Kimberton Elementary School

East Pikeland Township, Chester County, Pennsylvania

Technical Report 3

Alternative Methods Analysis

Consultant: Dr. John Messner

Friday November 21st, 2008

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

Ralph Kreider
Construction Option: Messner

Executive Summary:

The construction challenges, schedule acceleration scenarios and value engineering topics of Kimberton Elementary were shared by the project team for the purpose of further identification of problems and technical analysis of the construction project. Kimberton Elementary School had many constructability challenges. The most important of these being the contaminated ground water and site closure plan. It was the contaminated ground water that eventually led to the cancelation of the project. Due to delays in bidding the project the schedule now calls for completion of the foundation and exterior masonry to be completed during the winter months. This will require a lot of extra work all the while being less productive due to the temperature and weather. Because the neighboring fire hall did not allow the use of their land for access to the school, there is a large amount of work required to gain access to the site. This includes making major improvements to Pike Spring Roads / Route 113.

Phoenixville Area School District has few reasons to worry about having to accelerate the schedule of the building project. The site closure plan plays a critical role in keeping the project ahead, on, or behind schedule. Ideally, it would have gone as planned and could have been completed early. If the schedule needs to be accelerated the simplest solution is to increase manpower or work overtime. It might also be possible to look into other methods and techniques of completing construction.

The value engineering of Kimberton Elementary School was rather extensive considering the extra time it had before it went to bid. Kimberton originally proposed a geothermal heat pump system to condition it. This was the most economical over the life cycle of the building. However it was scrapped because of the contaminated ground water and a slightly less efficient water source heat pump system was to be utilized. The VE decision of Terrazzo vs. VCT was, like most other school projects, a topic of conversation for Kimberton. It was decided by Phoenixville Area School District that the Terrazzo was a smarter investment. Furthermore the roof finishes that were prescribed by the architect was challenged by Foreman. The school district agreed to construct the more economical shingled roof over a standing seam roof.

There are many issues of this project that should be identified. The underground contaminates and site closure plan is what made this project impossible to complete. Along side that are the challenges of dealing with a concerned public and a project that has been terminated. Detailed cost analysis is important for a construction manager such as Foreman Program and Construction Managers. Maybe more important than cost estimating and analysis is being able to phase and plan a school project properly. It is always a challenge to understand what the owner of a building asks for from their as-built drawing that they receive. Kimberton Elementary is almost entirely masonry, which can be a very labor intensive and time consuming process.

Each of these issues could be analyzed by various technical methods. The underground contaminates need to be further investigated and compared to other similar cases. Industry surveys could be developed to deal with the concerned public and project termination. New software could be researched and tested on this project to deal with estimation and phase planning. The as-built drawings are a huge consideration after the project is completed and opinions of owner's needs should be collect to better understand their needs. Alternate construction methods should be considered to deal with the labor intensive masonry. There are many topics that could be extensively studied that relate to this project.

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A. Constructability Challenges

There are many aspects of Kimberton Elementary School that make it a challenging project to complete. One major aspect is that there is contaminated ground water on the site from an old manufacturing facility in the area. A second challenge is that the schedule calls for placing foundation and masonry during the winter months. Yet another is the road work that needs to take place on Route 113 to gain access to the site.

Contaminated Ground Water and 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. There are two major site disturbances on the Kimberton Elementary School Site that would have been dealt with separately. The first was contaminates due to the site being used as a dumping ground. The second is the contaminated ground water on the site.

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 2000 sq ft were also used for household municipal disposal.

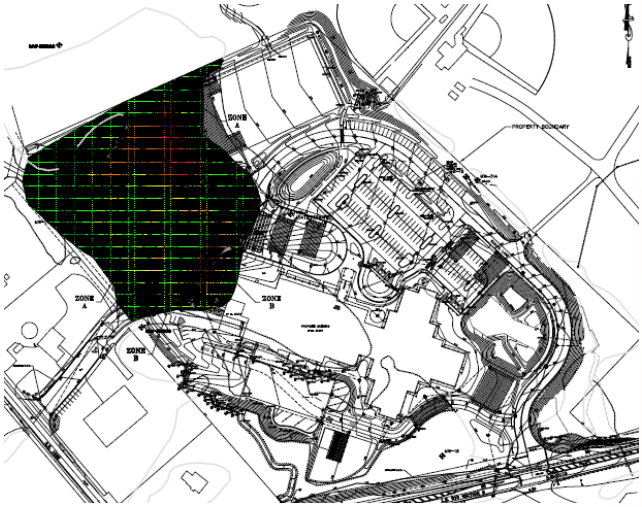

Figure 1: Area of Site Closure Plan

In order to get rid of the contaminates due to this site being used for a dumping ground there would have been approcimately 8,425.2 cubic yards (CY) of soil excavated. 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 2125 CY can remain on site and be used as fill. The 6300 CY that iscontaminated 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.

