?	Fri 8/18/06	Tue 11/28/06
27	Erect Structural Steel	25 days?	Fri 8/18/06	Thu 9/21/06
28	Erect Detailed Steel	10 days	Fri 9/22/06	Thu 10/5/06
29	Pour Slab on Grade	11 days?	Fri 9/22/06	Fri 10/6/06
30	Shore LV2	4 days?	Mon 10/9/06	Thu 10/12/06
31	Pour and Cure LV2 SOD	8 days?	Wed 10/11/06	Fri 10/20/06
32	Shore LV3	4 days?	Thu 10/19/06	Tue 10/24/06
33	Pour and Cure LV3 SOD	6 days?	Wed 10/25/06	Wed 11/1/06
34	Shore LV4	4 days?	Tue 10/31/06	Fri 11/3/06
35	Pour and Cure LV4 SOD	8 days?	Thu 11/2/06	Mon 11/13/06
36	Shore Roof	2 days?	Fri 11/3/06	Mon 11/6/06
37	Pour and Cure Roof	6 days?	Fri 11/10/06	Fri 11/17/06
38	Remove Shoring	24 days?	Thu 10/19/06	Tue 11/21/06
39	Sequence 3	88 days?	Tue 8/29/06	Thu 12/28/06
40	Pour Slab on Grade	13 days?	Tue 8/29/06	Thu 9/14/06
41	Erect Structural Steel	23 days?	Fri 9/22/06	Tue 10/24/06
42	Erect Detail Steel	1 day?	Wed 11/8/06	Wed 11/8/06
43	Shore LV2	1 day?	Fri 11/10/06	Fri 11/10/06
44	Pour and Cure LV2 SOD	6 days?	Mon 11/13/06	Mon 11/20/06



