Northeastern Pennsylvania Office Building

Christopher Havens

Construction Management

Dr. Chimay Anumba

November 16, 2011

Executive Summary

This technical report identifies issues with the construction of the Northeastern Pennsylvania Office Building, states potential areas of the schedule that could be altered to accelerate the project, and describes different value engineering topics that were proposed to the owner. Also discussed within this report are two industry issues that were addressed at this year's PACE Roundtable Meeting and several areas of the project that could be further analyzed as to their benefit for this project.

It is important for a project's overall success to have a cohesive project team. This helps avoid time and money lost trying to settle disagreements that may be the result of issues with work onsite. If the project team works together and avoids situations such as this, the project is more likely to stay on schedule and under budget because change orders do not need to be filed and approved for non-contracted work to continue. It is also important that the owner realizes that natural disasters can affect the project both directly and indirectly, and must be dealt with appropriately.

The project schedule for the Northeastern Pennsylvania Office Building had delays due to the pre-engineered metal building subcontractor used for this building. The reactions that were calculated were incomplete and delayed the fabrication of the structural steel frames, which inherently delayed the total project schedule. This problem could have been avoided if the project consisted of a standard steel framed structure rather than a pre-engineered metal building because standard steel frames do not require unique fabrication. This would have not only eliminated the delay in the original schedule, but it could have eliminated the fabrication activity, thus accelerating the schedule.

Although the owner is not receptive to value engineering proposed by the project team, it is still important that the team identify and suggest ways to improve the project by acceleration of the project schedule or reduction of the project costs through value engineering. Suggestions for this project include changing the structure to a standard steel structure and reducing redundancy within specific bid packages.

Integrated project delivery (IPD) is a form of project delivery that incorporates the project's team members in the design stage of the building. This could be used on the later phases of the owner's project because the buildings are nearly identical to the Northeastern Pennsylvania Office Building. This means the contractors and design professionals will be performing repetitious work, which can accelerate the schedule.

Areas of further analysis regarding the Northeastern Pennsylvania Office Building include changing the structure of the building to a standard steel structure, using IPD for the later phases of the project, altering the building design for the addition of a second floor, and varying the design of the project to achieve LEED Certification.

Table of Contents

Constructability Issues

Issues that arise during the construction of a building such as the Northeastern Pennsylvania Office Building can effectively cripple the success of the project. This is why an effective project team is crucial in delivering a quality building in a timely and cost-friendly manner to the owner. If constructability issues are identified and dealt with properly, the project has a much higher chance of being successful.

During construction of the Northeastern Pennsylvania Office Building, small issues arose that had to be handled by the contractors and subcontractors on site to avoid delays in the project schedule and additional costs to the owner. The first issue that arose involved the sitework and the amount of large rocks found when stripping the site and trenching out the foundations of the buildings. The original geotechnical report had recorded the entire site as Alton Gravelly Sandy Loam (AgB) as seen in Figure 1. This particular soil is generally well-graded and is most commonly found above a deep layer of bedrock. However, many large boulders were discovered when the site was being stripped. When the boulders were removed, large voids were left in the soil and had to be properly filled with excess soil stripped from other areas of the site. This would have given the site contractor a valid excuse to file a change order for this additional work. If the work had to be completed as a change order, the project risked being delayed while the change order was being drafted, processed, and approved.

This issue was avoided because the owner took the initiative of sitting down with the site contractor to rework out a contract that included the unexpected work and proper compensation from the owner. Because the owner started this process swiftly and without any friction, the contract was settled quickly and the sitework continued on schedule. Also, when the contract negotiations were occurring, the site contactor was proactive and suggested using the large boulders to be crushed and used on the gravel laydown area. The owner decided to encompass this activity in the sitework contract because it meant the large boulders would not cost any additional money to be removed from the site and dumped elsewhere.