Across Cold Stream Road is the existing USEPA superfund site. The Henry Company currently uses the site to manufacture asphalt. The site had been used for manufacturing resin, textiles and asphalt products. From 1947 to 1959 the previous owner disposed residues from the manufacturing process into eight lagoons. Volatile organic compounds (VOCs) were detected in 1981 from monitoring wells installed around the area. This began the clean-up process which included removing drums and excavating the lagoons. Additionally all local residential wells were treated in the area. In 1992, a public water system was built to mitigate potential contaminated drinking water.

Constructability Challenges

In 1989, the EPA decided to pump the contaminated groundwater to the surface to remove the contaminates by air stripping. After installation of the treatment system in 1993, it has been running continually and has removed over 4,000 lbs of VOCs. The VOCs of concern that contaminate the groundwater in the area are trichloroethylene, dichloroethylene, and vinyl chloride.

Kimberton Elementary School was to be built neighboring this site and several steps were to be taken to minimize the risk to the students that were to attend the school. First additional monitoring wells were installed on the site to ensure that the level of VOCs were within an acceptable concentration. These wells were monitored for one year as prescribed by the USEPA. The hazardous levels were found in the aquifers 180 feet below the surface. However trace amounts were found about this. Despite no trichloroethylene (TCE) or other VOC being detected under the building footprint a vapor mitigation system was incorporated into the schools design. This was a recommendation of the USEPA but was not necessary to contain the TCE based on an expert's opinions. According to this expert there can be no exposure to the chemical because the vapors will not intrude into the building. The vapor mitigation system is simply an extra precautionary measure. This expert states "The science clearly supports the conclusion that the Kimberton Elementary School can be built at the proposed site without unacceptable risk from vapor intrusion." The vapor mitigation system will completely protect the building from entering the building and diverts up through stacks in to the atmosphere in small concentrations.

Figure 2: Front Page of the Philadelphia Daily News June 19th, 2008

Installation of a vapor mitigation system is not an uncommon procedure and could be accomplished with very little additional effort and cost. It consists of three small pumps, three vapor stacks, three vapor pits and high grade vapor barrier underneath the building footprint. In most cases a vapor barrier would have already been in place to act as a moisture barrier. The only addition is the small pits, stacks and pumps. The stacks and vent pipes are not much different from a bathroom exhaust stack. This system should not add much extra challenge in construction. The school will also be tied into the city water to ensure that there is not exposure to the soil due to the contaminated groundwater.

However the main construction concern of the project was to get the residences of the community to understand the site issues and that there is no health concerns to the students. This is a true management problem due to the emotions of parents that come into play and this is different than most building projects. The parents are very unwilling to listen to scientific data when any carcinogenic chemical such as trichloroethylene is detected. It was the parents protesting construction of the elementary school that eventually lead to the cancelation of the project after bids were received for the project.

Cold Weather Concrete and Masonry Placement:

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.

Building Foundations	**58 days**	**Thu 10/16/08**	**Mon 1/5/09**
Foundation Excavation DC	20 days	Thu 10/16/08	Wed 11/12/08
Footings	20 days	Fri 10/17/08	Thu 11/13/08
Foundation CMU	24 days	Fri 10/24/08	Wed 11/26/08
Underslab Electrical	30 days	Tue 11/11/08	Mon 12/22/08
Install Underground Sanitar	25 days	Fri 11/14/08	Thu 12/18/08
BackFill Foundations	20 days	Mon 11/24/08	Fri 12/19/08
Install Electrical Duct Bank	5 days	Thu 11/27/08	Wed 12/3/08
Install Stone Base	10 days	Tue 12/23/08	Mon 1/5/09
Erect Steel	**62 days**	**Tue 11/18/08**	**Wed 2/11/09**
Erect Steel DC	30 days	Tue 11/18/08	Mon 12/29/08
Joist and Decking DC	15 days	Tue 12/2/08	Mon 12/22/08
Erect Steel BA	35 days	Tue 12/23/08	Mon 2/9/09
Joist and Decking BA	15 days	Thu 1/22/09	Wed 2/11/09

Figure 3: Part of Proposed Construction Schedule

In order to deal with the problem of concrete curing at below freezing temperatures several procedures will have to be followed. First off, accelerators will have to be added to the concrete so that the concrete sets properly. The areas will also have to be tented and heated in the coldest months of the year to ensure that the concrete will reach its proper strength. Working in cold weather will result is less production. Not only will tenting and other measures take more time but the mere temperature will result in less productive workers. In order to maintain the schedule extra manpower will be required. This manpower issue could simply be solved by adding more personnel to the job or working weekends which is not currently scheduled. Overall the cold weather placement of the concrete is estimated to increase the price by 5%-10% increase.

