CAMPUS SQUARE BUILDING

1426 North Third Street, Harrisburg, PA

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Executive Summary

This technical report has been put together to familiarize the reader with the Campus Square Building in Harrisburg, Pennsylvania. Included in the report are results from an interview with the Project Manager of Campus Square on topics of constructability challenges, schedule acceleration scenarios, and value engineering topics. Also included in the report are observations I made regarding problematic features of the building and its construction. Furthermore, four technical analysis methods pertaining to construction management topics are highlighted, which may be chosen as potential research topics for my thesis.

Below is a more specific outline of the topics discussed during the interview:

Constructability Challenges:

- Urban site location constraints
- Geothermal well drilling
- Existing utility interference

Schedule Acceleration Scenarios

- Schedule modifications due to delays caused by existing utilities
- MEP procurement and installation
- Increased manpower scenarios
- Elevator scheduling impacts

Value Engineering (VE) Topics

- VE strategies implemented on the project
- VE strategies not implemented
- Goals of the owner, and VE impacts

Problem identification and potential technical analysis topics:

- MEP coordination
- Coordination and communication with service providers and utility companies
- Utility interference alternatives
- Impact of the addition of a second elevator during construction

Constructability Challenges

After conducting an interview with William Sutton II, Wohlsen Construction's Project Manager for the Campus Square project, many interesting constructability issues were discussed and identified. Of the topics mentioned, the top three unique and challenging issues were: urban site location constraints, site flooding and delays due to geothermal well drilling, and existing utility interference throughout the duration of the project.

Urban Site Location Constraints

Located in the heart of downtown Harrisburg, Pennsylvania, Campus Square's site location resulted in many constructability limitations and logistical challenges. Overcoming these issues and developing a functioning logistical plan was critical to the projects' success. Because the footprint of the building extended to extents of the property line, there was little room for equipment, vehicles, materials, and storage. Furthermore, public pedestrian and vehicular access needed to be maintained along Reily, Susquehanna, and North 3rd Streets; creating an even more difficult problem in ensuring traffic flow, as well as public safety around an active construction zone.

GreenWorks Development, the owner of Campus Square, as well as many surrounding properties in the area, worked with Wohlsen in providing them additional space on nearby properties to be used as dumpster storage, subcontractor parking, and material storage and lay-down space. During weekly subcontractor coordination meetings, the logistical plan implemented by Wohlsen addressed where each contractor would have temporary space within the site. Similarly, equipment was provided by Wohlsen to transport materials, tools, and equipment from the off-site storage locations to the temporary areas onsite. This strategy of moving materials from off-site locations to the Campus Square site resulted in careful planning by both Wohlsen and their subcontractors in determining quantities of materials needed each day. **Figure 1**, pictured below, depicts the off-site spaces used while construction of Campus Square took place.

