Kimberton Elementary School

East Pikeland Township, Chester County, Pennsylvania

Thesis Proposal

The End Is Only The Beginning

Consultant: Dr. John Messner

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Ralph Gary Kreider

2009 Construction Option

http://www.engr.psu.edu/ae/thesis/portfolios/2009/rgk5000/

Kimberton Elementary School

East Pikeland Township, Chester County, Pennsylvania

Building Statistics:
- **Size:** 104,000 sq ft – Two Stories
- **Construction:** July 2008 – Jan 2010
- **Construction Cost:** $25.5 Million
- **Delivery Method:** Design-Bid- Build with Multiple Prime and CM Agency

Architecture:
- 650 students Elementary
- Two main wings: Classroom and Activities
- 30 750 SF classrooms
- 2 computer labs
- 3000 SF media center
- 650 seat auditorium/cafeteria
- 6000 SF gymnasium with full basketball and volleyball courts

Building Envelope:
- Masonry Veneer Exterior
- Split face block on first floor
- Green cementitious siding used on second floor
- Asphalt shingled gabled roof on top of the classrooms, media center, gymnasium, and entry
- White single-ply membrane flat roof on remainder of building

Structural:
- Structural Steel Building
- 1.5" 20 GA composite deck with 2.5" of NW concrete
- Classroom live load is 40 PSF
- Most columns are HSS8x8x1/2
- Spread footing support columns
- First floor is 4" cast-in-place concrete slab with 6x6 W2.9xW2.9 WWF

Mechanical:
- Water source heat pump
- Individual heat pumps for each classroom housed in the second floor mechanical room
- 6 water source heat recovery units manufactured by Des Champs housed on the roof
- Originally designed as geothermal heat pump

Electrical:
- Disturbed through building at 480/277V
- Supply Voltage is 33KV
- 5 Local Transformers step down to 208/120V
- Lighting uses 277V
- 125 KW Backup Generator
- 40 panel boards located throughout school

Lighting:
- 59 lighting types
- Classrooms use 3 32W T8 lamps
- Switching allows for 3 light levels
- The media center contains pendent and drop lights
- Gymnasium lighting is produced by high bay fluorescents
- Cafeteria/auditorium has dimmable metal halide lights

Project Team:
- **Owner**: Phoenixville Area School District
- **Construction Manger**: Foreman Program and Construction Managers
- **Architect:** Gilbert Architects
- **Structural:** Baker, Ingram, & Associates
- **M.E.P.:** Snyder Hoffman & Associates

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Executive Summary:

To replace the aging East Pikeland elementary school, the Phoenixville Area School District decided to build a 650 student elementary school on a fallow site next to the Kimberton Fair Grounds. Because of delays due to site containments, the proposed completion date was pushed back to January 2010. The cost of construction including all fees was $27.7 million ($270 dollars per square foot) plus $2 million for the site.

The site of Kimberton is complicated by the site closure plan. This project was cancelled due to contaminated groundwater underneath the proposed site. The site contained VOCs such as trichloroethylene, dichloroethylene, and vinyl chloride in aquifers 180 feet below the surface. The school board decided in June of 2008 to suspend the project and abandon the site at Kimberton. It is this cancellation that has played a critical role for a number of the analyses to be preformed during my senior thesis.

Schedule Acceleration during Site Closure Plan
The site closure plan is one of the biggest risks to the schedule due to possible unforeseen conditions. For this analysis I will detail the schedule of the site closure plan and look for alternate methods of site closure. Presumably other methods will impose less risk to the schedule. I will document the differences using 4D scheduling. If the schedule can not be reduced using an alternate method, then I will look for way to reduce the project schedule in general possibly using short interval production scheduling.

Evaluation of Alternate Site
An elementary school still needs to be built for the school district. An alternate site needs to be selected for the school. To relocate this building I will consider a number of factors including, building aesthetics, location on site, mechanical system to be used, soil and foundation system and other construction related factors. These analyses will include structural mechanical and architectural breadths.

Alternate Building Exterior Envelop
Due to delay in construction the masonry construction of the building will take place during the winter months. I will consider using precast concrete to replace the exterior masonry. This study considers which precast panels to use, cost of switching the system, and the possible schedule savings. Tying into my graduate education, I will use BIM to assist in the different analyses.

Integrated Project Delivery
Currently the construction industry is being transformed by the Integrated Project Delivery method. PA law requires multiple prime contracts as the project delivery method for schools. This method leads to extra changes. I will research if there is anyway to bring the contractors in early to have a method similar to integrated project delivery. This research will most likely result in an entirely new delivery method for projects.

Overall my thesis will incorporate the knowledge I have gained in my entire architectural engineering education at Penn State. It will focus in the areas of Critical Issue Research, Value Engineering Analysis, Constructability Review, and Schedule Reduction /Acceleration Proposal. My thesis will also consist of investigations based on my graduate level studies.

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Project Background

During the summer of 2005, Phoenixville Area School District decided to hire an architect and construction manager for the construction of a new elementary school. Because of enrollment projection and to replace the aging East Pikeland elementary school, the school district decided to build a 650 student elementary school on a fallow site next to the Kimberton Fair Grounds. This school was originally proposed to be open for the 2008 school year but because of delays due to site containments, the proposed completion date was pushed back to January 2010. The school was prepared to pay $26 million for the construction but because of delays that number was closer to $30 million. The cost of construction including all fees was $27.7 million ($270 dollars per square foot) plus $2 million for the site.