A more significant problem would be the Cold Weather Masonry. Several issues arise with water requirement to reach a given consistency is reduced, amount of air-entraining agent yields more entrained air. setting of the mortar is significantly delayed, heat-liberating reaction rates between Portland cement and water are substantially reduced and become minimal as mortar temperatures drop below 40' F (4.5' C), strength gain rates are reduced (www.maconline.org). “Cold masonry units lower the temperature of mortar placed in contact with those units. As noted above, this will slow reaction rates between cement and water, reduce strength gain rates, and delay tooling and setting times. If the units are cold enough, the temperature of the mortar may rapidly drop below freezing and result in disruptive expansion of the mortar as water in the mortar freezes. Wet or ice covered unit surfaces prevent development of good bond between mortar and unit. In addition to affecting the performance of masonry materials, cold weather may also affect the productivity and workmanship of masons. During cold weather, in addition to attending to normal construction tasks, masons are concerned with personal comfort and safety, additional materials preparation, handling, and protection of masonry. These extra activities consume more time as temperatures continue to drop.”
(http://www.maconline.org/tech/construction/cold1/cold1.html)
Different types of CMU may need to be selected based on their performance in cold weather. Mortar should have lower water content than normal at about 6% compared to 11 to 16 percent. This reduces workability. Accelerators will need to be added to the mortar to ensure it does not freeze before curing. Masonry units may need to be heated if temperature drop to low. Wind breaks, heated wall coverings, enclosures or heated enclosures may be necessary to ensure mortar setting properly and mason and laborer comfort and efficiency.

Road Work on Pike Spring Road / Route 113:

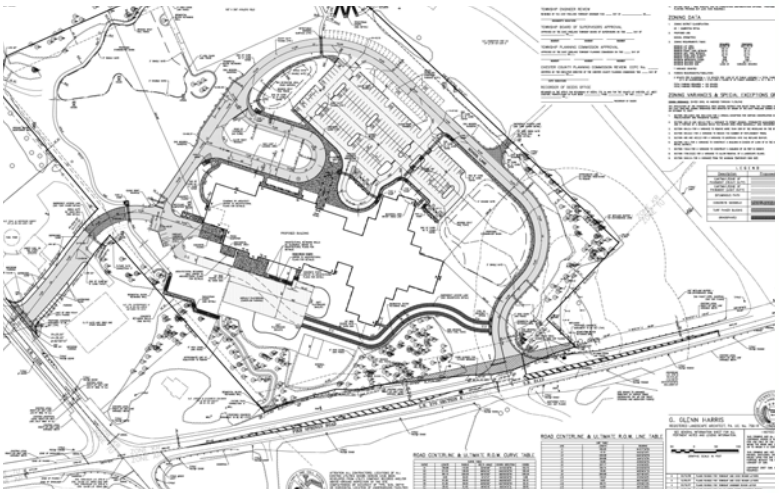

Figure 4: View of improvement to Route 113

Whenever major building projects take place, the local townships use it as an opportunity to improve the roads surrounding the site. This is no different when it comes to the construction of Kimberton Elementary School. Originally the school district proposed that the school be accessed via the neighboring fairgrounds and local fire hall entrance. This entrance would have required significantly less improvement to Route 113 and would have allowed for more green space for the students to use for recreation. As it stood, the project would have included creating an access drive from Route 113 as shown in Figure 4. The general contractor would have had to widen Route 113 enough for a left turn lane into the elementary school and widening the shoulders on both sides of the road between the intersection and fair grounds entrance. This widening is made increasing difficulties due to an existing retention basin opposite on Pike Springs Road from the proposed site. Additionally, the intersection of Cold Stream Road and Route 113 would have had to have been revamped by left turn lanes, and widening all of the shoulders.

This construction would have been rather challenging because of the volume of traffic on Route 113. All traffic shut downs and lane closures would have been coordinated with East Pikeland Township. Because of the volume of traffic especially during morning and evening commutes the lane closures would cause severe delays to commuters. For this reason most road work would have to take place during non peak hours to keep the disturbance to traffic flow to a minimum. This plan would result in few work hours to complete the project and would result in a longer duration of the Route 113 improvements project. There is also added risk to the employees when working on a highway this size. It was also difficult and time consuming to receive permit for the access to route 113. It would be potentially beneficially to look into rerouting the traffic around the site to reduce construction time. Hares Hill Road to Kimberton Road could be a possible alternate route during construction however this would have to be cleared with the township especially considering that this goes through a residential area. It seems as if this was once the primary route and the current 113 was built to bypass the village of Kimberton.

B. Schedule Acceleration Scenarios

There are many scenarios during the course of construction that cause a project the need to accelerate their schedule. They range from getting out of the ground slowly to having an exuberant amount of change orders. Below is an evaluation of the schedule acceleration scenarios for Kimberton Elementary School.

Critical Path:

The critical path for the construction of this school in East Pikeland Township is the site closure plan and erosion and settlement plan for the site. These plans are followed by establishing the building pad that the foundation will be placed on as part of the critical path. The critical path then proceeds onto the erection of the structural steel and then the steel decking. This is followed by the construction of the roof membrane along with the masonry veneer and fenestrations will enclose the building. Following the enclosure of the building the mechanical system will drive the critical path until the building is almost complete. The finishes will be able to keep up the mechanical contractor and be completed a few days after the mechanical contractor is finished.

Risk to Completion Date:

The biggest risk to completing the schedule as planned is the site closure plan. 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.