Project: Washington-Lee High School
Date: 4/9/08

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

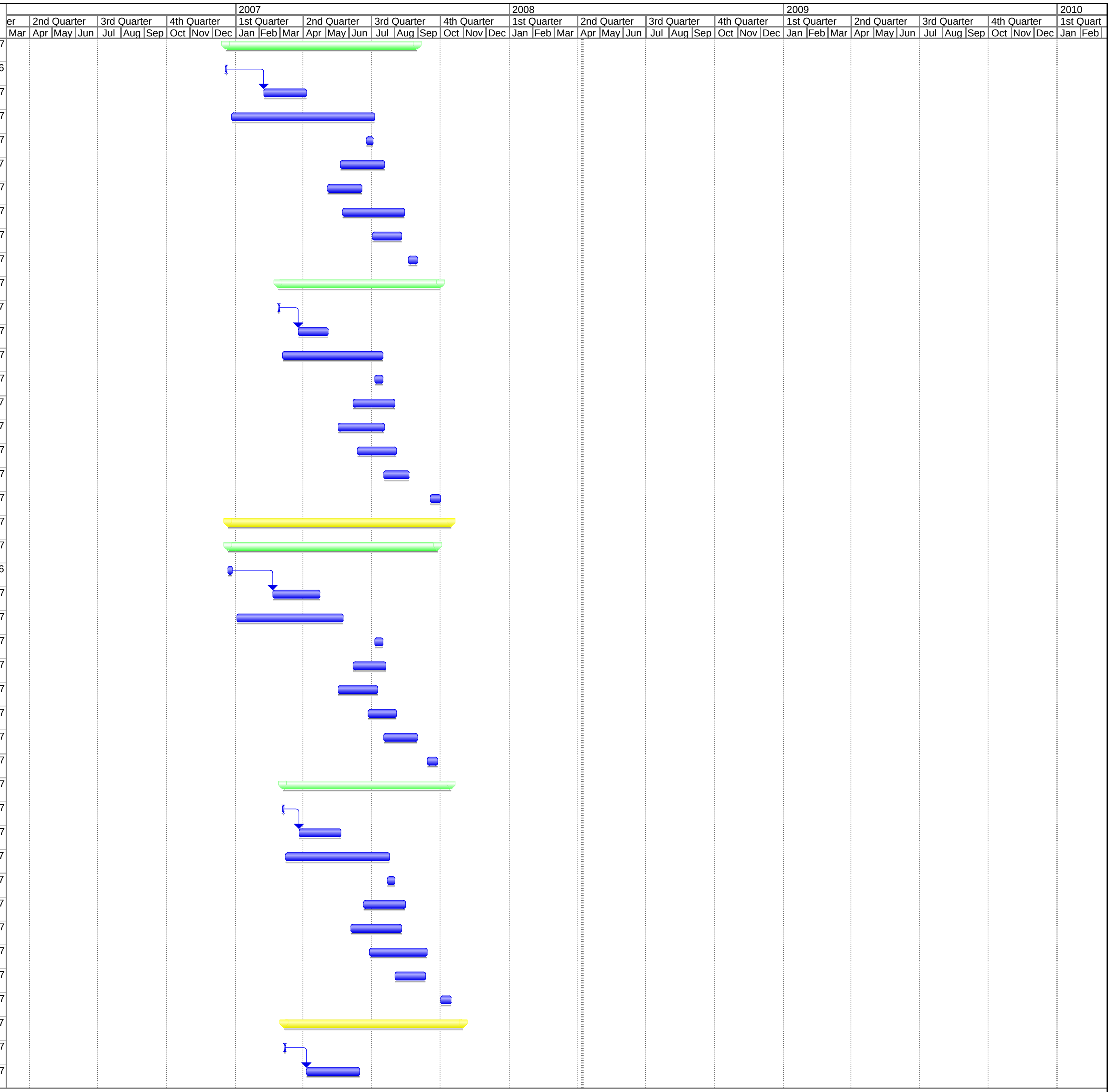
ID	Task Name	Duration	Start	Finish
45	Shore LV3	2 days?	Wed 11/15/06	Thu 11/16/06
46	Pour and Cure LV3 SOD	6 days?	Thu 11/30/06	Thu 12/7/06
47	Shore LV4	2 days?	Fri 12/1/06	Mon 12/4/06
48	Pour and Cure LV4 SOD	6 days?	Fri 12/8/06	Fri 12/15/06
49	Remove Shoring	28 days?	Tue 11/21/06	Thu 12/28/06
50	Sequence 4	38 days?	Wed 11/22/06	Fri 1/12/07
51	Pour Slab on Grade	14 days?	Wed 11/22/06	Mon 12/11/06
52	Shore LV2	2 days?	Mon 12/4/06	Tue 12/5/06
53	Pour and Cure LV2 SOD	6 days?	Fri 12/15/06	Fri 12/22/06
54	Shore LV3	2 days?	Mon 12/18/06	Tue 12/19/06
55	Pour and Cure LV3 SOD	6 days?	Tue 12/26/06	Tue 1/2/07
56	Shore LV4	2 days?	Wed 12/27/06	Thu 12/28/06
57	Pour and Cure LV4 SOD	6 days?	Wed 1/3/07	Wed 1/10/07
58	Remove Shoring	13 days?	Wed 12/27/06	Fri 1/12/07
59	Set Penthouse ERU's and AHU's	4 days?	Mon 11/27/06	Thu 11/30/06
60	Penthouse Joists	6 days?	Mon 12/4/06	Mon 12/11/06
61	Demobilize Crane	2 days?	Mon 12/4/06	Tue 12/5/06
62	Exterior	170 days?	Fri 9/29/06	Thu 5/24/07
63	Spray on Fireproofing	81 days?	Fri 9/29/06	Fri 1/19/07
64	Perimeter Masonry	129 days?	Tue 10/3/06	Fri 3/30/07
65	Masonry Veneer	127 days?	Fri 11/3/06	Mon 4/30/07
66	Windows	126 days?	Thu 11/30/06	Thu 5/24/07
67	First Floor	210 days?	Mon 11/13/06	Fri 8/31/07
68	First Floor East	200 days?	Mon 11/13/06	Fri 8/17/07
69	Layout Floor Plan	2 days?	Mon 11/13/06	Tue 11/14/06
70	Frame Metal Stud Walls	27 days?	Tue 1/2/07	Wed 2/7/07
71	MEP Rough in	110 days?	Fri 11/17/06	Thu 4/19/07
72	Ceiling Grid	7 days?	Tue 5/15/07	Wed 5/23/07
73	Electrical/Lighting Fixtures	57 days?	Tue 4/24/07	Wed 7/11/07
74	Drywall	85 days?	Tue 2/20/07	Mon 6/18/07
75	Paint	68 days?	Tue 5/8/07	Thu 8/9/07
76	Interior Finishes	23 days?	Mon 7/2/07	Wed 8/1/07
77	Punchout Area	10 days?	Mon 8/6/07	Fri 8/17/07
78	First Floor West	155 days?	Mon 1/29/07	Fri 8/31/07
79	Layout Floor Plan	2 days?	Mon 1/29/07	Tue 1/30/07
80	Frame Metal Stud Walls	27 days?	Wed 1/31/07	Thu 3/8/07
81	MEP Rough in	117 days?	Fri 2/2/07	Mon 7/16/07
82	Ceiling Grid	7 days?	Fri 5/25/07	Mon 6/4/07
83	Electrical/Lighting Fixtures	55 days?	Thu 5/3/07	Wed 7/18/07
84	Drywall	37 days?	Fri 4/20/07	Mon 6/11/07
85	Paint	62 days?	Mon 5/21/07	Tue 8/14/07
86	Interior Finishes	15 days?	Mon 7/23/07	Fri 8/10/07
87	Punchout Area	10 days?	Mon 8/20/07	Fri 8/31/07
88	Second Floor	205 days?	Tue 12/19/06	Mon 10/1/07



Project: Washington-Lee High School
Date: 4/9/08

Task	Progress	Summary	External Tasks	Deadline
Split	Milestone	Project Summary	External Milestone	