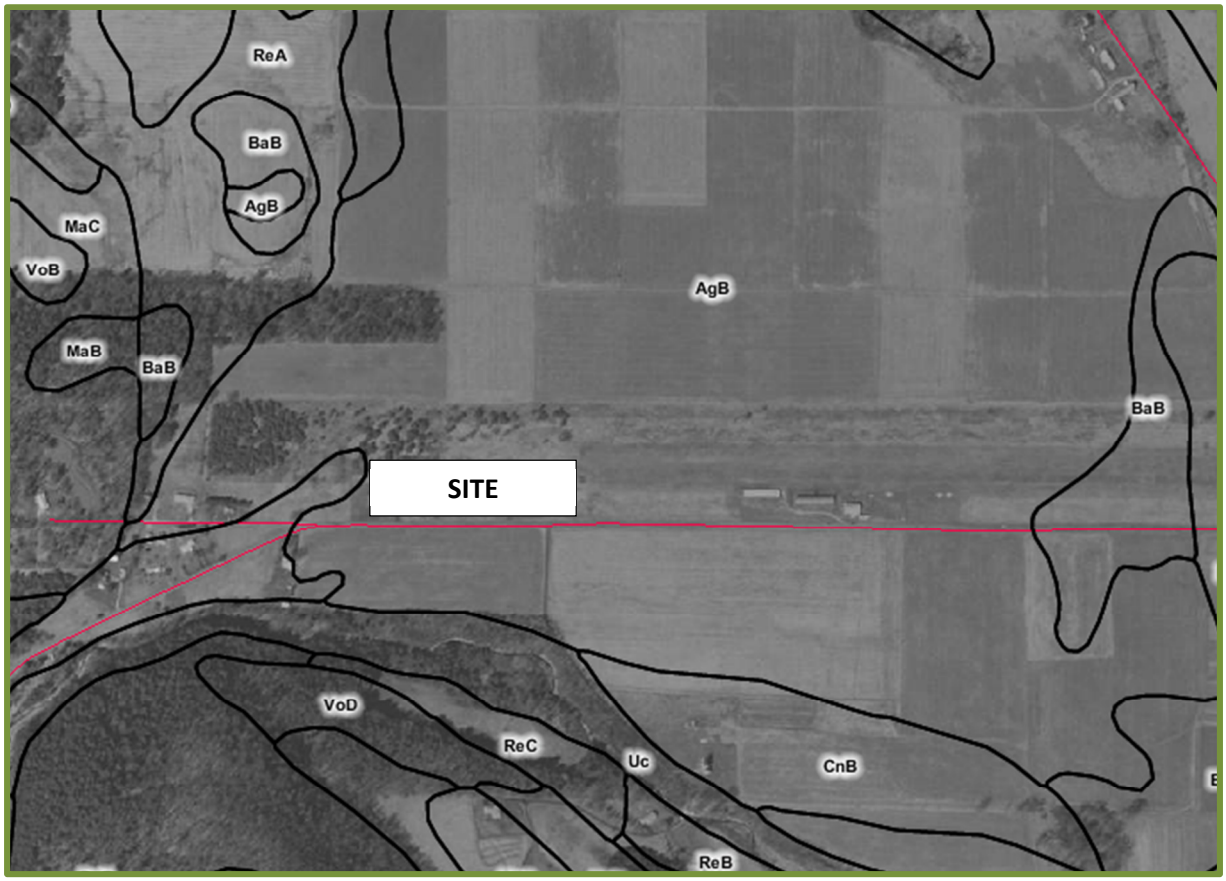

Figure 1. Soil Identification Map for Northeastern Pennsylvania Office Building

Another minor issue that arose during construction involved the identification of the pre-engineered metal building frames. There was an unidentified miscommunication between the pre-engineered building company and the steel fabricator as to how the frame pieces were to be labeled for the erectors to identify the pieces when constructing the building's structure. Rather than numbering the frames from South to North across the shop building, the frames were labeled from North to South. Since the frames were being installed from South to North, the contractor assumed the frames were labeled as such. This error was not found until frames 1 through 4 (Figure 2) were fully erected. The pre-engineering building company, who was also responsible for erecting the structure, had to deconstruct frame 1 and replace it with the proper frame. Frames 2 through 4, however, could remain in the incorrect positions because it was confirmed that they were all identical frames. With the project slightly ahead of schedule, the contractor was able to correct the error during their standard working hours without negatively affecting the project schedule.