Areas of Potential Acceleration:

If the site closure plan were to run long, the construction manager would have to look into potential areas to accelerate the construction process. The most likely solution would be to work overtime and to work some weekends until the schedule is back on track. Another potential solution is to double crew sizing of excavation and foundations. On a site this size there should not be a congestion issue. It would be possible to add a second crane to the site and work towards the center of the building. One crane could be used to complete the classroom wing of the building while the other could be used to construct the activities wing. It would also be prudent to see if the some of the masonry wall can be replaced by prefabricated units that could save on installation time on site. Also delays in the construction would allow for better conflict resolution of the mechanical systems of the building. This would allow for more of these units to be fabricated off site and have less onsite installation time. It would also be advantageous to breakdown the schedule so that it is known which trade is to be in which location at each time. A detailed schedule and phasing plan would allow less trade stacking and improve productivity.

Cost and Techniques:
The costs would be unknown until it is determined how much delay would have been encountered in the closure plan. If the delays were minimal, the schedule could have been compressed with very minimal costs, however if large amounts of contaminants were found then the delays and cost would be much greater. Doubling crews in theory should add no cost to the building process if they do not delay each other and cause any interferes. It would be ideal to treat each wing almost as two separate projects in this case to reduce the interferences. Adding overtime to the project will result in extra cost to the project by paying them one and a half times the normal rate. Additionally if the overtime period is extended for a long period of time this will cause the workers to be less productive and result in more costs to the project. Prefabricating could actually result in less cost to the project. However, this solution needs to be foreseen early to allow for the long lead time on some of the prefabricated units. Mechanical prefabrication already takes place on most projects and should not add cost. Nevertheless, if the mechanical shop of the prime contractor cannot handle the additional load this could result in having to pay the shop overtime or subbing out some of the fabrication of the ductwork.

C. Value Engineering Topics

Several areas of value engineering were discussed on this project from the HVAC systems to the finishes. The main goal of Value Engineering is to save costs while increasing the overall value of the project. Value Engineering does not always mean pursuing cheaper initial costs, but rather lower costs over the life-cycle of the building. This includes maintenance, repair and replacement of the products. The owner's needs of the lowest life cycle cost were the deciding factor for most of the value engineering decisions. While aesthetics are important to the owner, the appearance was usually not the deciding factor in their decision. For Kimberton Elementary School the value engineering ideas focus on three major areas: the HVAC system, foundation walls, the floor finishes and the roof finish type.

HVAC System:

Several items that were considered where the HVAC system which was originally intended to be a geothermal system, which would have had a higher initial cost but a lower operating cost and an overall cheaper life cycle cost. But this was not implemented due to the concern with the contaminated ground water and the drilling of the wells bringing the contaminated ground water to the surface. This geothermal heat pump system (GHSP) has good humidity control, can vary between heating and cooling, has no visible heat rejection equipment and the overall lowest estimated life cycle cost. The problems with this system are the shorter equipment life, no economizer cycle and high construction cost. The system cost approximately $31 per sq. ft. at a total cost of 3,190,644. Other systems included that were considered were a water source heat pump and a Variable Air Volume system. The VAV system has good humidity control, an economizer cycle and simple systems operations. The drawbacks of this system are the location and number of VAV boxes and that there is a cooling tower and boiler to maintain. This system would cost $27 per square foot for a total cost of $2,778,948. While not the most economical, the system that was chosen because of the groundwater contaminated to ensure that no VOC would reach the surface was the water source heat pump. The water source heat pump has good humidity control, heats and cools at the same time, has the lowest initial cost. The disadvantage of the system is a shorter life of equipment, has no economizer cycle, and has a cooling tower and boiler to maintain. Overall the initial cost of this system is 25.50 per square foot for a total cost of $2,624,562.

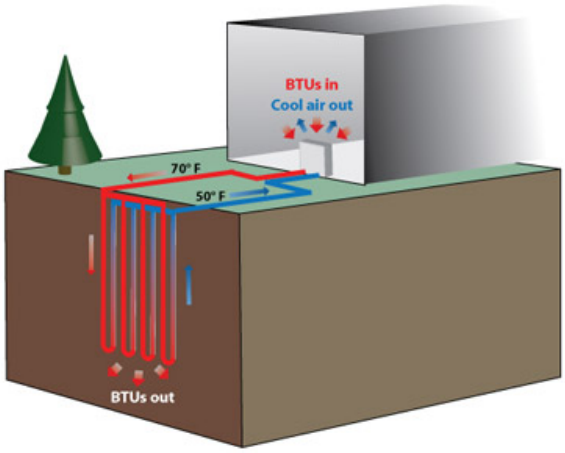

Figure 5: Example of Geothermal Heating System (www.nyserda.org)

Figure 6: Example of Chiller that replaced Geothermal System (www.wegotchillers.com)