The site will have to be grub and the site closure plan will have to be completed before any major work on this site can be completed. Spread footings support the structural steel for the building. The footings for this building will be placed using traditional forming methods and pumped into place and then machine vibrated. The building's walls are made up of mostly CMU except metal studs are used in several locations. The exterior of the building contains a CMU veneer as well as cementitious siding. The mechanical system of the building is an all air system with individual water source heat pumps to heat each zone. There are also various heat recovery units, roof top units. The system is dependent on two boilers and single cooling tower. Kimberton is protected by an active automated fire extinguishing system with each sprinkler head having no more than 130ft of coverage. Fire walls separate the building in two and protect areas of vertical movement. The elementary school distributes 240/277V throughout the building and steps it down to 208/120v using 5 transformers throughout the building. The building is backed by a 125 KW generator.

The site of Kimberton is complicated by the site closure plan. The 3.85 acre area of the closure plan will be a retention pond and should not delay the construction of the building once ground is broken. The main access for construction will be from Route 113. There are no fire hydrants on site however the fire hall is on the neighboring property. Existing utilities are under Cold Stream Road and will be supplied to the elementary school via the service drive between CJ tire and Emery Oil to the mechanical room on the west side of the building. There are no buildings in the area that will interfere with construction. Overall the site is relatively open and should allow for plenty of lay down area.

The Kimberton project is being delivered with a design-bid-build method with 15 multiple prime contracts and a construction management agency overseeing. Each Contract is held by the owner (Phoenixville Area School District). The construction manager will run the day to day management of the project and the school will release the payments. Foreman Program and Construction Managers plan to staff the job with a project manager and site manager. The FPCM will act as the liaison between prime contractors, architect, and owner.

This project was cancelled due to contaminated groundwater underneath the proposed site. The site contained VOCs such as trichloroethylene, dichloroethylene, and vinyl chloride in aquifers 180 feet below the surface. The school board decided in June of 2008 to suspend the project and abandon the site at Kimberton. The school board is currently considering its options and deciding how it will proceed from this point.

A. Schedule Acceleration during Site Closure Plan

The preexisting site conditions of the 19.8 acres site at the corner of Route 113 and Cold Stream Road add an extra challenge to the project and eventually lead to its cancelation. To deal with these issues CMX engineering devised a site closure plan. A major site disturbance on the Kimberton Elementary School Site is contaminates due to the site being used as a dumping ground.

Approximately four acres of the northwest corner of the site had been used for storage, burning and disposal of construction waste just prior to Phoenixville Area School District purchasing the land. In the fifties and sixties it is believed that the 2,000 sq ft were also used for household municipal disposal.

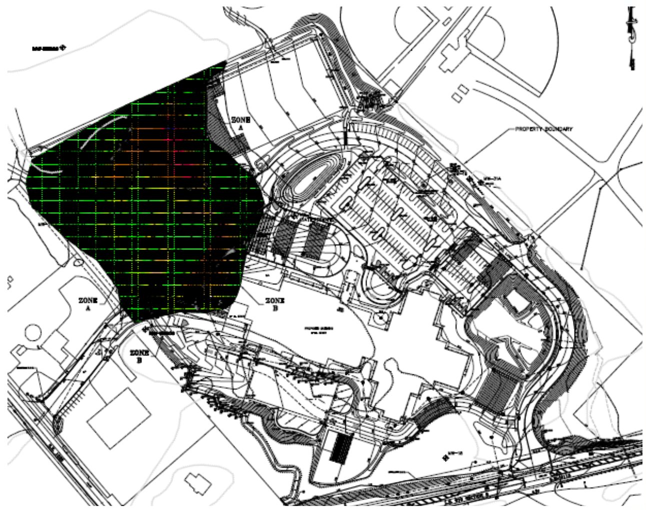


Figure 1: Area of Site Closure Plan

The current site closure plan involves the excavation of approximately 8,425 cubic yards (CY) of soil. The soil will need to be removed until bedrock is reached, which is approximately 10 ft below the current grade of the soil. It is estimated that 6,300 cubic yards (CY) is actually contaminated and about 2,125 CY can remain on site and be used as fill. The 6,300 CY that is contaminated soil will need to be removed from the site and treated. The soil will be sorted through to determine if it is acceptable for fill. After the area is brought to the proposed grading and filled with acceptable materials, it will be covered with a fabric liner and two feet of topsoil. This area will then be reforested.

This closure plan is an enormous risk to the schedule. There could be unforeseen conditions that could hold the entire project up if the site closure plan is not completed in a timely manner. When analyzing the site prior to bidding the project it is possible that hazardous waste could have been missed. If oil tanks, asbestos or any other unforeseen hazardous material is found during excavation it will delay the project. The closure plan pretty much needs to be wrapped up before any serious construction on other parts of the site begins. The construction manager has allowed 12 weeks of the 18 month project schedule. If there are delays in this it could push back the substantial completion date. This is also an area of potential gain in the schedule. Twelve weeks is much more time than what is required to complete the site closure plan as documented. If this is the case the project could be out of the ground early. Based on a low rate of excavation of only 50 CY per hour of material the contaminated material should be able to be removed in about four weeks. This would allow the rest of the schedule to move up by nearly two months. However this cannot be relied on based on the number of variables associated with the site closure plane.