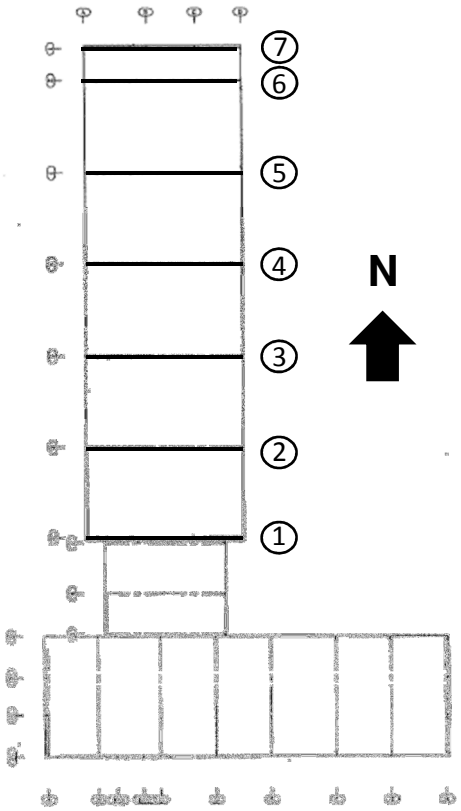

Figure 2. Shop Building Frames

Occasionally a situation arises during construction that could never be identified to be effectively avoided or corrected. For example, the Northeastern Pennsylvania Office Complex experienced a natural disaster that negatively impacted the schedule without directly affecting the project's work. The township in which the Northeastern Pennsylvania Office Building resides in was flooded in early September. Although the project site was not flooded, other factors impacted the project in a variety of negative ways.

The owner of the Northeastern Pennsylvania Office Building has caused friction with the local community members because of the nature of their work in Northeastern Pennsylvania. Therefore, they are continuously trying to improve their relations with the local communities. For this project, they had decided to employ local contractors for many of the bid packages. The site, concrete, tile, paint, carpet, plumbing, and general contractors were all local companies performing work on this building. When the flood occurred, the site was being cleared and graded, the site utilities were being run underground, and the concrete foundations were being poured. This means the site, concrete, plumbing, and general contractors were all performing work around the time the flood ensued. Many of the workers for these subcontractors lost their homes due to the

flooded town. When a disaster such as this happens, the work is still under contract to be completed on schedule. However, since the owner was very interested in building better relations with the community, they ceased work on the project. The owner had also instructed the contractors to help with the flood relief and they could charge their time to the Northeastern Pennsylvania Office Building as a change order. Although this extra money did not add any value to the project, it built good relationships and trust between the owner and the contractors, as well as the owner and the local community. Not only was it helpful that the workers were able to work on their own houses, but the site contractor used loaders and dump trucks from the project site to help with the town's cleanup efforts. The owner forewent thousands of dollars and about two weeks of schedule, but the impacts of the self-sacrificing efforts were considered a higher priority for the owner.

Schedule Acceleration

Although the Northeastern Pennsylvania Office Building project schedule does not have a strict date for substantial completion, the owner would still be pleased with a product turned over sooner than later. Because of this, the project team suggested ideas that would help accelerate the schedule without compromising the quality of the product or the safety of the workers.

Since this project is a pre-engineered metal building, the subcontractor responsible for the structure of the building had to perform reaction tests for the building's steel frames. After the Notice to Proceed was received, the subcontractor began calculating the reactions for the steel. These reactions, however, took about ten days longer to be completed than originally expected because of incomplete or incorrect reactions being used. The poor quality reactions caused a delay that not only affected the structural frame shop drawings, but also affected the fabrication of the structural frames and the design of the concrete piers upon which the frames will bear. For pre-engineered metal buildings, the concrete piers that support the frames must be designed specifically for each frame because it supports moment and vertical loads for the tapered frames.