Foundation Walls:
The foundation walls of Kimberton Elementary School were to be constructed as CMU masonry foundation walls that varied between twelve and 8 inch block. Foreman program and construction managers proposed a sixteen inch poured concrete wall. CMU masonry foundation walls had an advantage of being the standard installation practice for foundation walls, however a few drawbacks include the high labor cost, more lay down area is required and a potential for damaged block. On the other hand a pour concrete foundation wall would benefit the project by having a single sub for footer, column base and foundation walls, lower labor costs, easier to install and a lower overall cost than a CMU foundation wall. Unfortunately the poured concrete also has the potential for unacceptable strength after placement and concrete prices fluctuate often which could lower the overall saving. CMU foundation walls for Kimberton Elementary School would cost about $152,000 compare to about $118,000 if they were poured concrete. Foreman suggested that the school district change the design to have a cost savings of $34,000, however because the foundation walls were already designed as CMU the school district decide to keep the CMU foundation walls.

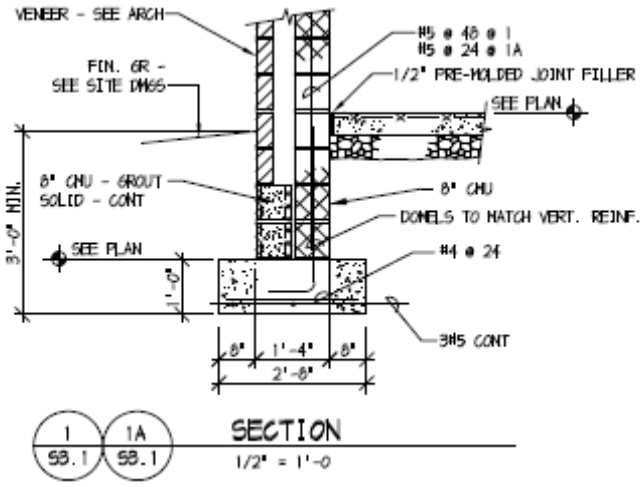

Figure 7: Current CMU foundation detail

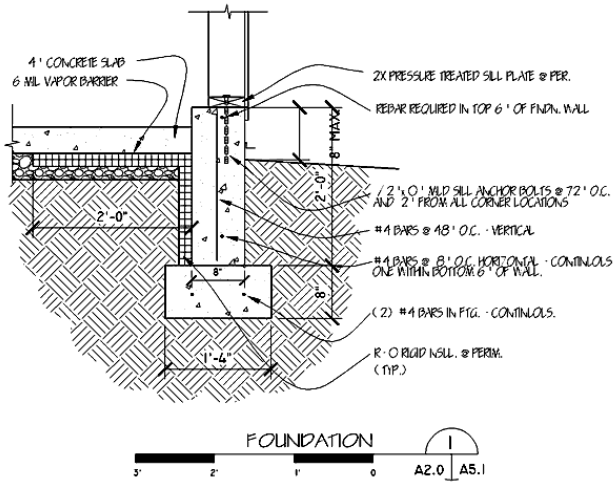

Figure 8: Example of poured concrete foundation wall detail (www.norsewoodsmith.com)

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Kimberton Elementary School
East Pikeland Township, Chester County, PA

Floor Finishes:

One major finish item that is always considered when value engineering during a school construction is Terrazzo vs. VCT or Vinyl Tile. Terrazzo has high durability, ease of maintenance, a life cycle of 50 plus years, and a pleasant appearance. The disadvantage of terrazzo is the high initial cost, the difficulty to match for repair, high repair cost and long installation time. The cost of terrazzo is approximately $21 per square foot and a total cost of $451,815. The VCT on the other hand cost only $1.98 per square foot and a total cost of $42,600, has a much lower initial cost. The VCT also has a large selection of colors and styles, easy to repair and easy to install. The major setback of VCT is that it is less durable, has a higher maintenance cost, and a life cycle of only about 20 years. Yet another option was Vinyl Tile. Vinyl tile is more durable than the VCT, has a higher life cycle of more than 25 years, is easy to repair and is easy to repair. It is more expensive than VCT at $5.25 per square for a total of $112,954. The initial cost of VCT is attractive if upfront costs are the main focus. Vinyl tile is the median range flooring materials with Terrazzo being the high end flooring

Figure 9: Example of Terrazzo Flooring (www.greendale.k12.wi.us)

PASD decided to go with the Terrazzo due to its lower maintenance cost, longer life cycle and lower life cycle costs. The other flooring finishes were placed in as alternates on the bids sheet as replacing all corridors with VCT or just the second floor being replaced with VCT. Phoenixville Area School District decided to reject these alternate bids and go with the terrazzo flooring for its lower life cycle cost.

Figure 10: Example of VCT Floor (www.commercialcarpetsofamerica.com)

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Construction Option: Messner

Standing Seam Roof vs. Shingled Roof:
Another item that was considered for value engineering of Kimberton Elementary School was the standing seam roof that was originally proposed for the sloped portion of the elementary school roof. Foreman suggested that this roof be replace with an asphalt shingled roof on the sloped roof areas. The standing seam roof has higher durability and good aesthetics, however is difficult to repair and has a higher cost at $22.78 per square foot and a total cost of $94,423. The shingled roof on the other hand has a shorter life cycle but is easier to repair and has a lower initial cost of $11 per square foot and $45,595 total. The school district accepted this Value Engineering item and went with the asphalt shingles. The school district did not see any extra benefit in the extra cost of the standing seam roof especially considering its difficulty to repair. Again the school district was concerned with more than the appearance of the roof.