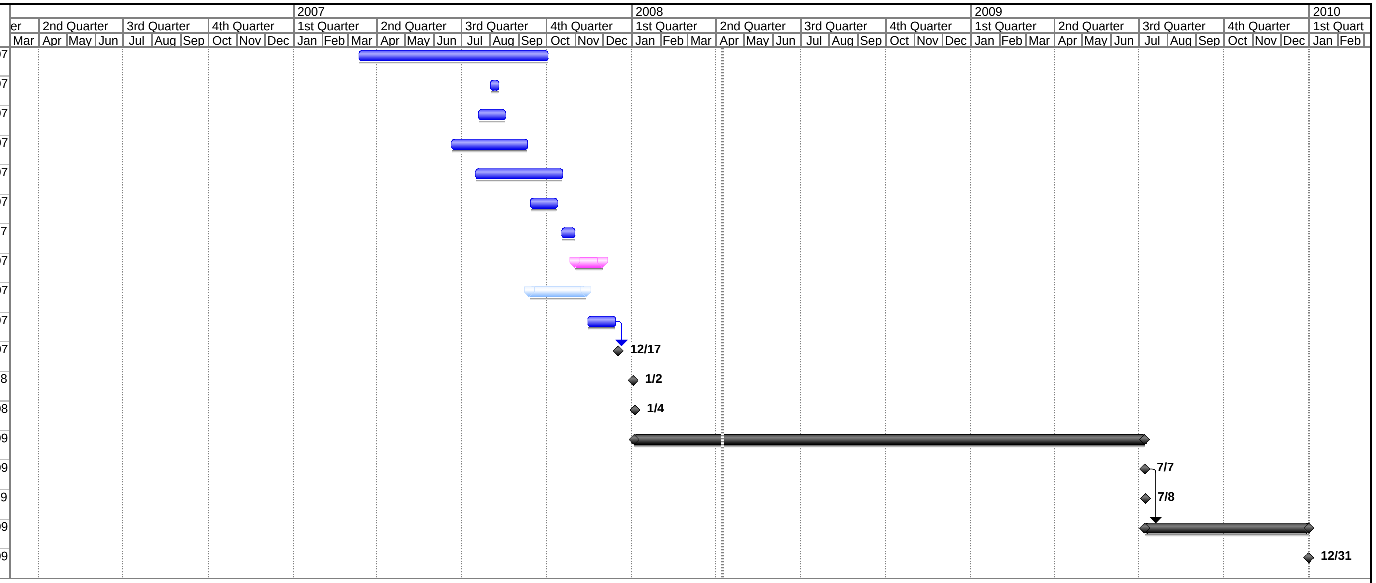
ID		Task Name	Duration	Start	Finish
89		Second Floor East	184 days?	Tue 12/19/06	Fri 8/31/07
90		Layout Floor Plan	2 days?	Tue 12/19/06	Wed 12/20/06
91		Frame Metal Stud Walls	41 days?	Thu 2/8/07	Thu 4/5/07
92		MEP Rough in	137 days?	Wed 12/27/06	Thu 7/5/07
93		Ceiling Grid	7 days?	Mon 6/25/07	Tue 7/3/07
94		Electrical/Lighting Fixtures	43 days?	Mon 5/21/07	Wed 7/18/07
95		Drywall	32 days?	Fri 5/4/07	Mon 6/18/07
96		Paint	59 days?	Thu 5/24/07	Tue 8/14/07
97		Interior Finishes	29 days?	Tue 7/3/07	Fri 8/10/07
98		Punchout Area	10 days?	Mon 8/20/07	Fri 8/31/07
99		Second Floor West	155 days?	Tue 2/27/07	Mon 10/1/07
100		Layout Floor Plan	2 days?	Tue 2/27/07	Wed 2/28/07
101		Frame Metal Stud Walls	30 days?	Mon 3/26/07	Fri 5/4/07
102		MEP Rough in	96 days?	Mon 3/5/07	Mon 7/16/07
103		Ceiling Grid	7 days?	Fri 7/6/07	Mon 7/16/07
104		Electrical/Lighting Fixtures	40 days?	Thu 6/7/07	Wed 8/1/07
105		Drywall	44 days?	Fri 5/18/07	Wed 7/18/07
106		Paint	38 days?	Wed 6/13/07	Fri 8/3/07
107		Interior Finishes	24 days?	Wed 7/18/07	Mon 8/20/07
108		Punchout Area	10 days?	Tue 9/18/07	Mon 10/1/07
109		Third Floor	212 days?	Fri 12/22/06	Mon 10/15/07
110		Third Floor East	200 days?	Fri 12/22/06	Thu 9/27/07
111		Layout Floor Plan	4 days?	Fri 12/22/06	Wed 12/27/06
112		Frame Metal Stud Walls	45 days?	Tue 2/20/07	Mon 4/23/07
113		MEP Rough in	102 days?	Wed 1/3/07	Thu 5/24/07
114		Ceiling Grid	7 days?	Fri 7/6/07	Mon 7/16/07
115		Electrical/Lighting Fixtures	32 days?	Thu 6/7/07	Fri 7/20/07
116		Drywall	37 days?	Fri 5/18/07	Mon 7/9/07
117		Paint	28 days?	Wed 6/27/07	Fri 8/3/07
118		Interior Finishes	33 days?	Wed 7/18/07	Fri 8/31/07
119		Punchout Area	10 days?	Fri 9/14/07	Thu 9/27/07
120		Third Floor West	161 days?	Mon 3/5/07	Mon 10/15/07
121		Layout Floor Plan	2 days?	Mon 3/5/07	Tue 3/6/07
122		Frame Metal Stud Walls	40 days?	Tue 3/27/07	Mon 5/21/07
123		MEP Rough in	99 days?	Fri 3/9/07	Wed 7/25/07
124		Ceiling Grid	8 days?	Mon 7/23/07	Wed 8/1/07
125		Electrical/Lighting Fixtures	40 days?	Thu 6/21/07	Wed 8/15/07
126		Drywall	50 days?	Mon 6/4/07	Fri 8/10/07
127		Paint	55 days?	Fri 6/29/07	Thu 9/13/07
128		Interior Finishes	29 days?	Thu 8/2/07	Tue 9/11/07
129		Punchout Area	10 days?	Tue 10/2/07	Mon 10/15/07
130		Fourth Floor	171 days?	Wed 3/7/07	Wed 10/31/07
131		Layout Floor Plan	2 days?	Wed 3/7/07	Thu 3/8/07
132		Frame Metal Stud Walls	51 days?	Fri 4/6/07	Fri 6/15/07