If the building were still being built, the site closure plan would be one of the first concerns for the construction agency. There are many issues that would come with it. Most of which are covered previously in this technical report. Most of the financial risks have been placed on the owner, however that does not mean the construction manager is not responsible for managing the risks for the owner. If these unforeseen risks are encountered how does a construction agency deal with them? There will most likely have to be additional time added to the schedule. If no additional time is granted then the remaining part of the schedule will have to be accelerated in order to keep the elementary school opening on time. Additionally there will be extra management required during the entire closure plan, what is required from the construction management agency?

The analysis of the site closure plan will focus primarily on the schedule implications of the plan.

1. The first step of this analysis is to read and understand the site closure plan completely.
2. Develop a plan to be implemented if unforeseen conditions are encountered. This plan will primarily consist of a plan to accelerate the schedule so that the project can finish on time.
3. As part of the unforeseen conditions plan, I will develop a detailed schedule that breaks down the activities of the plan by location and duration. The more detailed the schedule of the plan the easier it will be to find solutions to the situations.
4. Search for areas of improvement in the schedule by using 4D scheduling and phase planning. Additionally, excavating contractors should be contacted to see how they would improve the progress of the site closure plan.
5. If areas of schedule reduction can be found.
    a. The schedule will have to be recalculated.
    b. Also there will be additional costs related to schedule acceleration these will need to be calculated and compared to the cost of having the school open late.
6. If no improvement can be found look for alternate method of closing the site.
    a. If required, contact CMX for ideas of alternate methods of site closure.
    b. Search case studies for other site closure plans.
    c. Develop a schedule for these alternate methods.
    d. Compare the alternate methods schedule to the original project schedule.
    e. Compare the cost of the alternate methods to the original cost of the site closure plan.
7. If there are no alternate methods that are feasible for Kimberton Elementary.
    a. Alternate methods of schedule acceleration during the actual construction of the project should be researched.
    b. An alternate building exterior is one option and will be explored in another analysis.
    c. Another possibility is to consider is a short interval production schedule.
        i. This is a possibility on the classroom wing because of the repetitive nature of an elementary school.
        ii. This would result in less trade stacking and improve productivity.
    d. Work overtime and to work some weekends until the schedule is back on track.
    e. Double crew sizing of excavation and foundations which in theory would not increase the cost of the project.
    f. Add a second crane to the site and work towards the center of the building.
        i. One crane could be used to complete the classroom wing of the building while the other could be used to construct the activities wing.
8. Calculate the cost and schedule implications of each method of acceleration.

B. Evaluation of Alternate Site

Where does the construction company go after the project has been canceled? The school district still needs an elementary school for the growing population. How should the school district proceed? For this analysis I will establish a new location for the elementary school and reconfigure the building for the new site.

Before a new site is located, I should briefly analyze other cancellations of school projects. This can be done by researching the internet and conversing with industry ties. It would also be a good idea to survey them to see what they would have done. The next step would be to consider what approach the school is currently taking and evaluate that. I know the school district is discussing purchasing a nine-hole golf course neighboring the high school and middle school in Phoenixville. There are also factors about this new site that should be considered before purchasing the land. This is a decision that will need to be made by the school district however a few things they should think about are the redeveloping of landscape, the soil conditions, and mechanical system.

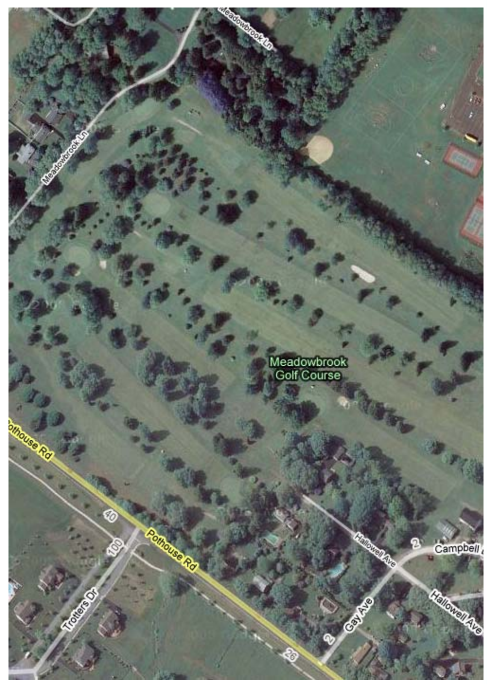


Figure 2: Possible Alternate Location

The analysis will focus on the following steps:

