STEM Building

Science **T**echnology **E**ngineering **M**athematics

Hagerstown Community College

Hagerstown, MD

Technical Assignment 3

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Executive Summary

A meeting was held with the project team of the STEM Building to obtain the information stated in Technical Assignment 3. Areas of discussion included constructability challenges, schedule acceleration scenarios and value engineering topics.

Three constructability challenges were identified and discussed in detail. The first challenge was blasting and brought major concerns of safety, disruption of class and the damaging of utility lines and neighboring buildings. The next challenge that came to light was crane location. There were two proposed locations at the North and South of the building. The decision was made to set the crane on the South side of the building because of an overhead power line on the North side. The final constructability challenge was excavating to competent rock. In several areas, competent rock was found lower than expected. To remedy this issue, the project team proposed to form up lean concrete back to the original footing elevation, backfill around the lean concrete and set the footing at the designed elevation.

The only schedule acceleration scenarios discussed in the meeting were hiring extra crews and stacking trades. Although the project team stated this is not preferable, this all the further they had looked into the matter.

Value engineering by the project team was not performed on the STEM Building. This was because the owner was very experienced and worked with an excellent architect. The owner knew exactly what they wanted and the architect delivered at the target price.

Also included in Technical Assignment 3 are two sections for problem identification and technical analyses methods. The only problem identified was the over excavation to locate competent rock. From this, a third solution was proposed. This solution would include forming a small amount of lean concrete for leveling purposed and setting the footing at a lower elevation on the lean concrete. The wall would be lengthened down to the footing and the remaining area would be backfilled. This is save money on concrete.

Four technical analyses methods were developed. They will show an impact on the building and provide areas for possible enhancement. They are stated below and will be discussed in further detail in this assignment.

1. Lowering foundation walls to footings
2. Expanding the green roof
3. Cistern design
4. Structural integrity for green roof and cistern

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Constructability Challenges

Challenge 1: Blasting

On the STEM Building project, excavation will be performed via blasting. This is due to the large masses of limestone rock upon which the footprint of the building resides. Traditional means of excavation would be ineffective and blasting, although more expensive, will allow excavation to be completed in a timely manner. Blasting also brings its challenges regarding the relocation of existing utilities, neighboring buildings and safety; a major concern of the owner. The first obstacle in relocating existing utilities is locating existing utilities. Traditionally subcontractors would have a general idea of where an existing utility line was located and carefully excavate until found. This is not an option on this project because of the limestone. The exact location of utilities lines must be identified. HESS Construction + Engineering Services, the general contractor, hired a specialty subcontractor to perform the task. To locate the water line for example, the subcontractor would hook two clamps to the fire hydrant and send an electric current down the pipe. A special device was used to detect the current and then the utility line was marked with either flags or spray paint. Figure 1 below shows an example of the utility line locator.

Figure 1: Utility Line Locator

Once located, a series of small blasts are performed. These blasts must be very precise to come as close as possible to the pipe to minimize the amount of jack hammering and/or rock breaking. Both methods are timely and inefficient. A rock breaker is shown below in Figure 2. In essence, it's a jack hammer hooked up to a backhoe.

Figure 2: Rock Breaker

On the other hand, if a blast occurs too close to a utility line, there is a high risk of damaging the pipe. This would be more costly than the time and money for jack hammering/rock breaking. Therefore under blasting is preferable to over blasting to stay on the safe side. To ensure successful blasting, HESS contracted with C.W. Hetzer Inc. A long-time leader in blasting and has much experience working in Washington County, Maryland, where the STEM Building is located. All the existing utilities that need to be moved are highlighted below in Figure 3. They include two underground electrical lines (yellow), multiple storm lines that are interconnected (brown), telecommunication line (orange), two water lines (blue) and a fire hydrant (red).