Project: Washington-Lee High School
Date: 4/9/08

Task		Progress		Summary		External Tasks		Deadline
Split		Milestone		Project Summary		External Milestone	

ID		Task Name	Duration	Start	Finish
133		MEP Rough in	146 days?	Tue 3/13/07	Tue 10/2/07
134		Ceiling Grid	7 days?	Thu 8/2/07	Fri 8/10/07
135		Electrical/Lighting Fixtures	21 days?	Fri 7/20/07	Fri 8/17/07
136		Drywall	58 days?	Thu 6/21/07	Mon 9/10/07
137		Paint	68 days?	Tue 7/17/07	Thu 10/18/07
138		Interior Finishes	21 days?	Fri 9/14/07	Fri 10/12/07
139		Punchout Area	10 days?	Thu 10/18/07	Wed 10/31/07
140		Finishing Site work	22 days?	Thu 11/1/07	Fri 11/30/07
141		Commissioning	43 days?	Thu 9/13/07	Mon 11/12/07
142		Anticipated Delays	22 days?	Thu 11/15/07	Fri 12/14/07
143		Owner Move-in	1 day?	Mon 12/17/07	Mon 12/17/07
144		School Begins in new building	1 day?	Wed 1/2/08	Wed 1/2/08
145		Notice to Proceed on Phase 2	1 day?	Fri 1/4/08	Fri 1/4/08
146		Phase 2 Construction	393 days?	Fri 1/4/08	Tue 7/7/09
147		Phase 2 Completion	1 day?	Tue 7/7/09	Tue 7/7/09
148		Notice to proceed on Phase 3	1 day?	Wed 7/8/09	Wed 7/8/09
149		Phase 3	127 days?	Wed 7/8/09	Thu 12/31/09
150		Building Complete	1 day?	Thu 12/31/09	Thu 12/31/09



Project: Washington-Lee High School Date: 4/9/08	Task	Progress	Summary	External Tasks	Deadline
	Split	Milestone	Project Summary	External Milestone	

Appendix B

Green School Survey Questions

Washington-Lee High School

Matthew Hoerr | CM | Messner

Green School Questionaire for Owners/School Districts

Name

Email

School District

Has your district completed a construction project or renovation in the last 5 years?

If yes, are any of the new or renovated buildings going for LEED certification?

Do you know the benefits of having a green school? If so, where did you get that information?

Where do most of the operational costs of your schools come from?

What keeps your new projects from going for LEED certification?

What is the major determining factor in whether or not one of your new buildings goes for LEED certification?