1. Select a new location for building on the site.
    a. Locate a site plan of the golf course.
    b. Visit the golf course and document it.
    c. Develop an existing site of the nine-hole golf course using Revit.
    d. Pick the location based on relation to other existing schools, minimal excavation, utility services, solar considerations, etc.
2. Make sure the school fits the site atheistically (architectural breadth)
    a. Develop renderings in existing site.
    b. Landscape the golf course keeping as much of the original topography and vegetation as possible.
    c. Make sure that all of the features of the original landscape of the elementary will be included with the new site.
    d. Render the building on new site to present that it will work aesthetically
3. The foundations will need to be checked to make sure that they will still work as designed. (structural breadth)
    a. Check soil conditions of new site.
    b. Obtain geotechnical surveys of the golf course.
        i. If there are no geotechnical surveys then it may be possible that the borough would have soil reports of neighboring buildings.
        ii. The school district would also have the soil reports from the building of the high school and middle school.

c. Check the soil bearing capacity and compare it to the bearing capacity of the previous Kimberton site.
d. If the soil bearing capacity is equal or higher, the foundation can be maintained as designed.
e. If the soil bearing is lower then I will redesign several of the footers.
    i. This adjustment can most likely be scaled to redesign the rest of the building.
f. Use the assistance of the structural engineer of Kimberton Elementary School, Baker, Ingram and Associates, to understand how they developed the original foundation.

4. Another analysis to consider is what HVAC system could be used on the new site.
    a. Originally proposed to use a geothermal heat pump to heat and cool the building but was changed due to site contamination.
    b. Look into what is required to convert it back to geothermal heat.
    c. Contact the mechanical engineer, Snyder Hoffman and associates, to receive the original specs of the geothermal heat pump.
    d. "Reinstall" the system into the building and make all the changes required.
        i. Rather simple because the system was almost fully design before it was changed.
    e. Price the lifecycle cost of the different system based.
    f. Placing where the geothermal wells would go on site is also an essential consideration.
        i. Locate wells using Revit to display and coordinate.
5. Revisit technical analysis preformed during previous technical reports for the new building location.
    a. Update project schedule based on a change of date and different site conditions. (i.e. No site closure plan.)
    b. Develop a new site utilization plan based on the golf course site.
    c. Re-estimate the structural system if any changes were made to the foundations.
        i. Track using the model that was already created in Revit and track the quantity changes.
    d. Adjust general conditions estimate based on the time and setting.
6. Perform any additional analysis required during the relocation to golf course that I have not yet considered.

C. Alternate Exterior Building Envelop

Due to many delays during the preconstruction process, the schedule for construction had been pushed back a year and half. The school was originally proposed to break ground in January of 2006 and be ready for occupancy in September of 2008. With the delays the schedule would have the foundation placement beginning in mid-October if the site closure plan goes according to plan. The exterior masonry will not be completed until late March.

Figure 2: Example of Precast Masonry School Building (www.cpci.ca)

Currently, in order to deal with this cold weather placement of concrete and masonry, different techniques like accelerators and tenting will have to be implemented. This extra effort will add around 5% -10% to the concrete and masonry cost. (see technical report 3 for future information of cold weather concrete and masonry placement.)

To complete this analysis I will consider an alternate exterior finishing system of precast concrete panels. The goal is to enclose the building faster so that the contractors can work during the winter months indoors. Hopefully the installation of precast in winter will be more productive than masonry. To complete this analysis I will perform the following:

1. Detail the schedule of the current masonry system and place the schedule into a 4D model using Navisworks.
2. Research a precast panel that could be used to replace the concrete masonry units.
    a. Get in contact with a local precast supplier. (Nitterhouse possibly).
    b. Look up unique design solutions on internet.
    c. Make sure the R-values are high enough and equal to or above previous.
    d. Verify that the panels are aesthetically acceptable.
        i. Model in Revit.
        ii. Send to the project architect for comment.
3. Estimate the cost of the solutions and compare the lifecycle cost to current exterior system.
    a. Use Revit model and test Autodesk Quantity Takeoff to link to a timberline database.
        i. Explore a new software program, Autodesk Quantity Takeoff for its potential.
        ii. Use of building information modeling could eliminate a lot of the tedious work required when quantity estimating.
        iii. Determine the correct method of modeling.

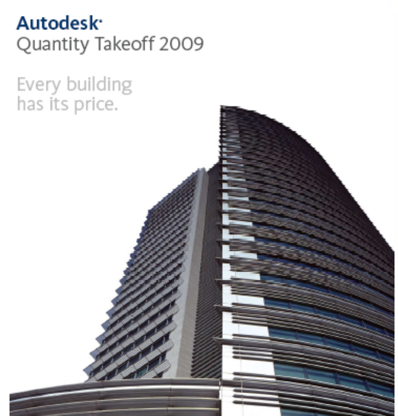


Figure 3: Autodesk Quantity Takeoff (www.autodesk.com)

   iv. Develop a process for modeling so that it can be taken off properly.
  b. Important to Foreman Program and Construction Managers.
  c. Foreman Program and Construction Managers spend a number of resources on the estimation of building projects at various times during design.
     i. Currently, Foreman takes off drawings and estimating using the paper drawings provided by the architect.
     ii. Time consuming process and needs to be repeated at each stage of design.
     iii. The Kimberton Elementary School project was taken off at three separate times.
        1. Because the project was delayed all of the figures had to be adjusted for time which is not a perfect transition because different elements of the construction project changed at a different rate over the one and half years the project was delayed.
     iv. The individual prices of divisions of the project are very important because of the multiple prime contracts method used on Pennsylvania school projects.
     v. It is not only necessary to know a change in the overall project cost but also the change in cost of individual project packages.
  d. Disseminate process on BIM Wiki.
4. Reevaluate the schedule due based on the precast system hopefully saving time.
  a. To compare the two different schedules I will place the precast system into Navisworks.
5. Study whether or not there will be reduced site congestion around the building because of no scaffolding, however there maybe need for a second crane in order to keep the schedule.
6. Develop a delivery schedule of the precast panels.