The delay caused by poor reactions at the onset on the project pushed all subsequent activities back by two weeks. This could have been prevented if the pre-engineered metal building subcontractor performed higher quality work when doing the reactions. The shop drawings would have been more accurate, the steel would have been fabricated and delivered on time, and the concrete designs could have been completed earlier to allow the concrete subcontractor to begin their work. Fortunately, the owner does not need this building occupied as soon as possible, and the entire project schedule was allowed to be pushed back two weeks to compensate for this lost time.

A solution to eliminate this delay would also be to change the building structure from a pre-engineered metal building to a standard steel structure. This not only would have eliminated the delay in the project caused by the poor quality reactions, but would actually accelerate the entire project schedule. The fabrication time for the pre-engineered metal building could have also been completely removed from the project schedule since standard steel beams and columns would be prefabricated and would only need to be purchased. This means the building structure could have begun erection after the concrete foundations were finished. If this were the case, the schedule could have been accelerated about one month.

Value Engineering

Suggestions that have been made to the owner concerning value engineering for the Northeastern Pennsylvania Office Building have not been accepted and applied as they might typically have been for a different project. This is because the owner of the building is a large business that is comfortable and confident in constructing pre-engineered metal buildings for their office operations across the country. Although successful value engineering suggestions could save the owner both money and time on this project, all suggestions have not been accepted at this point in time.

Although the value engineering suggestions have not been accepted and implemented for this building, it is important that the project team identifies areas for improvement and shows that they are doing their due diligence by making the owner aware of potential savings in time and money.

One suggestion that could have been proposed at the beginning of the design phase would be to construct a standard steel framed structure rather than a pre-engineered metal building. As discussed in the 'Schedule Acceleration' section of this report, the pre-engineered metal building extended the length of the project schedule. This is because the frames require reaction calculations before shop drawings are completed. Since there was a delay in the completion of the reactions, the fabrication of the steel frames was delayed, as well as the design of the concrete piers. Since standard sizes of structural steel do not require a fabrication period that is inserted into the project schedule, this activity could be removed. Also, it would be less expensive to purchase standard sized steel members rather than have custom steel frames fabricated for this building.

Also, with the pre-engineered metal building frames eliminated, the concrete piers could be a more standard footing design. This would decrease the design time for the footings and allow for the footings to be placed earlier. This, in turn, would permit the structural steel members to be erected earlier and allow for the subsequent trades to follow suit.

Finally, some bid packages for smaller trades within the project were found to be redundant. For example, the ceramic tile subcontractor's bid package specified excessive waterproofing before setting their tile. Elimination of redundancy within the bid packages not only reduces the amount of materials going into the building, but it also reduces the amount of time that the subcontractor is performing redundant work.

Critical Industry Issues

Assembling/Procuring an Integrated Team

It is vital for members of the construction industry to understand what an integrated project delivery system (IPD) is and what must happen for it to be successful since the industry is always evolving. As new minds enter a workforce with new project concepts such as IPD, more veteran industry members must learn to accept and comprehend these concepts to build better, more efficient projects as their careers progress.

Integrated project delivery is a method of designing and constructing a project by implementing all parties involved into a single project team at the commencement of the project. The team members would include an architect, design consultants, a general contractor, and subcontractors. The collaboration of these members during the design phase can be effective at reducing scope busts, reducing design errors, and improving cost and schedule estimations. Subcontractors and general contractors can provide helpful insight towards the design of the project because they have experience installing the same work that the design professionals are implementing in the project. Also, the contractors can more efficiently estimate the costs of the building systems and the time required to install the work because they have a deeper understanding of how the systems are to be constructed.