* Indicates Response Required

Appendix C

Crane Data Sheets

Washington-Lee High School

Matthew Hoerr | CM | Messner

Washington-Lee High School

Matthew Hoerr | CM | Messner

Washington-Lee High School

Matthew Hoerr | CM | Messner

Washington-Lee High School

Matthew Hoerr | CM | Messner

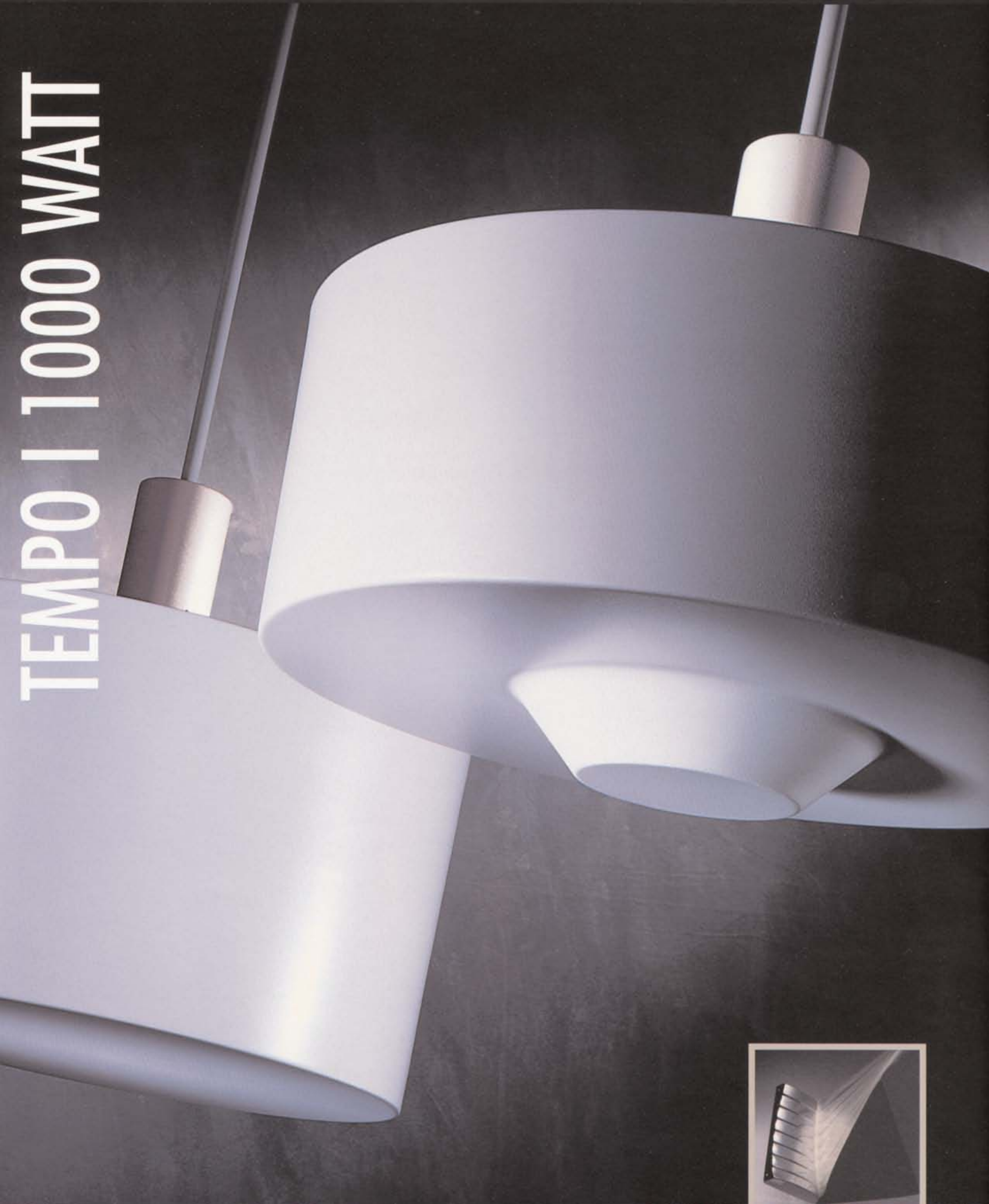
Washington-Lee High School

Matthew Hoerr | CM | Messner

Appendix D

Lighting Sheets

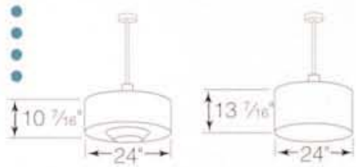
FORUM, INC. PITTSBURGH, PA



Catalog No.
TWR-1000-1/MH-
120 PR-a-24FB-WG

Wire Guard option.
Specify: WG

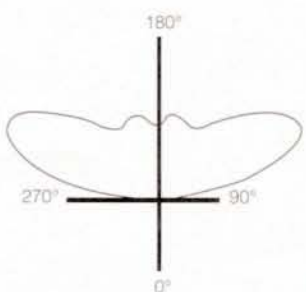
Available Size



Distribution Pattern

Catalog No.
TWR-1000MH

B.A.L. Test No. 1509



The Tempo I/1000 Watt is a luminaire designed to accommodate large areas; high ceiling applications where the use of 1000 Watt MH or Sodium can achieve the desired footcandle level with a minimum of luminaires. The patented reflector (Pat. 4-293-900) system permits installation as close as 48" from the ceiling.