D. Integrated Project Delivery:

The multiple prime contracts requirement by Pennsylvania state law makes it almost impossible to use an integrated project delivery method to construct a school or public building. This prevents the benefits of this delivery method from ever being explored. The low bid requirement often results in a lower quality project and more problems such as excessive change orders during the construction process. Currently the construction industry is being transformed by the Integrated Project Delivery method. It is possible that the public projects will be left behind.

The requirement of multiple prime contracts in many ways is unjust to the school district. An integrated delivery process model should be developed that fulfills the requirement of multiple prime contracts. The contractors need to be brought in early during the design development in order to have a better more profitable project for all parties involved.

In order to accomplish this, Pennsylvania law on multiple prime contracts will need to be researched in order to appreciate the reason for creating the multiple prime contracts requirement in the first place. The Pennsylvania Separations Act (Act 104 of 1913) was established "to protect subcontractors from unscrupulous prime contractors." (Statistics from http://www.mbawpa.org/SeparationsAct.pdf) The law requires multiple prime contracts when the contract is over $4,000 for public buildings. The separation act does not allow the choice of delivery system but forces them into the multiple prime contract delivery type. Some studies show that construction costs increase by 13% due to the act. Is this the best way for contractors, schools, and construction managers? I will further research act 104 to see how the law needs to be adjusted in order to make integrated project delivery possible on schools and public projects in Pennsylvania.

From that point the contractors that operate as multiple primes should be surveyed in order to understand what is best for their companies as well as what is a conceivable model for an integrated project delivery with multiple prime contracts. After the contractors were surveyed a first attempt at setting up a process model for integrated multiple contracts could be developed. This process model would probably include a modified bidding process at schematic design. This would require contractors to both add overhead to cover the variables as well as have them make some of the design decisions so that there would not be change orders and other problems down the road. Once the process model is developed, it should be distributed to the contractors with a detailed explanation of the benefits. The contractors could again be surveyed to see if they would buy into the process because of the foreseeable benefits. This process model would then be shared to the general public via the internet and possibly delivered to Pennsylvania schools as a possible method to construct their next building project.

It is most likely that the law will have to be changed or adjusted. I could also contact a local representative and see what steps would be necessary to change the law to allow a different contract type. As a more detailed analysis I would consider writing a petition to the Pennsylvania legislator.

E. Conclusions

Weight Matrix

Below is the weight matrix for approximate percentages of my four analyses of my thesis project. Each percentage is based on how much of the study I feel will focus in the areas of Critical Issue Research, Value Engineering Analysis, Constructability Review, and Schedule Reduction / Acceleration Proposal. Moreover the table also illustrates the percentage total value of the overall thesis project.

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
Site Closure Plan	5%	5%	5%	5%	20%
Alternate Site Evaluation	5%	10%	10%	5%	30%
Alternate Exterior Building Envelope	5%	5%	5%	10%	25%
Integrated Project Delivery	15%	0%	10%	0%	25%
Total	*30%*	*20%*	*30%*	*20%*	**100%**

Critical Issues Research

My investigation in an integrated project delivery method will be my primary research into issues critical to the construction industry. This contract strategy which I primarily learned about in my BIM execution graduate class is very important to Pennsylvania school districts and contractors. The Site Closure Plan analysis deals with risk and how to creatively plan for the risk. By performing an evaluation of an alternate site I will have to research other project cancellations. Because of the economy there are most likely a number of other schools projects that have been cancelled. It will be interest to see the steps they are taking to move forward. Finally the exterior building enclosure system analysis will consider new technologies in precast concrete panels. A majority of my thesis will focus on research of industry issues.

Value Engineering Analysis

The goal of the ownership is to deliver a school building on time, and on budget. Value engineering will be considered during my evaluation of an alternate site for the building. In this evaluation there are tremendous opportunities to value engineer the building. For example, the mechanical system can be converted to geothermal. (part of my mechanical breadth) The evaluation of risk on the site closure plan will be considering alternate methods of completing this task. Hopefully these alternate methods will be less expensive than the original method proposal. The alternate exterior building envelope study will study the value engineering of the precast panels for the building over exterior masonry. Overall, I feel that the consideration of value engineering during my thesis investigation will add value on my project.

Constructability Review
My suggestions and modifications will lead to a more constructible building. The alternate site evaluation will incorporate many constructability challenges. First the site utilization plan will have to be completely redeveloped. The atheistic of the building will have to be considered which ties in to an architectural breadth. Furthermore, the relocation will also include reviewing the constructability and stability of the foundation on the new site. The site closure plan analysis will consider the feasibility of the current plan. It will hopefully improve the method of closure used. Additionally the analysis of the exterior building enclosure system will present a number of constructability questions. Choosing an alternate system like precast could possibly reduce site congestion but also add issues of its own. Moreover, the integrated project delivery will hopefully ease the construction of the entire project. Overall, this analysis will be incorporated throughout my entire thesis.