Theoretically, an IPD system is a fantastic way of delivering a successful project. However, there are multiple barriers in today's field of construction that limit the possibilities of IPD. One major obstacle that must be overcome to properly use IPD is finding an owner that is open-minded enough to try it. The owner would have to be knowledgeable of what IPD is and how it could benefit them before it would be considered for their project. This also requires an owner that is comfortable contracting team members during the design phase of the project that would have a positive impact on the building design. Along those lines, a great deal of trust is required between all team members in order for an IPD project to be successful. For example, the architect and design consultants must trust the contractor's suggestions for more efficient construction. The owner must also trust all of the members will work to the best of their abilities to deliver the best product for them. Without this trust, IPD isn't successful because contracts are difficult to negotiate at the onset of the project and an unsatisfied team member could inhibit the design process.

Another problem that IPD must overcome before it has a chance to be widely used is to build well-documented cases in which IPD has been implemented. Since there are very few projects that have used IPD, it is difficult for an owner to buy into the process. Once a few IPD projects have been built and well-documented, owners will be able to see

the amount of money, schedule, and frustration that can be saved when compared to the traditional method of construction.

Although the Northeastern Pennsylvania Office Building was not an IPD project, this delivery system could be used on later buildings for this owner. It is the first phase of a five phase project that includes two nearly identical buildings and two five-story office buildings. An IPD system could effectively be used for the later building phases of the project. The first phase was a typical design-bid-build project, and the contractors and design team will soon be completing their first project together. If the owner were to try IPD on phase two and three, the contractors and design team will have experience working together on a nearly identical building. This means less time would be needed to select a project team through the bidding process. Also, since the contractors have installed the same building systems once before, they could contribute helpful input on the design of the systems of the later phase buildings. The nearly repetitious work could also shorten the schedule of the later phases because the workers are familiar with the work being installed.

Learning Systems for Training a Sustainable Workforce

Since the construction industry is quickly trending towards environmentally-friendly construction methods, it is important that the workforce responsible for performing the field work is sufficiently trained in sustainable work. For example, field personnel should be made aware of the impact of paperless documents being used in the field because of the lower impact it creates on the destruction of trees used for paper production. Also, as sustainable building systems continue to evolve and improve, so do the individual components of the systems. These components have to be properly installed and made operable by workers that may not be familiar with the new components. An electrician, for example, may have twenty years of experience doing electrical and lighting installations, but may not have any knowledge of how to properly install photovoltaic cells on a roof. If their company receives photovoltaic work, they may not be qualified to work on the project.

Although the Northeastern Pennsylvania Office Building does not have any large sustainability-based building systems, it is still important that the workforce understands why it is important to take environmentally-friendly measures during construction. As previously mentioned, paperless projects reduce the amount of paper needed on the jobsite. Also, other tasks that reduce our impact on the environment should be outlined to workers, such as turning off heavy equipment when it is not being operated. Not only does this reduce the amount of emissions entering the atmosphere, but it saves the contractor fuel costs. Meetings, much like Toolbox Talks used for safety issues, can help contractors suggest ways to create a more environmentally-friendly construction project. An incentive

program could be established to reward employees who suggest effective ways to achieve this.

Professional Contacts

During the breakout sessions of the PACE Roundtable discussions, two individuals appeared to be willing to provide advising with regards to this project. Richard Fiore, vice president of Leonard S. Fiore, Inc. has constructed multiple projects similar to the Northeastern Pennsylvania Office Building as a general contractor based in Altoona, PA. Mr. Fiore has also previously worked with the architect of the Northeastern Pennsylvania Office Building on other projects.

Another business professional that offered his assistance concerning this project was Chris Taylor, operations manager for Southland Industries. If the situation arises that the mechanical systems for the Northeastern Pennsylvania Office Building will be redesigned, he is willing to provide advising as to the redesign of the building system. Mr. Taylor also has experience and knowledge regarding IPD projects that he has worked on while at Southland.