Applications: Tennis Courts, Factories, Gymnasiums, Natatoriums and any high ceiling large area applications

How To Specify

TWR - 1000/1 MH - 120 PR-a - 24DB - OPTION

- Indicates Tempo H.I.D.
- Indicates Form: R=Round, S=Square (Consult factory)
- Light Source: MH=Metal Halide, HPS=High Pressure Sodium
- DB=Dimple Bottom, FB= Flat Bottom
- EM-S=Incandescent Socket Only, EM-Q=Incandescent Stand-By Light 120V Only 250W Max., WG=Wire Guard
- Indicates Finish: W=White (Standard), C=Custom
- Indicates Wattage 1000W
- Type of Ballast Remote Only
- Voltage 120V or 277V
- Style: PR-a=Remote Ballast, PR-c=Remote Ballast Chrome Sleeve
- 24" Dia. Only

SPEC-BEAM™

COOL RUNNING TECHNOLOGY
Available soon.

SPEC-BEAM™
SPECIFICATION GRADE HIGH-BAY

Intended Use

Ideal for one replacement for HID high bay luminaires. Provides large area lighting in a variety of photometric distributions for warehouse, industrial, commercial, retail and manufacturing areas.

Features

Patented T5HO Cool Running™ Technology UL Listed operation up to 55° C with 5-year ballast warranty will soon be available.

Four optical systems that can be tailored to meet specific application needs. All reflectors systems include 95% reflective specular Alanod MIRO® 4. Reflector warranted for 25 years.

Focus – Precision control narrow distribution for maximum punch in tight spaces.

Narrow – Standard distribution for narrow distribution in narrow aisles or higher mounting heights.

Medium – Ideal for wide aisle or medium mounting heights. High reflectance specular.

Wide – The best choice for medium mounting heights in general or open spaces at medium to low mounting heights.

Reflector choices include uplight or direct. No uplight options include 2-3% uplight for heat management venting.

Suitable for single monopoint or two-point fixture mounting, chain, cable or monopoint hangers.

Lamp shielding option is available with hinge and rotary cam latches for easy access to optical system. Lenses are held in place with lens clips.

Option fixture housing with aluminum construction.

Listings

UL Listed to US and Canadian safety standards.

Ordering Information

Example: **FSB 654L**

Series

FSB	SPEC-BEAM™

Number of lamps/wattage

Lamps installed[1]

254L	2-lamp, 54W T5HO
354L	3-lamp, 54W T5HO
454L	4-lamp, 54W, T5HO
654L	6-lamp, 54W T5HO
232L	2-lamp, 32W T8
332L	3-lamp, 32W T8
432L	4-lamp, 32W T8
632L	6-lamp, 32W T8

Unlamped

232	2-lamp, 32W T8
332	3-lamp, 32W T8
432	4-lamp, 32W T8
632	6-lamp, 32W T8

Photometric distribution

(blank)	Narrow distribution with uplight 0.9≤SC<1.2
NDS	Narrow distribution no uplight 0.9≤SC<1.2[2]
KD	Medium distribution with uplight 1.2≤SC≤1.4
KDS	Medium distribution no uplight 1.2≤SC≤1.4[2]
SD	Spread distribution with uplight 1.4<SC≤1.8
SDS	Spread distribution no uplight 1.4<SC≤1.8[2]
WD	Wide distribution with uplight 1.8<SC[3]
WDS	Wide distribution no uplight 1.8<SC[2]
TD	Focus distribution with uplight SC<0.9[3]
TDS	Focus distribution no uplight SC<0.9[2,3]

Lamp shielding[4]

(blank)	No shielding
A12	Pattern 12 acrylic[5]
ACL	Clear acrylic, 0.125″
PCL125	Clear polycarbonate, 0.125″

Voltage

(blank)	MVOLT[6]
120	120 volt
277	277 volt
347	347 volt
480	480 volt[7]

Ballast configuration

(blank)	Standard configuration (see chart)
2/3	(2) 3-lamp ballast
2/2	(2) 2-lamp ballast

Ballast type

T5HO

(blank)	Program start, 1.0 BF

T8

(blank)	Instant start, 1.2 BF
GEB10IS	Instant start, 0.88 BF

Lamps installed

T5HO

(blank)	F54T5HO/841
LP830	F54T5HO/830
LP835	F54T5HO/835
LP850	F54T5HO/850

T5HO Amalgam

LP830A	F54T5HO/830
LP835A	F54T5HO/835
LP841A	F54T5HO/841

T8

(blank)	F32T8/741
LP730	F32T8/730
LP735	F32T8/735

Options

EL14	Emergency battery pack (1400 Lumens)[8]
GLR	Internal fast blow fusing[9]
OCS	OnePass® Installed[9]
MSIA	Occupancy sensor prewired aisle wedge[9]
MSI360	Occupancy sensor prewired 360° area for 25′[9]
AL	Aluminum construction, PAF
PAF	Powder coat after fabrication
WGI	Wireguard, 11 gauge, PAF
OUTCTR	Wiring leads through center of fixture (For use with monopoint hanger when using hanger as a wiring connection point)

Accessories (Order as separate catalog number)