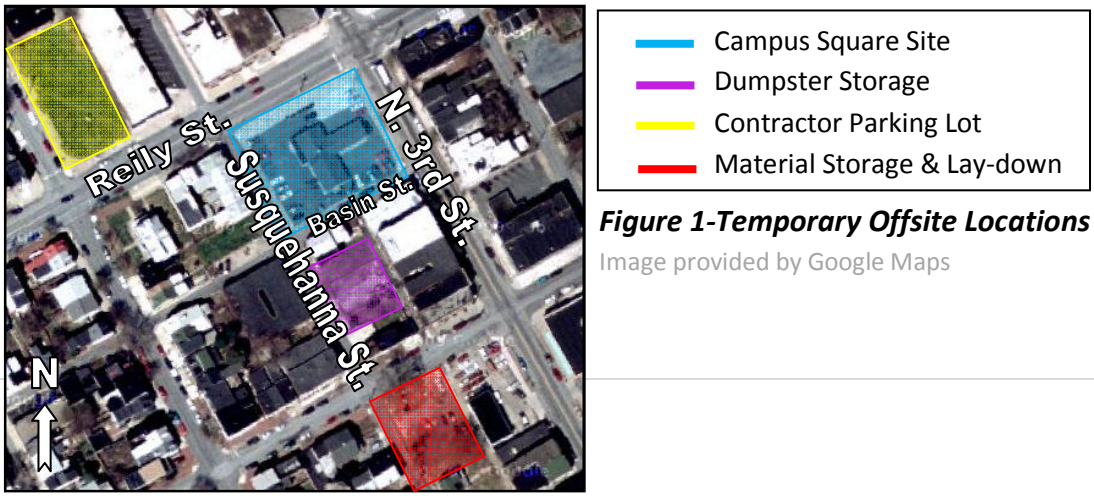

Figure 1-Temporary Offsite Locations

Image provided by Google Maps

In order to provide additional movement and storage/lay-down space within the confines of the site, Wohlsen was able to extend the site fence partially out into the surrounding streets. As seen below in the site photo, barriers and fencing was used to secure the site from the public, as well as protect the workers within the site. This strategy permitted public pedestrian and vehicle traffic along to be maintained along the surrounding streets throughout all phases of construction.

Geothermal Well Drilling

Campus Square hosts a 46-well, closed loop geothermal system. Originally, two drilling rigs were to be implemented simultaneously on either end of the site, scheduled to complete the drilling in approximately one month. However, when two rigs began work, the drilling resulted in too much water flooding the site. Handling the unforeseen amount of water, as well as issues such as undermining the basement and foundations, forced Wohlsen to re-think their initial drilling strategy. The solution was to deploy only one rig to limit the amount of water that would be put onto the site during drilling. While drilling was performed on one end of the site, foundation and basement concrete work was performed simultaneously on opposite side of the site. Due to the limitation of only one drill, the schedule was delayed one month. Furthermore, an erosion and sedimentation plan was expanded to account for the increased water and run-off levels. The layout for the E&S plan is pictured in **Figure 2** on the following page.