Schedule Reduction / Acceleration
My analysis of schedule reduction will most heavily be considered when understanding the impacts of an alternate exterior building envelope system. An alternate system will hopefully reduce the schedule of the building. The site closure plan presents a tremendous risk to the schedule if any unforeseen conditions are found. I will propose alternate methods of site closure to increase productivity of the plan. If these methods are not available I will reduce the schedule by using short interval production scheduling. Additionally I will consider the same modifications to the schedule at an alternative site that is required because of the project cancelation. Reduction of the schedule will be intertwined through my entire thesis.

Incorporation of Graduate Classes
As required to complete my integrated masters here at Penn State, a number of my analysis will incorporate ideas generated during my graduate course work. These studies will focus primarily on the use of building information modeling to aid in the construction process. The general understanding and the impact on industry were furthered by my AE 597G course. It this course we learned a great deal about how each use of building information modeling will benefit a project and what steps should be taken before implementing each use in construction. I will use BIM to further illustrate each of my analyses that I am proposing to study. I will further explore another topic of AE 597G which is integrated project delivery. The delivery method needs BIM to tie it together. These two graduate level topics will tie my entire thesis together.

Final Thoughts
Overall I feel that my thesis is focused on topics that are very pertinent to the industry today and in the future. I feel that the process I develop while using building information modeling will not only benefit myself but will also benefit any individual that I come in contact with or reads my work. Generating a strategy for an integrated project delivery method in the setting for multiple prime contracts could have a profound effect on how many school buildings are delivered in the future. I look forward to implementing the step necessary to complete the large number of tasks before me.

Appendix 1 – Breadth Studies

Architectural Breadth

The evaluation of an alternate site is very architecturally intensive. First I will need to locate the building aesthetically on the site as well as the best location for environmental gain. I will need to architecturally review the building to make sure that it will fit the site in the first place. Modification may be necessary. I will also evaluate the floor plan to see if the functionality is still maintained. Additionally the site will also have to be completely redeveloped to make sure that it incorporates all the uses of the original site plan.

My study into an alternate exterior enclosure will have to consider the aesthetics of the proposed precast concrete systems. This will need to be considered at both locations and it will be very important to maintain the architect's original image of the elementary school.

Mechanical Breadth

When relocating the building it may be feasible to return to the originally proposed system of geothermal heat which was changed due to site contamination. This will involve reviewing the design and making the necessary changes to use geothermal heat. I would also evaluate the life cycle cost of the system. I would also need to locate the geothermal wells on the site and make sure they are up to the requirements of the system.

In addition to the relocation of the building, the analysis of an alternate building enclosure system would have to consider thermal heat gain and loss based on the system's heat transfer rates. If the R-value is significantly higher, it may be possible to reduce the size of the HVAC system.

Structural Breadth

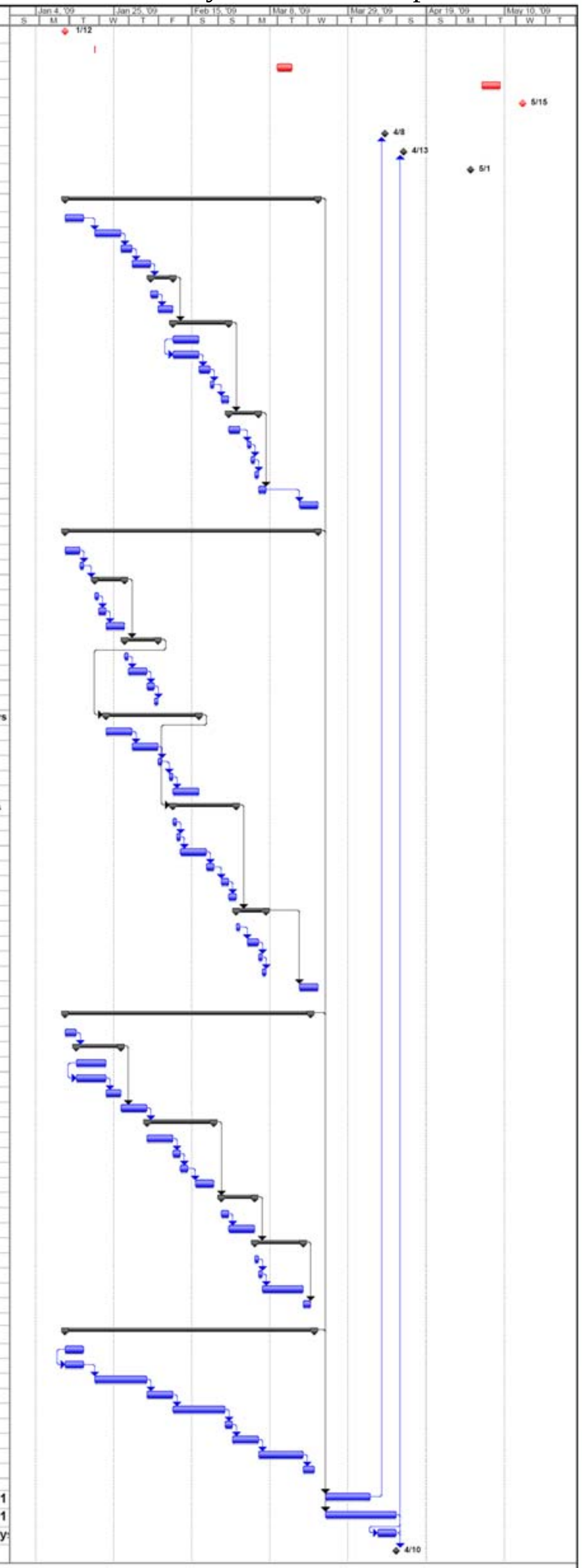
When evaluating the alternate site, the structural stability of the foundation will need to be confirmed because of different site soil bearing capacity. I will need to check these soil conditions and make sure the soil bearing capacity is at least as high as the original site. If it is not as high I will have to redesign a few of the footers and possibly use those changes to scale the other footers to the proper size. Depending on the soil type this could be a simple analysis or a very complex analysis.