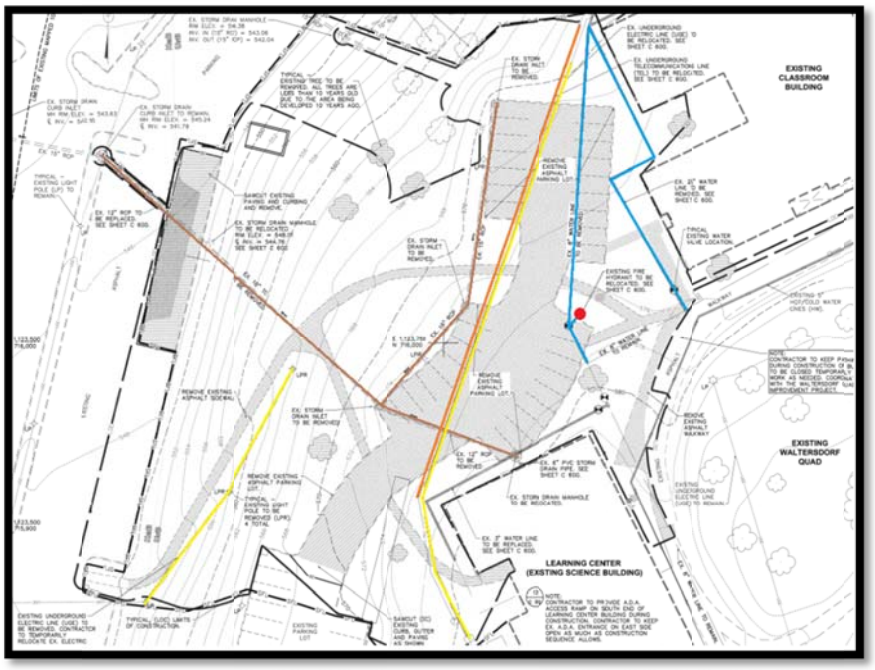

Figure 3: Existing Utility Lines

Once existing utilities have been relocated, mass blasting can begin. Safety becomes a major concern of the owner during this process. Mass blasting uses larger chargers that when detonated, can send rock flying great distances through the air. An example of this is shown below in Figure 4.

Figure 4: Mass Blasting

The safety concern is that such rock has the potential of striking a pedestrian and causing physical harm. To mitigate this risk, C.W. Hetzer will implement blasting mats. Comprised of recycled tires linked together by metal chains, these mats are laid over the area being blasted. The mats absorb the upward force of the blast and hold down the best part of any potential fly rock. The site is also cleared at each blast as another safety precaution. An example of a blasting mat is shown below in Figure 4 for reference.

Figure 5: Blasting Mat

The footprint of the STEM Building is in close proximity to contractor staging and two neighboring buildings: Classroom Building and Learning Center. See Figure 6 below.

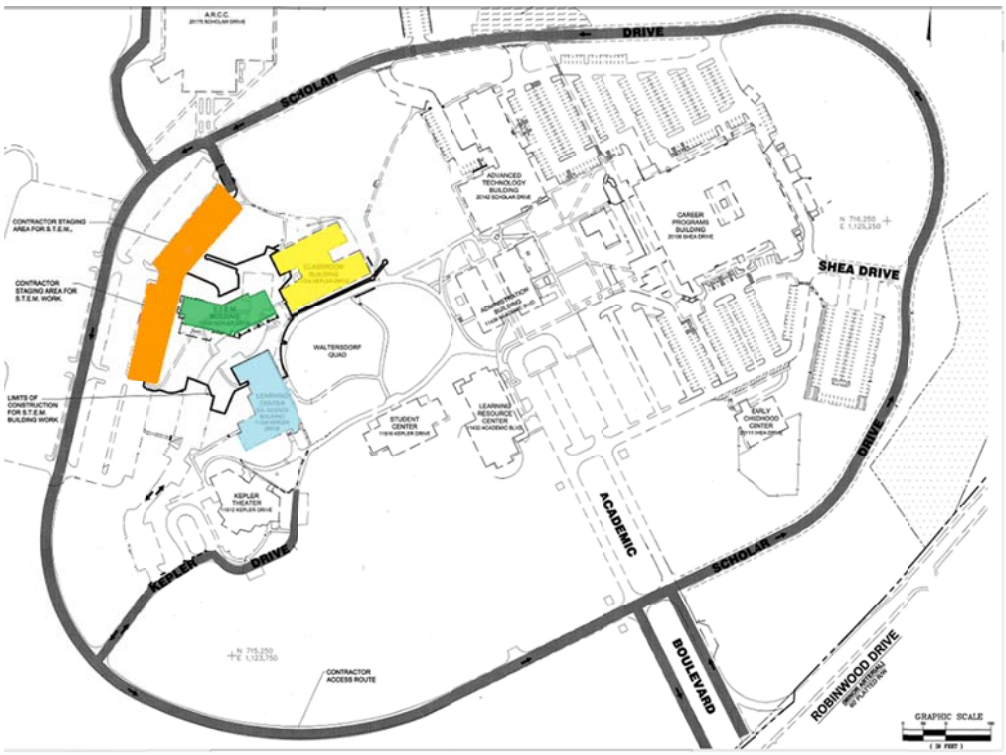

Figure 6: STEM Building (green), Classroom Building (yellow), Learning Center (blue), Contractor Staging (orange)

Two main concerns arise due to this condition: potential damage to the buildings and the disruptions of class. Similar to the relocation of existing utilities, precise blasts must be used to ensure no damage is done. Potential damages include cracks in walls and breaking windows. This is another reason for hiring C.W. Hetzer. They have assured HESS and Hagerstown Community College, owner of the STEM Building, that the upmost care will be used during blasting to mitigate damages. HESS has also taken it upon themselves to photograph the neighboring buildings and locate any existing damages before blasting occurs. This will diminish the possibility of faulty blame if damages are to surface.