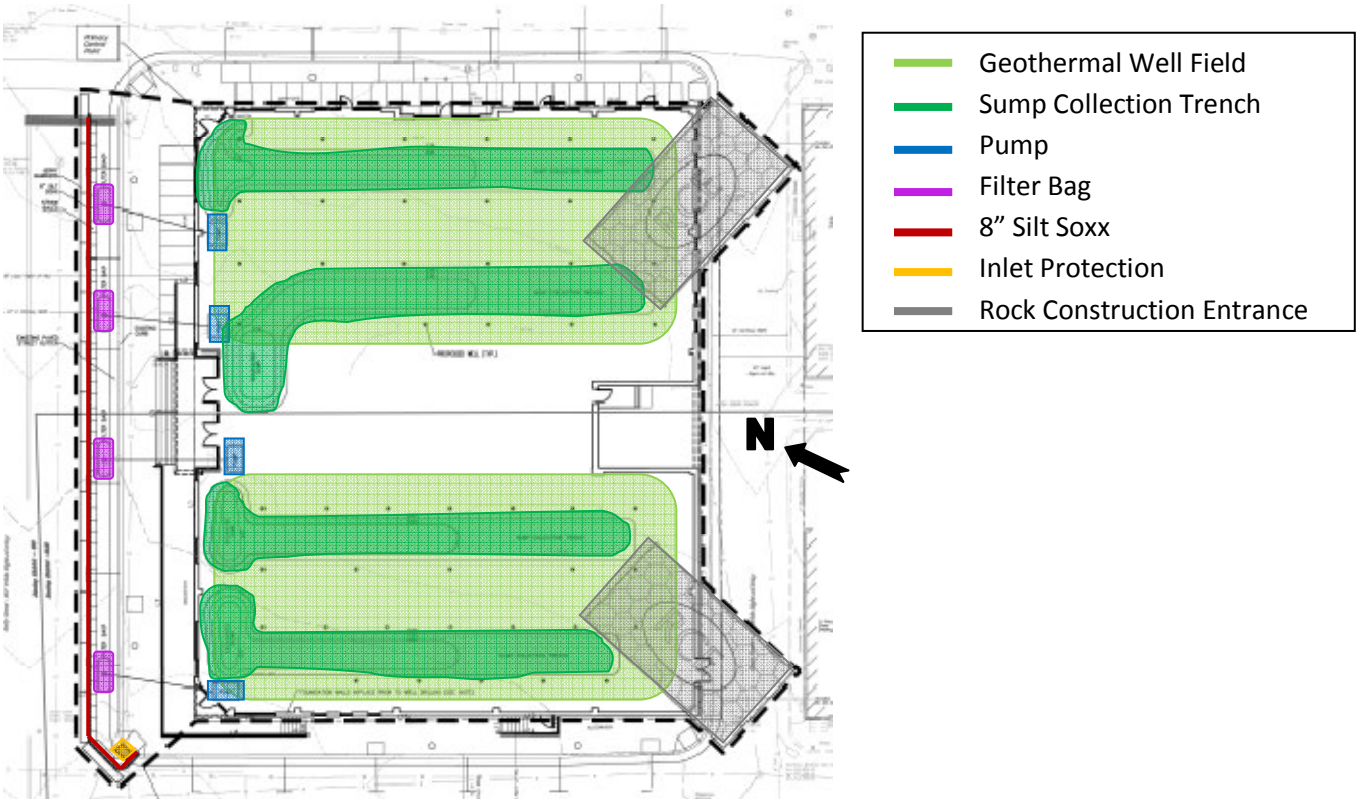

Figure 2 - E&S Plan Drawing provided by Wohlsen Construction Company

Existing Utility Interference

Existing overhead power lines ran along the existing sidewalk on Reily Street and within the property line of Campus Square on Basin Street. These existing utilities created logistical problems throughout the construction of the building, particularly steel erection and exterior façade work. The two poles with transformers along Basin Street needed to be relocated because they were within the designed footprint of the building. This involved coordination with the local providers in installing the new lines, moving the existing lines, and removing the existing poles. However, Wohlsen's initial scheduled dates and durations for this work was not completed by the utility providers during the planned for dates. This resulted in a two month delay when the steel erector was forced to stop work once the erection sequence reached the utility pole locations, resuming when the utility companies performed the power line relocation.

The lines along Reily Street were required to remain live during construction. Due to OSHA requirements as well as safety measures enforced by Wohlsen, coordination with the power provider was conducted in scheduling temporary outages when facade work was taking place

near the lines, specifically the curtain wall system and masonry work. **Figure 3** below are construction photos of the utility poles along Basin Street (left), and Reily Street (right).

Figure 3 – Existing Utility Poles and Power Lines

Delays resulting from geothermal well drilling and existing power lines resulted in a three month delay to the construction schedule, as well as affected initial General Conditions estimates and administrative projections. This delay is discussed in further detail in the Schedule Acceleration Scenarios portion of this technical report.

Schedule Acceleration Scenarios

Wohlsen Construction was initially awarded the core and shell portion of Campus Square, and upon completion of the contract, was later awarded fit-out work as well, which began November 2009. As with most core and shell projects, the MEP package and the elevator procurement and installation drove the critical path and construction schedule. Due to long procurement times and detailed planning and coordination, it was necessary to keep these activities on schedule. Of course with any construction project, foundations, superstructure, and enclosure were also important milestones of the critical path in order for the next type of work to initiate. Because the C&S portion of Campus Square is currently complete, a unique perspective can be taken when analyzing the actual construction schedule versus the original planned durations and sequence.

As mentioned previously in this technical report, many unforeseen issues arose early in construction. Geothermal well drilling needed to be complete before foundations and basement walls could be completed and major steel erection could begin. When only one drilling rig could be used, a one month delay immediately ensued. Stacking concurrent activities with the drilling once the delay was realized, assisted in mitigating some delay, but overall, the pace of the drilling could not be accelerated.

Bringing utilities such as power, water, and gas, as well as compensating for existing utilities was also an important milestone to reach in order for other activities to begin. Wohlsen originally planned for a one month duration for utility work to take place. However, due to unforeseen coordination problems with the utility companies and other issues, a total delay of 4 months occurred. In order to compensate for the lost time, construction was performed on Saturdays for the duration of the job. Furthermore, an originally scheduled duration of 15 days for “winter stop time” was eliminated, and steel erection, among other trades, was conducted throughout the winter. In dealing with the delay, it was important to Wohlsen to have all subcontractors “buy” into the new construction schedule in order to limit any additional lost time.

GreenWorks Development decided to add an additional elevator to the building after steel was erected, and slab on deck work had already initiated. The scope addition resulted in intense coordination among all parties involved on the project, as well as delays to nearly every subcontractor. Additional steel took four weeks to detail and procure, and another two weeks to install. The slab on deck was delayed on all upper floors by two weeks. This was directly in the critical path of the building envelope. The project completion date was obviously extended again in order to compensate for the change order, and came at a cost of nearly $250,000.00.