Technical Analysis Options

Structural Steel System Impact on Project Schedule and Cost

The owner of the Northeastern Pennsylvania Office Building constructs many buildings across the country that are very similar to this project. The industrial look of the Galvalume siding is something the owner wishes to remain consistent on their buildings. However, the project could benefit in many ways by changing the structure from a pre-engineered metal building to a normal steel structure building. Galvalume siding and roofing could still be attached to the steel to achieve the same industrial look that the owner is seeking. However, the schedule could be accelerated and the costs associated with the building's structure could be reduced.

Delays that occurred due to incomplete reactions for the pre-engineered metal frames pushed back the project schedule by two weeks. This could have been avoided if this frame system was not used on this project. Since the steel members would not be tapered like the pre-engineered metal building, the fabrication activity line on the project schedule would not exist. This means the building's structure could be erected as soon as the footings were ready. The structural steel replacement would also mean the concrete footings could be a more traditional size and shape, and therefore could be cast earlier in the project schedule.

The project costs could also be reduced if the structure were converted to a standard steel structure. This is because standard wide-flanged beams can be ordered in standard sizes and do not require special fabrication like the pre-engineered metal building frames. The concrete footings could be designed as a more traditional size and shape, which may reduce the amount of concrete and steel reinforcing required in the foundation. Finally, the pre-engineered metal building company would not be required for this project. This means the steel structure erection could be included in the general contractor's bid package. This has the possibility of reducing the amount of fee on this work that the owner would be responsible for covering because the contractor would not be charging their mark-up fee on top of the pre-engineered metal building company's fee.

If this project variation were to be further explored and analyzed, areas of research would include the impact on the project schedule, the impact on the costs associated with the structural system, the size and type of steel members required, the size reductions associated with the concrete footings, and the possibility of connecting the Galvalume siding to the new steel structure. Since the general contractor would also assume the responsibility of erecting the structure, confirmation would be needed to ensure they would be able to perform this work in a timely and cost-effective manner.

Integrated Project Delivery for Phases 2 and 3

Although the Northeastern Pennsylvania Office Building (Phase 1) was a traditional design-bid-build project, the later project phases could use an integrated project delivery approach with the same project team contracted on Phase 1. If the later phases were to use an IPD approach, the contractors that performed the work on the first project phase would be able to provide potentially helpful information on the design of the later phases to reduce project document errors and avoid problematic areas of the design. This could save the owner time and money by eliminating time-consuming activities in the field and avoiding change orders that would be required to fix document errors.

If the contractors were used in an IPD system for the later project phases, the project could potentially see more expedited schedules. This is because the three phases consist of buildings that are nearly identical. Since the contractors have performed the work once before, the repetition of work may make the contractor's work easier and faster to perform. Also, if the contractors worked well together on the first phase of the project, there is a good possibility of their working relationships improving throughout the later phases of construction. This potentially reduces the risk of contractors having disputes onsite or back charging each other for dispute resolution.

One of the more important reasons that an IPD system would be suggested for the later phases of this multiphase project is to accelerate the schedule. An IPD project is much like a design-build project because the early stage of work can be performed while the later stages are still being designed. In this respect, with the contractors on hand at the onset of the project, some work can be performed much earlier in the project schedule. For example, the sitework subcontractor can begin clearing and grubbing the site once the notice to proceed is received. It should be noted that the notice to proceed can be received sooner because there is no delay while the project documents are produced, the contractors receive the documents to compile bids, the contractors are selected, and contracts are drafted and signed.

If the later phases of this project were to become IPD projects, further analysis would be required to determine the time savings associated with how much this would expedite the project schedule. It would also require a more in depth analysis of how much costs could be saved due to the contractor's impact on the design of the buildings.

Phase 2 and 3 Expansions

Since the owner of the Northeastern Pennsylvania Office Building has been steadily expanding their business in this region over the past five years, there is a very high possibility that this building may need to be renovated to provide more square footage of usable working space. Due to the unique design on the pre-engineered steel structure of the building, there is not a possibility of creating additional floors above the office building without demolishing the current building. This means the owner can only expand by constructing a separate building to the east of the office building, as shown in Figure 3. By building outwards rather than upwards, a portion of the gravel laydown yard is eliminated. Also, more parking would be required to accommodate the additional employees for the expanded building. Finally, the building's utilities will have to be run underneath the gravel laydown area to access the utility easement at the north end of the site. This would interrupt work being performed at the shop building or in the yard while they are being run.