FSBAC120	Aircraft cable 10′ Y hanger (one pair)
FSBAC240	Aircraft cable 20′ Y hanger (one pair)
HSD36	Chain hanger, 36″
THSD	Monopoint hanger w/ top opening
THSDHB	Monopoint hanger w/ 3/4″ hub
THSDSK	Side covers for Monopoint hanger (For use with Monopoint hanger when using hanger as a wiring connection point)

NOTES:

1. Lamps installed are F54T5HO/841 for T5HO or F32T8/741 for T8. All T5HO fixtures ship lamped.
2. No uplight reflectors options incorporate heat managing venting above the fixture that produce 2-3% uplight.
3. T5HO lamps only.
4. Lamp shielding is provided in door frame.
5. A12 not available with WD and WDS distribution.
6. 120-277 volt.
7. For use with T5HO. Consult factory for T8.
8. UL Listed for 40°C only. Consult factory for 6-lamp fixtures.
9. Specify voltage.

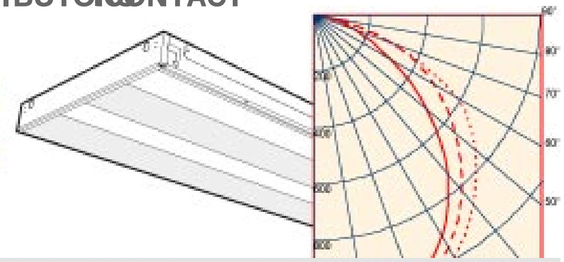
Availability and Dimensions

Nominal size	Series	Number of lamps	Lamp type	Height
12″x4″	FSB 2	2	32, 54T5HO	4.7"
	FSB 3	3	32, 54T5HO	4.7"
16"x4″	FSB 4	4	32, 54T5HO	4.7"
24″x4″	FSB 6	6	32, 54T5HO	4.7"

Standard Ballast Configuration Chart

Lamp type	2-lamp	3-lamp	4-lamp	6-lamp
T5HO	(1) 2-lamp ballast	(1) 3-lamp ballast	(1) 4-lamp ballast	(1) 4-lamp ballast and (1) 2-lamp ballast
T8 (0.88)	(1) 2-lamp ballast	(1) 3-lamp ballast	(1) 4-lamp ballast	(1) 4-lamp ballast and (1) 2-lamp ballast
T8 (1.2)	(1) 2-lamp ballast	(1) 3-lamp ballast	(2) 2-lamp ballasts	(2) 3-lamp ballasts

LITHONIA PHOTOMETRICS



Photometric Data File Viewer

Following the the basic photometric performance for the product you selected. For additional calculation capabilities, download this file and use a lighting design software package such as Visual.

TEST:	LTL 14962
MANUFAC:	Lithonia Lighting
LUMCAT:	FSB 654 WDS
LUMINAIRE:	SPEC-BEAM 24"X4', 6 lamp, T5HO, Wide Distribution, Solid Top
LAMP:	SIX 54 WATTS SYLVANIA LAMPS
LAMPCAT:	FP54/841/HO. LUMEN RATING = 4400 LMS.
OTHER:	THREE ICN-2S54 ADVANCE BALLAST OPERATING AT 120V AND 361.5W
Number Lamps:	6
Lumens Per Lamp:	4400
Photometric Type:	Type C
Luminous Width:	1.96 ft
Luminous Length:	4 ft
Luminous Height:	0 ft
Ballast Factor:	1
Input Watts:	361.5
Efficiency (Total):	93.2 %
Efficiency (Up):	2.9 %
Efficiency (Down):	90.3 %

Spacing Criteria

Angle	Value
0	1.18
90	2.12

Candela Values:

	0	22.5	45	67.5	90
0	5,135	5,135	5,135	5,135	5,135
2.5	4,798	4,802	5,055	5,373	5,630
5	4,791	4,877	5,099	5,324	5,526
7.5	4,768	4,965	5,272	5,353	5,461
10	4,733	5,074	5,424	5,558	5,613
12.5	4,681	5,187	5,616	5,848	5,811