The Project Manager for Campus Square mentioned other areas where the schedule could have been slightly accelerated. He suggested foundations could have been slightly accelerated if another crew was added. The foundations were constructed utilizing one crew working together in one direction. With the addition of another crew, working the opposite direction, the total duration could ideally be cut in half. Similarly, the brick façade could have been accelerated if simultaneous faces of the building were laid. More importantly, increased manpower in significant numbers was difficult to request from all subcontractors in order to expedite the construction durations, and make up for delays. This was due to the smaller size of some subcontracting companies used, and the availability of manpower in the area. Simply put, a dramatic reduction in delayed time could not be achieved due to limitations of resources, and feasible costs associated.

Value Engineering Topics

Wohlsen Construction delivered the core and shell of Campus Square for approximately $9,000,000. The original negotiated price between Wohlsen and GreenWorks was approximately $8,750,000. Much of the differences in costs were in part due to unforeseen delays and additions, including $500,000 of Change Order work. $150,000 in value engineering (VE) efforts was implemented in order to reduce overall costs while maintaining the owner's intents and goals behind construction of building. Discussed below are some of the major VE items from Campus Square.

<u>VE Efforts Implemented In Campus Square:</u>

Curtain Wall System Deletion

Approximately $20/SF was reduced in the façade price by eliminating one of the curtain wall systems from the face of the building along Reily Street. Although glazing helps daylighting efforts, it hurts thermal efficiency. However, the curtain wall was eliminated mainly for overall CSF savings.

Basement Level Square Footage Reduction

$500,000 was saved after reducing the square footage of basement used primarily for mechanical space. Conceptually, the original plan was to allow for proposed storage or parking. **Figure 4** below compares the conceptual and finalized floor plan for the basement space.

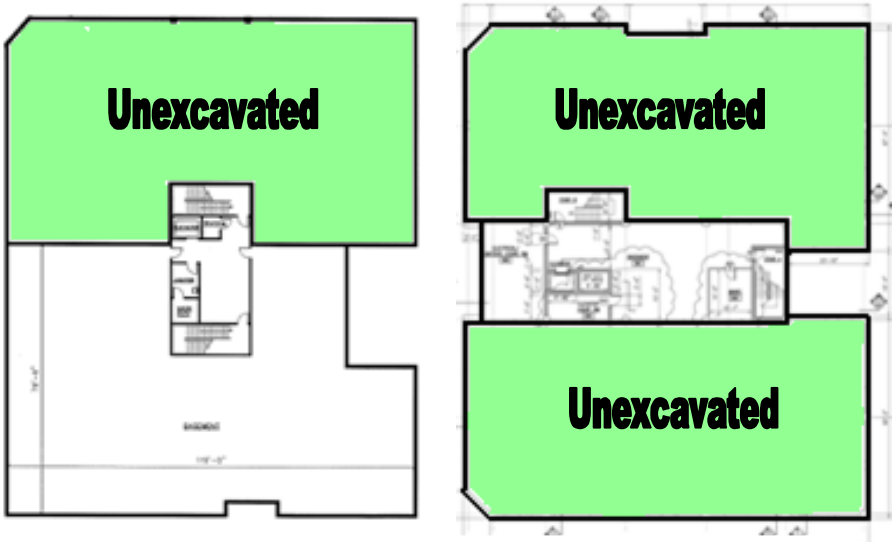

Figure 4 – Conceptual vs. Finalized Basement Plan

Drawings provided by Wohlsen Construction Company

Rainwater Harvesting System Deletion

The owner wanted to implement a rainwater harvesting system on the roof of the building in order to reduce non-potable water usage, as well as promoting education on sustainability. However, it was mutually agreed after a lifecycle cost study was performed that the 25 year payback duration did not financially make sense.

Ornamental Trim Substitution

$75,000 was saved after replacing an ornamental ball and rod trim system with an EIFS trim along the top of the building. **Figure 5** below compares the conceptual and finalized designs.