Overall, my thesis investigations will require a very well rounded breadth of architectural knowledge and is not just limited to my understanding of building construction.

Appendix 2 - Proposed Thesis Schedule

Below is a schedule on how the specific task required for each analysis will be completed.

ID	Task Name	Duration	Start	Finish	Predecessors
1	Classes Begin	0 days	Mon 1/12/09	Mon 1/12/09	
2	Martin Luther King Day	1 day	Mon 1/19/09	Tue 1/20/09	
3	Spring Break	5 days	Mon 3/9/09	Sat 3/14/09	
4	Final Exams	5 days	Mon 5/4/09	Fri 5/8/09	
5	Commencement	0 days	Fri 5/15/09	Fri 5/15/09	
6					
7	Final Summary Report Due	0 days	Wed 4/8/09	Wed 4/8/09	97
8	Presentation	0 days	Mon 4/13/09	Mon 4/13/09	99
9	Awards Jury / Senior Banquet	0 days	Fri 5/1/09	Fri 5/1/09	
10					
11	Site Closure Plan	44 days	Mon 1/12/09	Fri 3/20/09	
12	Understand Site Closure Plan	5 days	Mon 1/12/09	Fri 1/16/09	
13	Develop unforeseen conditions plan	5 days	Tue 1/20/09	Mon 1/26/09	12
14	Detail site close plan	3 days	Tue 1/27/09	Thu 1/29/09	13
15	Use 4D modeling	3 days	Fri 1/30/09	Tue 2/3/09	14
16	Look for areas schedule reduction	4 days	Wed 2/4/09	Mon 2/9/09	15
17	Recalculate schedule	2 days	Wed 2/4/09	Thu 2/5/09	
18	Determine cost of acceleration	2 days	Fri 2/6/09	Mon 2/9/09	17
19	Lookfor Alternative Methods of Closure	11 days	Tue 2/10/09	Tue 2/24/09	16
20	Contact CMX	5 days	Tue 2/10/09	Mon 2/16/09	
21	Research Case Studies	5 days	Tue 2/10/09	Mon 2/16/09	20SS
22	Develop Schedule of Alternative Methods	3 days	Tue 2/17/09	Thu 2/19/09	21
23	Compare to orginal Schedule	1 day	Fri 2/20/09	Fri 2/20/09	22
24	Determine cost of alternate method	2 days	Mon 2/23/09	Tue 2/24/09	23
25	Find other areas of schedule acceleration	6 days	Wed 2/25/09	Wed 3/4/09	19
26	Develop SIPS	3 days	Wed 2/25/09	Fri 2/27/09	
27	Calculate Overtime Costs	1 day	Mon 3/2/09	Mon 3/2/09	26
28	Double Excavation and foundation crew	1 day	Tue 3/3/09	Tue 3/3/09	27
29	Add Crane	1 day	Wed 3/4/09	Wed 3/4/09	28
30	Calculate the cost and schedule implications	2 days	Thu 3/5/09	Fri 3/6/09	25
31	Report information	5 days	Mon 3/16/09	Fri 3/20/09	30
32					
33	Evaluation of Alternate Site	44 days	Mon 1/12/09	Fri 3/20/09	
34	Research Previous Canceled school projects	4 days	Mon 1/12/09	Thu 1/15/09	
35	Consider a nine hole golf course	1 day	Fri 1/16/09	Fri 1/16/09	34
36	Locate Building on site	6 days	Tue 1/20/09	Tue 1/27/09	35
37	Locate stie plan of golf course	1 day	Tue 1/20/09	Tue 1/20/09	
38	Create site plan in revit	2 days	Wed 1/21/09	Thu 1/22/09	37
39	Pick find location	3 days	Fri 1/23/09	Tue 1/27/09	38
40	Fit school to site atheistically	7 days	Wed 1/28/09	Thu 2/5/09	36
41	Develop renderings in existing site	1 day	Wed 1/28/09	Wed 1/28/09	
42	Landscape golf course site	3 days	Thu 1/29/09	Mon 2/2/09	41
43	Transfer features from kimberton site	2 days	Tue 2/3/09	Wed 2/4/09	42
44	Render building on new site	1 day	Thu 2/5/09	Thu 2/5/09	43
45	Check foundations	17 days	Fri 1/23/09	Mon 2/16/09	40FS-10 days
46	Check soil type	5 days	Fri 1/23/09	Thu 1/29/09	
47	obtain geotechinical surveys	5 days	Fri 1/30/09	Thu 2/5/09	46
48	check soil bearing capacity	1 day	Fri 2/6/09	Fri 2/6/09	47
49	Determine if foundation is acceptable	1 day	Mon 2/9/09	Mon 2/9/09	48