Figure 11: Example of Shingled Roof (www.huntconstructionutah.com)

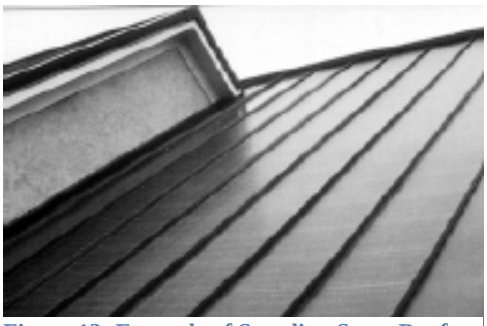

Figure 12: Example of Standing Seam Roof (www.cisolar.com)

D. Problem Identification

Underground Contaminates and Site Closure Plan:

If the building were still being built the underground containments and 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. There are risks with the present plan. 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 than 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?

Dealing with Concerned Public:

What is the responsibility of a construction management when dealing with public opinion? On this project the parents of the children that were to attend Kimberton Elementary School obtained information about the site containments late in the construction process. A few of the parents went around and got the remaining parents to sign a petition to discourage the school board from building the school on this land. The parents would not consider the scientific data that was presented about the site as safe for occupying and had their minds made up before the data was even presented. In turn, the Philadelphia Daily News presented the facts correctly in the news article it wrote, however the front page showed a child in a radiation suit which turned the building of the school into a public relations nightmare. Philadelphia TV was covering the events that occurred. This all culminated with the school board rejecting all bids and abandoning the site on June 19th, 2008 because of pressures from the local community. What role should a construction manager take in answering public fears about the site?

Figure 13: Front Page of the Philadelphia Daily News June 19th, 2008

Dealing with Project Termination:

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? A new location for the building must be found. Also the building will need to be reconfigured for the new site. Are there any other solutions that can be used? There was a large amount of money lost by abandoning the site. How is this money recovered? How do you deal with public reaction of the loss in tax money? Whenever a project is canceled there will most likely be losses by all parties involved.

Cost Estimation for a Construction Management Agency:

Foreman Program and Construction Managers spends a number of resources on the estimation of building projects at various times during design. Currently, Foreman takes off drawings and estimating using the paper drawings provide by the architect. This is a time consuming process and needs to be repeated at each stage of design. The Kimberton Elementary School project was taken off at three separated times.

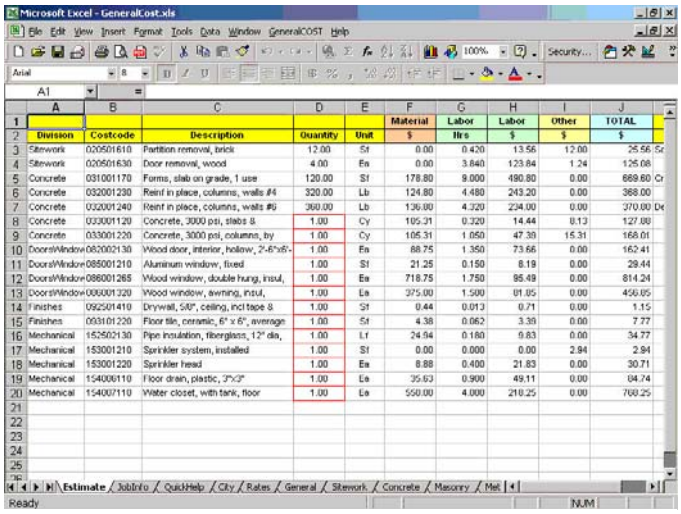

Figure 14: Example of cost estimation takeoff sheet (www.regnow.com)

However 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. The individual prices of divisions of the project are very important because of the multiple prime contracts method used on Pennsylvania school projects. It is not only necessary to know a change in the overall project cost but also the change in cost of individual project packages.

Phase Planning for a Construction Management Agency:

One of the most vital parts of a construction management project is the phasing of the building. Although not as critical for Kimberton Elementary School, phase planning when building any school is crucial to the project opening on schedule. In many situations it is difficult to portray these ideas to the school district administration and boards because they do not necessarily have the ability to translate prints with the same ease as an industry member. The different parties involved visualize the building in many different ways. The information should be delivered in the best manner for each member of the project team to utilize.