15	4,614	5,292	5,780	6,014	5,956
17.5	4,539	5,358	5,891	6,057	6,102
20	4,458	5,377	5,969	6,137	6,545
22.5	4,367	5,352	5,964	6,449	7,133
25	4,266	5,329	5,936	6,957	7,748
27.5	4,155	5,305	5,943	7,430	8,233
30	4,033	5,267	6,067	7,875	8,630
32.5	3,902	5,184	6,349	8,293	8,802
35	3,763	5,097	6,655	8,737	9,002
37.5	3,612	4,986	7,041	9,117	9,156
40	3,452	4,843	7,534	9,382	9,070
42.5	3,282	4,663	8,060	9,299	8,759
45	3,104	4,492	8,390	8,955	8,303
47.5	2,921	4,390	8,501	8,240	7,789
50	2,730	4,415	8,301	7,490	7,260
52.5	2,533	4,483	7,739	6,653	6,651
55	2,332	4,640	6,888	5,746	5,906
57.5	2,129	4,827	5,949	4,817	5,016
60	1,921	4,932	4,997	3,964	4,071
62.5	1,713	4,822	4,057	3,199	3,221
65	1,504	4,473	3,243	2,587	2,572
67.5	1,300	3,888	2,527	2,124	2,110
70	1,101	3,121	1,948	1,763	1,678
72.5	911	2,390	1,534	1,453	1,430
75	730	1,727	1,211	1,148	1,148
77.5	564	1,122	929	873	902
80	403	690	660	649	669
82.5	255	455	433	386	393
85	141	272	211	195	211
87.5	58	121	98	107	119
90	25	48	70	92	97
92.5	27	29	42	76	93
95	39	34	30	27	52
97.5	54	40	35	30	28
100	73	46	41	34	32
102.5	95	51	45	39	35
105	117	56	50	45	41
107.5	139	58	53	48	47
110	161	58	53	51	50
112.5	180	56	54	54	52
115	199	52	54	54	53
117.5	218	50	54	54	53
120	238	46	55	56	52
122.5	259	46	53	56	55
125	280	52	56	58	59
127.5	301	67	57	51	59
130	321	93	49	52	53
132.5	341	129	51	49	54
135	359	171	45	43	46
137.5	379	222	41	42	41

140	395	275	43	42	43
142.5	412	321	53	44	39
145	430	365	74	41	45
147.5	444	399	107	47	49
150	459	424	149	71	67
152.5	474	447	210	108	107
155	486	467	289	152	154
157.5	498	486	347	213	213
160	509	501	398	271	255
162.5	519	514	451	326	284
165	527	521	488	381	327
167.5	534	530	512	438	384
170	541	536	527	491	433
172.5	546	543	537	517	489
175	550	547	541	533	519
177.5	551	552	545	540	530
180	544	544	544	544	544

Average Luminance (cd/sq.m)

	0	45	90
55	5,582	16,489	14,138
65	4,886	10,536	8,354
75	3,871	6,423	6,088
85	2,220	3,321	3,319

Return to: Pentron - T5 Fluorescent | Print Page

Product Number:	21022
Order Abbreviation:	FP54/850/HO
General Description:	54W, T5, PEN High Output (fluorescent la Safeline coati 5000K Color Temperature, earth phosph CRI, ECO

Product Information	
Abbrev. With Packaging Info.	FP54850HOSLECO 40/CS 1/SKU
Actual Length (in)	45.8
Actual Length (mm)	1163.2
Base	Miniature Bipin
Bulb	T5
Color Rendering Index (CRI)	85
Color Temperature/CCT (K)	5000
Diameter (in)	0.67
Diameter (mm)	17.0
Family Brand Name	PENTRON® SAFELINE®
Initial Lumens at 25C	4243
Initial Lumens at 35C	4753
Mean Lumens at 25C	3946
Mean Lumens at 35C	4420
Nominal Length (in)	48
Nominal Wattage (W)	54.00

Additional Product Information

Product Documents, Graphs, and Images

Packaging Information

Footnotes

- Approximate initial lumens after 100 hours operation.
- The life ratings of fluorescent lamps are based on 3 hr. burning cycles under specified conditions and with ballast meeting ANSI specifications. If burning cycle is increased, there will be a corresponding increase in the average hours life.
- Minimum starting temperature is a function of the ballast; consult the ballast manufacturer.
- There is a NEMA supported, industry issue where T2, T4, and T5 fluorescent and compact fluorescent lamps operated on high frequency ballasts may experience an abnormal end-of-life phenomenon. This end-of-life phenomenon can resultin one or both of the following: 1. Bulb wall cracking near the lamp base. 2. The lamp can overheat in the base area and possibly melt the base and socket. NEMA recommends that high frequency compact fluorescent ballasts have an end-of-life shutdown circuit which will safely and reliably shut down the system in the rare event of an abnormal end-of-life failure mode described above. The final requirements of this system are yet to be defined by ANSI. For additional information refer to NEMA papers on their WEBSITE at www.NEMA.org.
- SYLVANIA ECOLOGIC fluorescent lamps are designed to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) criteria for classification as non-hazardous waste in most states. TCLP test results are available upon request. Lamp disposal regulations may vary, check your local & state regulations. For more information, please visit www.lamprecycle.org
- SAFELINE lamps satisfy the criteria of having a non-shattering covering for prevention of glass and other lamp components in your product by containment within the safety coating material. The covering must be intact or the lamp must be replaced to be in compliance. An onsite inspector will require correction if the lamps are installed improperly or not maintained properly.
- SAFELINE lamps are intended for indoor use only. Lamps must be used in ambient temperatures below 135 degrees F. For T8 and T12 lamps, the coating is designed to withstand constant operating temperatures up to 239 degrees F and has a melting point in excess of 500 degrees F. For T5 lamps, the coating is designed to withstand constant operating temperatures up to 500 degrees F and has a melting point in excess of 620 degrees F. Lamps must be used in open fixtures with sockets that provide adequate lamp pin to socket contact. Lamps must not be used with defective ballasts sockets, or fixtures with improper wiring.

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