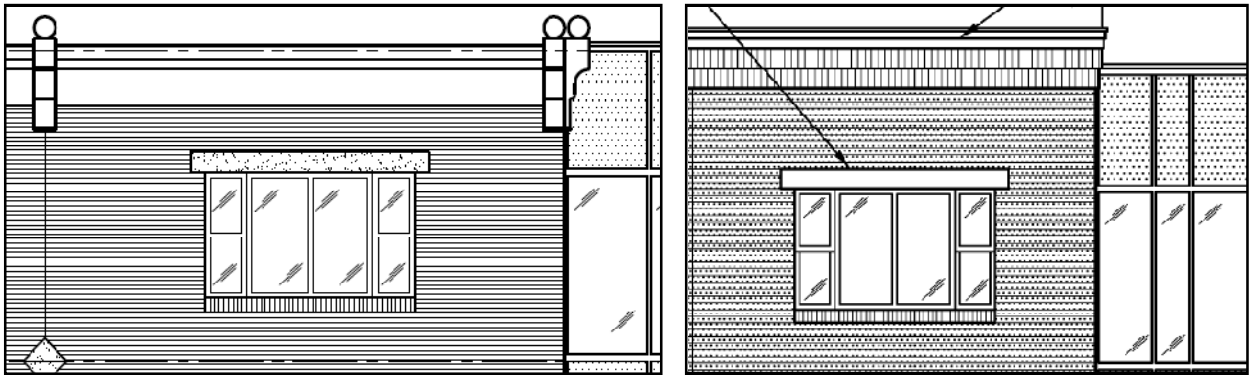

Figure 5 – Conceptual vs. Finalized Trim Design

Drawings provided by Wohlsen Construction Company

Masonry Block Substitution

Architectural precast concrete panels were originally designed to be constructed on top of a limestone block base as a historical aesthetic along the street level of the building. An early VE proposal substituted the precast for a masonry block, saving approximately $60,000. This was later rejected by the owner, and compromise was made with another product, for an approximate savings of $30,000. **Figure 6** to the right compares the two mock-ups constructed of the two masonry systems. The bottom system was chosen.

Figure 6 – Masonry Block Mock-Ups

Bathroom Accessories
The owner saved $15,000 by subcontracting the installation of the bathroom accessories. They were able to save this amount because the professional cleaning company they employed offered to perform the work at no cost to the owner.

VE Efforts Not Implemented In Campus Square:

Black EPDM Roof System
After consulting with a leading membrane roofing supplier, it was suggested to Wohlsen that a Black EPDM roof system may be more thermally advantageous than a white TPO system due to the location of Campus Square. The Harrisburg region experiences more heating days than cooling, and a black system was said to save more money on heating, than the money it would cost during cooling days. However, it was decided to implement the white TPO system due to the sustainability efforts being implemented in Campus Square.

Geothermal System
The geothermal package implemented in the building had an upfront cost of approximately $300,000 more than a conventional system. However, GreenWorks Development was seeking out a highly efficient, sustainable building, and was willing to pay the additional upfront cost of an efficient system.

Prefabricated Exterior Panels
Early during preconstruction, Wohlsen and GreenWorks researched implementing prefabricated exterior panels, which could potentially reduce a sizable amount of time in enclosing, as well as turning-over, Campus Square. However, due to a lack of tenant interest/availability, there was no immediate need for an accelerated schedule, and a higher priced building.

GreenWorks Development had a goal of building a highly efficient, sustainable building which showcases green building methods. The owner wanted Campus Square to achieve, at a minimum, a LEED Silver certification which was not only met, but exceeded with a LEED Gold rating. However, some conceptual design efforts were sacrificed in order to save costs, and were very accepting of many of Wohlsen's VE efforts.

Problem Identification

Mechanical, electrical, and plumbing (MEP) coordination was implemented for Campus Square by means of coordination meetings. Three major coordination meetings were held between Wohlsen and the mechanical, electrical, plumbing, and sprinkler subcontractors during the design phase of the building. These phases of design were: contract award, 50% design completion, and permit drawing completion. All the MEP systems were coordinated using CAD overlays which were evaluated and adjusted at each meeting when clashes occurred. Coordination meetings were lengthy in duration, and resulted in slow re-design turnaround periods when addressing clashes during design and construction phases.

The overhead power lines running parallel with Reily and Basin Streets resulted in numerous logistical problems. For example, steel erection was affected because of the need to use multiple crane locations and mobilizations, as well as costly delays in construction which pushed back the completion date of Campus Square. During preconstruction, moving the existing power lines underground was proposed as an alternative in dealing with the issue. However, the decision was made that it was too costly to perform the aforementioned work, and Wohlsen assumed the coordination issues in dealing with the utility companies and service providers

When interviewing the project manager, he suggested various problems he encountered when coordinating work with the utility companies and service providers. The two month delay encountered related to this issue was in part due to starting initial dialog and planning with PP&L too late. Furthermore, the PM mentioned he may have relied too heavily on the electrical contractor in coordinating the necessary work needed in dealing the with power lines. Wohlsen attempted to push the service providers and utility companies in accelerating their work in an attempt to makeup some of the lost time.