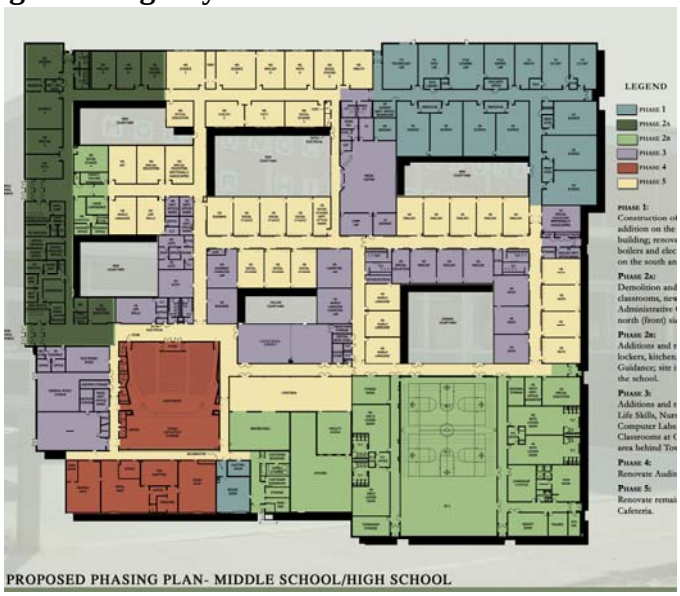

Figure 15: Example of Traditional Phasing Plan (www.mrsd.org)

Delivery of As-Built Drawings to the School District:
One of the most difficult aspects of the construction project is passing the management of a building project from the builder to the owner. Getting the owner to take over the building and handle its own management of the newly completed building is challenging especially when the construction manager continues to work with the school district on other construction projects. What is the best way to deal with this transfer of information? What information needs to transfer? In what format should the information be transferred?

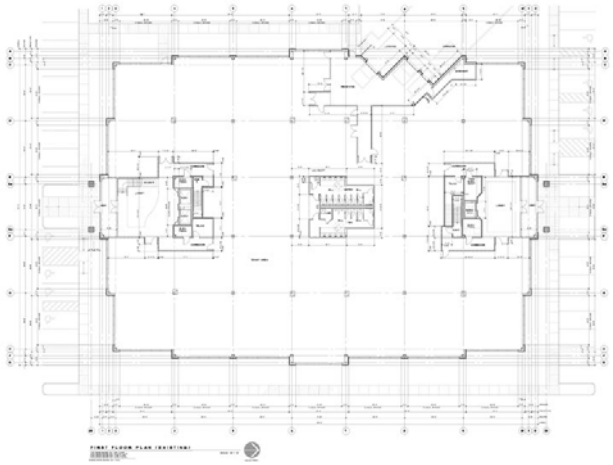

Figure 16: Example of Traditional As-Built Drawings (www.jmwyman.com)

Masonry Construction is a Very Labor Intensive Construction Method:
Like a number of elementary schools most of the walls of Kimberton are concrete masonry units. This building construction method is very labor intensive. With a productivity rate of 240 blocks a day per mason, other methods should be considered before the construction of the building takes places. Additionally this masonry construction is taking place in cold weather months. Alternatives may not be as affected by the cold weather.

Integrated Project Delivery is Challenging with Multiple Prime Contracts:
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.

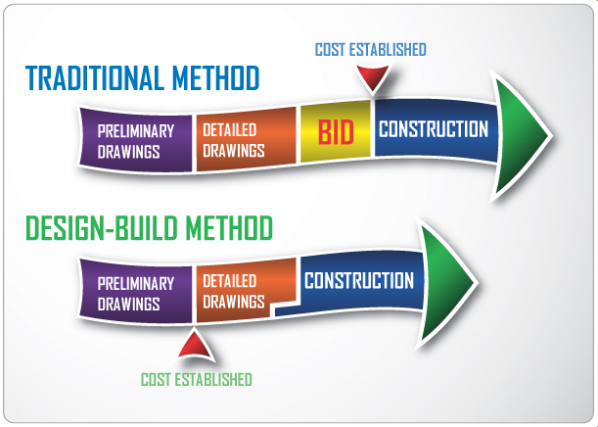

Figure 17: Traditional Method vs. Design-Build Method (www.designbuildrose.com)

E. Technical Analysis Methods

Underground Contaminates and Site Closure Plan:

Further analysis of this topic would consist of completely dissecting the plan and what it entails to complete it. To comprehend it better, CMX could be contacted to see how the plans typically occur. No attempt has been made to find any alternate methods of site closure, this should be done. There has to be many other ways to close a site besides what was proposed. Why were these methods not used? Are any of the other methods faster that would help ease the constraints of the project schedule? This will require a breadth of information that was gained through the soils classes. Additional knowledge would be required from and beyond those classes. There are most likely other cases where closure plans similar to the proposed plan have been preformed successfully or unsuccessfully. These case studies should be brought to light in this research.

Figure 18: A possible unforeseen condition (farm3.static.flickr.com)

Additionally plans for dealing with unforeseen conditions should be created to insure that the project schedule would not have been affected. The schedule for the site closure plan should be broken down and detailed to allow the subcontractors to have a better understanding of what is expected of them. A plan for dealing with each type of unforeseen condition should be developed as well so that if they are encountered there will be no loss of time deciding what should be done. Also the project schedule should be analyzed further to see where possible gains could be made. It may be possible to develop a short interval production schedule for the classroom wing of the elementary school because of the repetitive nature of the building in this area. This more productive option should be developed and considered as a time savings option.