The later phases of this project could be designed to allow additional floors to be added to the original office building if it needed to be expanded. In order to accomplish this, the pre-engineered metal structure would have to be replaced with a different structural system that would allow for additional stories. Assuming a structural steel system is chosen, multiple floors could be added to the original building if needed. Research would need to be conducted to compare the initial costs of larger steel members and concrete footings to the costs of the sitework and additional permitting required for an expansion building. Also, since the demand for water, electricity, waste systems, and telecommunications would increase if the project were expanded vertically, research would have to be done to determine the additional amount of demand and what kinds of cost and schedule implications that may entail.

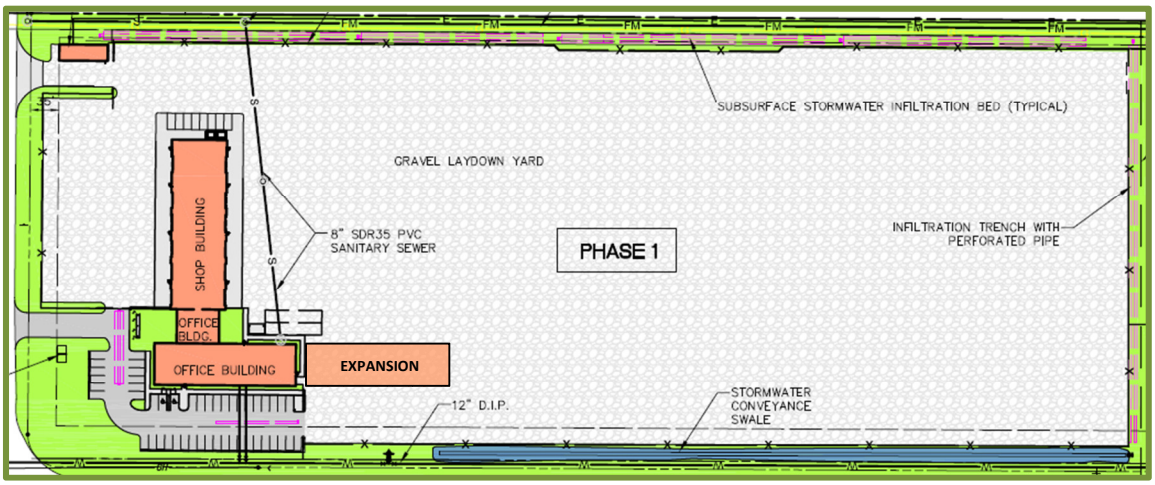

Figure 3. Area of Future Expansion on the Northeastern Pennsylvania Office Building

LEED Certification

Although the owner of the Northeastern Pennsylvania Office Building is not striving for LEED Certification, a case could be made to implement sustainable systems for this project to push it towards a certification. There are two primary routes to achieving this goal. The design team could introduce a large environment-friendly building system such as solar panels or a wind turbine to gain LEED points. However, systems such as this introduce high costs during the construction phase of the project. Although it may have a return on investment over a period of time, the owner may not be interested in a system such as this because of the initial costs.

The design team could also implement smaller, less expensive alters to the current design that would add LEED points to this project. For example, bike racks and a bus stop could be added to the project to boost the amount of points this project would receive. Other additions would include using water-efficient plumbing fixtures and low-emitting finishes within the building.

If further analysis is pursued to receive a LEED certification, the less expensive method would be chosen. This is due to the fact that it would require less time and money to implement small changes to the project, as opposed to completely redesigning an entire building system. Areas of research would include deciphering which alterations would be feasible for this particular project. It would also include the impact that these alterations would have on the project schedule and costs.