Perhaps the largest problematic issue encountered during construction of Campus Square was in dealing with GreenWorks' decision to include an additional elevator in the building, after steel had been erected. The $250,000 scope addition involved extensive participation from the owner, designers, and all contractors in devising a solution for the best way to install the elevator. Overall, the elevator affected the completion of the slab on deck by two weeks, impacted all MEP subcontractors, involved weeks of additional steel procurement and installation, and resulted in dramatic construction schedule modifications

Technical Analysis Methods

Four topics that I could possibly complete a construction management analysis on are the following:

1. How could the MEP coordination process been improved?

2. How much time could have been saved if the existing power lines bordering Campus Square were moved underground?

3. If the second elevator was designed for during preconstruction, how would this have impacted the overall construction duration and cost?

4. If GreenWorks Development was able to secure tenants for Campus Square during preconstruction, how would the use of prefabricated exterior panels impact the delivery of the building?

MEP Coordination
Preconstruction for Campus Square was nearly an entire year until GreenWorks gave Wohlsen permission to begin construction. This long time was mainly due to economic impacts, as well as the lack of tenant interest. MEP coordination was performed through meetings and CAD overlays. The project manager from Wohlsen mentioned how 3D modeling may have been helpful in limiting the amount of meetings that took place; as well as mitigating MEP clashes during construction. I will talk to different players involved with the MEP coordination process, and discuss how process could have been improved in order to deliver a more successful project. After the interview, I would research the impacts of incorporating Building Information Modeling (BIM) for MEP coordination and clash detection during the preconstruction phase of Campus Square. In developing my analysis, cost implications, schedule impacts, and overall feasibility of alternative MEP coordination efforts will need thorough research.

Underground Power Lines
GreenWorks Development, during preconstruction, decided paying the additional costs associated with moving the power lines located along Reily Street underground. Once construction began, coordination fell apart when dealing with relocating the utilities poles along Basin Street resulting in sizable delays. If the power lines along Reily Street were moved underground, and the utility poles handled during the originally scheduled duration, many aspects of construction would have been affected. For instance, without power line interference, the crane used during steel erection, would have only needed to be placed in one location. Furthermore, the erection sequence could be entirely re-done, and performed faster

and cheaper. Delays would not have occurred with the utility poles, resulting in a shorter construction duration. I would analyze the costs associated in handling the power lines and utility poles differently compared to the costs related to delays in construction. Additionally, the construction schedule would be re-sequenced and shortened. I would need to interview a representative of the local utility company to discuss the means and methodology behind relocating power lines underground, and the logistical impacts this would have on Campus Square.

Elevator Impact

As previously mentioned, preconstruction was a lengthy phase of the overall project. If the second elevator was added to the scope during this time, how would this have reduced the project schedule, as well as costs? The addition of this item during construction was a large increase in cost and overall schedule. Elevators are a driving factor in any critical path, and forced the project team to greatly modify the construction strategy. Costs and delays associated with the entire scope addition will need to be analyzed in determining the impact of adding the elevator into the scope during preconstruction. Furthermore, the structure of Campus Square will need to be analyzed in determining sizing of the impacted members affected where the elevator was installed, and how the structure could have been modified in design.

Prefabricated Exterior Panels

If GreenWorks had secured tenants early in the preconstruction, or even the conceptual phase, they may have wanted to construct Campus Square in an accelerated fashion. One method of accelerating the schedule would be to utilize prefabricated exterior panels instead of the brick façade laid onsite. Research would need to be done to determine the feasibility of manufacturing the panels, the increased cost of the envelope of the building, as well as schedule implications. The preconstruction phase would not be nearly as long due to the fact that much of the delay was GreenWorks' choice not to begin construction; therefore, determining how fast the building could be constructed with less preconstruction time would need to be determined. Furthermore, the structural system would also need to be analyzed in redesigning the means of connecting panels to the structure of the building, as well as associated costs.