Dealing with Concerned Public:

Figure 19: Example of concerned public (www.onlinepetition.com)

To complete this analysis, a case study of the situation should be developed that outlines the events of the project. This case study will be given to a number of industry contacts in the construction management and the general contracting arenas. Accompanying the case study will be a survey for the contacts to complete. The survey can include questions that are both quantitative and qualitative. “On a scale of 1 to 10, do you feel that the construction manager in this case handled the general public properly?” is an example of one of the questions that could be asked. It is also valuable to have open ended question that would allow those surveyed to give their recommendations on what should have been done. Furthermore there are a number of case studies where projects were canceled due to public opinion. There are lessons from these past cases that could have possibly been used to avoid the situation at Kimberton elementary school. As a result of all this research a company strategy or plan should be developed for dealing with the public that can be implemented in any company and be able to be adjusted for each project.

Dealing with Project Termination:
There are also a number of case studies to be analyzed. Kimberton elementary is not the first school project to be cancelled for various reasons. This problem can be further examined by adding it to the case study that is sent to the industry contacts and getting their opinions on the subject.

The school district should also be contacted to see how they are approaching the current situation. A possible architectural analysis of the termination is looking for a new site for the designed building. Once the site is selected the existing design will need to be adjusted. An architectural breadth could be the redesign of the aesthetics of the building to fit the new site. The site and landscape will need to be adjusted based on the building's placement. Not to mention that the site lighting and day lighting of the building will change when it is relocated. In addition, the soil characteristics of the site will be different from the original proposed site which will require a redesign of all of the foundations. The mechanical system could be reverted to the Geothermal System which was originally proposed. Basically all breadths of the architectural engineering program could be covered in the relocation of the project to a new site. The use of building information modeling could ease the transfer to a location and simplify all of the calculations required to ensure the building's success on the new site.

Cost Estimation for a Construction Management Agency:
Autodesk has just released a new software program, Autodesk Quantity Takeoff, this should be explored for its potential. The use of building information modeling could eliminate a lot of the tedious work required when quantity estimating. The BIM studio could also act as a platform for the exploration into the product. The struggles and successes of this BIM Studio should be documented. Not only when it comes to Autodesk Quantity Takeoff, but all of the BIM Software used. Another interesting note about this process is finding the best way to model the information so that the quantity takeoff software can pull the information from a model. It may also be valuable to develop a modeling process to allow for takeoff to occur.

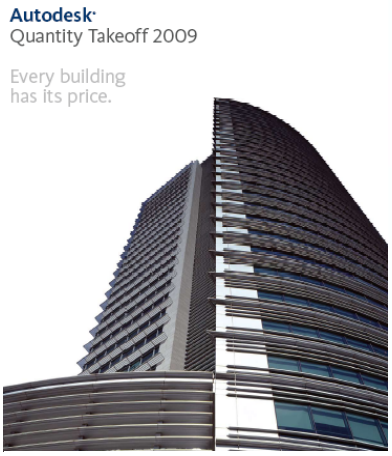

Figure 20: Autodesk Quantity Takeoff (www.autodesk.com)

Phase Planning for a Construction Management Agency:
Four dimensional planning has been documented and analyzed, however new techniques or software should be explored. It would be possible to explore new software and how better phase planning could have benefited Kimberton Elementary School if it would have been built.

Delivery of As-Built Drawings to the School District.
This is a topic that is currently being explored by the BIM Execution Plan team. It could possibly be explored further in a thesis analysis. Phoenixville Area School District should be asked specifically in this case to get a better understanding of what they would have liked to receive from the contractors. There are very few process models of how to integrate information from a building information model into facility management software. An understanding of Phoenixville's facility management tools must be done as a first step; furthermore the other programs to replace the Phoenixville's current tools should be examined.

Masonry Construction is a Very Labor Intensive Construction Method:
Alternate systems to the masonry walls need to be explored. For example precast units could possibly be used to replace this. In fact the precast units could most likely replace the structural system as well. It may also be possible to use pour concrete walls throughout the building. Another possibility is metal stud walls covered in different finishing systems. Different systems should be scrutinized through research and contacting vendors. Once an alternate system is selected, its affects on the schedule, manpower, and cost should be inspected. Most likely BIM would be used to perform this inspection.

Figure 21: Example of Precast Masonry School Building (www.cpci.ca)

Context Aware Building Information Modeling:
Beginning to explore how context aware building information modeling would contribute to future research. The roles and requirements of specific parties on a project should be documented in order to understand what contextual information is required by each person. This could be done through surveys of the construction industry as well as examining case study projects. These roles and needs should be documented and shared with the rest of the industry.

Integrated Project Delivery:
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. 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 a conceivable model for an integrated project delivery with multiple prime contracts consist of. 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 school as a possible method to construct their next building project.