50	Possibly redesign several foundation	5 days	Tue 2/10/09	Mon 2/16/09	49
51	Reevaluate HVAC System	13 days	Tue 2/10/09	Thu 2/26/09	45FS-5 days
52	establish changes for geothemal system	1 day	Tue 2/10/09	Tue 2/10/09	
53	Contact Snyder Hoffman for orginal specs	1 day	Wed 2/11/09	Wed 2/11/09	52
54	"Reinstall" into building	5 days	Thu 2/12/09	Wed 2/18/09	53
55	Price life cycle cost	2 days	Thu 2/19/09	Fri 2/20/09	54
56	Compare to broiler and chiller	2 days	Mon 2/23/09	Tue 2/24/09	55
57	Place geothermal wells on site	2 days	Wed 2/25/09	Thu 2/26/09	56
58	Revist technical analysis on new location	6 days	Fri 2/27/09	Fri 3/6/09	51
59	Update project schedule	1 day	Fri 2/27/09	Fri 2/27/09	
60	Develop Site Utilization Plan	3 days	Mon 3/2/09	Wed 3/4/09	59
61	Adjust structural estimate using revit	1 day	Thu 3/5/09	Thu 3/5/09	60
62	adjust general conditions estimate	1 day	Fri 3/6/09	Fri 3/6/09	61
63	Time for extra analysis	5 days	Mon 3/16/09	Fri 3/20/09	58
64					
65	Alternate Exterior Building Envelope	42 days	Mon 1/12/09	Wed 3/18/09	
66	Detail current masonry schedule	3 days	Mon 1/12/09	Wed 1/14/09	
67	Research Precast system	7 days	Thu 1/15/09	Mon 1/26/09	66
68	contact supplier	5 days	Thu 1/15/09	Thu 1/22/09	
69	look up unique design solutions	5 days	Thu 1/15/09	Thu 1/22/09	68SS
70	confirm R-Values	2 days	Fri 1/23/09	Mon 1/26/09	69
71	Confirm Mechanical System	5 days	Tue 1/27/09	Mon 2/2/09	67
72	estimate and compare life cycle costs	14 days	Tue 2/3/09	Fri 2/20/09	71
73	use autodesk QTO	5 days	Tue 2/3/09	Mon 2/9/09	
74	evaluate QTO	2 days	Tue 2/10/09	Wed 2/11/09	73
75	Determine modeling process	2 days	Thu 2/12/09	Fri 2/13/09	74
76	share process on BIM wiki	5 days	Mon 2/16/09	Fri 2/20/09	75
77	Reevaluate schedule for time savings	7 days	Mon 2/23/09	Tue 3/3/09	72
78	Use NavisWorks	2 days	Mon 2/23/09	Tue 2/24/09	
79	Create 4D model	5 days	Wed 2/25/09	Tue 3/3/09	78
80	Generate Site plan based on system	4 days	Wed 3/4/09	Mon 3/16/09	77
81	evaluate site congestion	1 day	Wed 3/4/09	Wed 3/4/09	
82	evaluate site logistics	1 day	Thu 3/5/09	Thu 3/5/09	81
83	develop plan	2 days	Fri 3/6/09	Mon 3/16/09	82
84	Develop delivery schedule to reduce congestion	2 days	Tue 3/17/09	Wed 3/18/09	80
85					
86	Intergrated Project Delivery	43 days	Mon 1/12/09	Thu 3/19/09	
87	Research intergrated project delivery method	5 days	Mon 1/12/09	Fri 1/16/09	
88	Research PA law on multiple prim contracts	5 days	Mon 1/12/09	Fri 1/16/09	87SS
89	Survey multiple prime contractors	10 days	Tue 1/20/09	Mon 2/2/09	88
90	Develop process model for MPIPD	5 days	Tue 2/3/09	Mon 2/9/09	89
91	Distribute for comment	10 days	Tue 2/10/09	Mon 2/23/09	90
92	Share with industry	2 days	Tue 2/24/09	Wed 2/25/09	91
93	Learn what changes in law are necessary	5 days	Thu 2/26/09	Wed 3/4/09	92
94	contact representatives	3 days	Thu 3/5/09	Mon 3/16/09	93
95	write a petition	3 days	Tue 3/17/09	Thu 3/19/09	94
96					
97	Write Summary Report	10 days	Mon 3/23/09	Fri 4/3/09	86,65,33,11
98	Create Presentation	15 days	Mon 3/23/09	Fri 4/10/09	86,65,33,11
99	Practice Presentation	5 days	Mon 4/6/09	Fri 4/10/09	98FS-5 day:
100	Present	0 days	Fri 4/10/09	Fri 4/10/09	99



Project: schedule
Date: Fri 12/12/08

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

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