Disruption of classes must be taken into account during the blasting process. HESS has scheduled the blasting to take place in the summer, at which point, minimal classes will be held. In addition to this, C.W. Hetzer has agreed to set off multiple blasts at once in order to minimize distraction. Although the blast may be slightly louder, this will reduce the blast commotion to two-three times per day. HESS also must notify Bob Spong, Director of Facilities Management and Planning, before each blast to verify that other major activities are not it progress (i.e. exams, assemblies, conferences, etc.).

Challenge 2: Crane Location

Selecting the steel crane location for the STEM Building is also a challenge. It was apparent that the crane should be located outside of the footprint, near the middle of the building to allow full coverage. The debate was whether to place it on the North or South side of the building. The two crane location options are shown below in Figure 7.

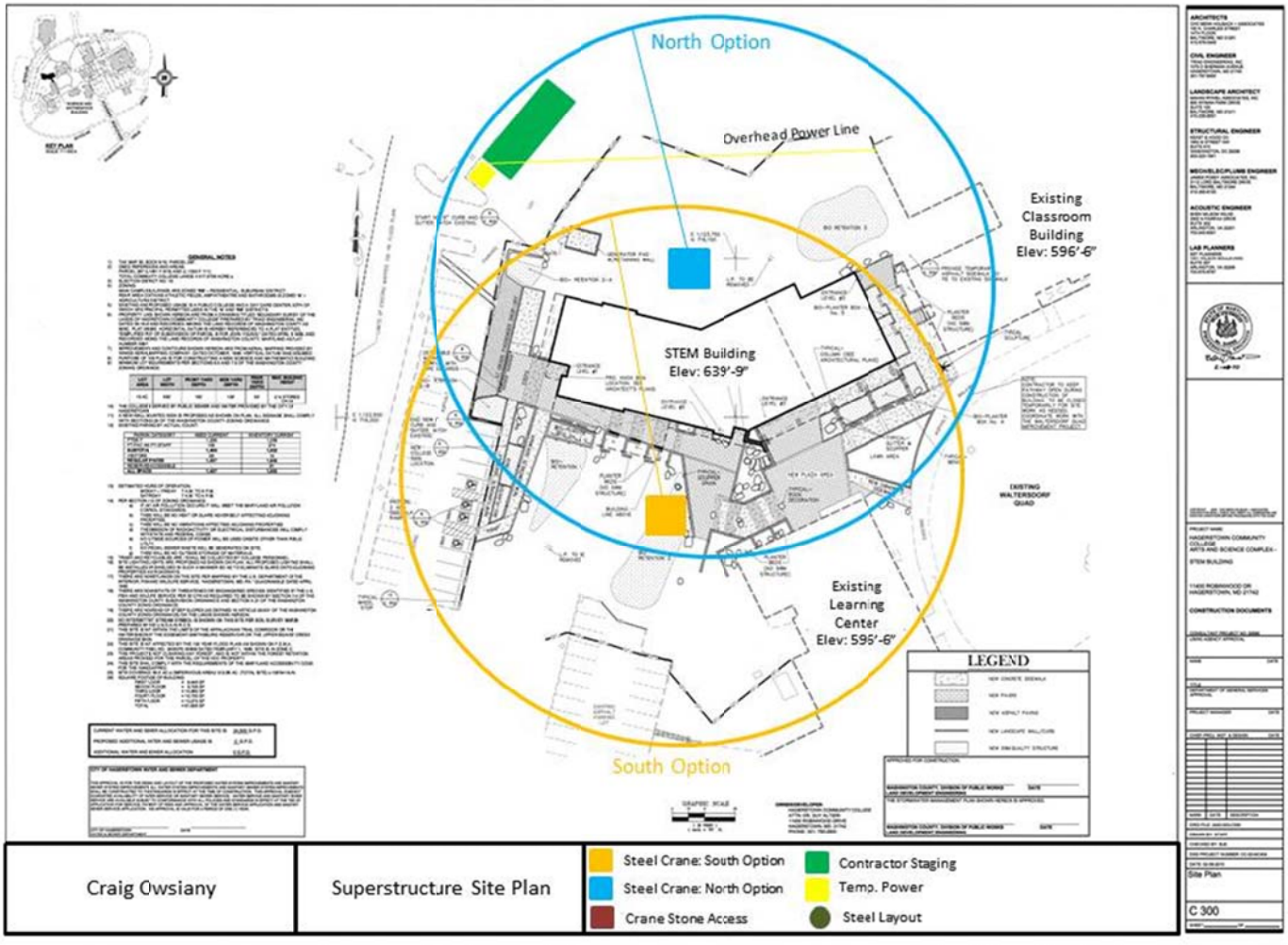

Figure 7: Crane Options

The final decision was made to set the crane on the south side of the building. The driving factor was an overhead power line that runs from the existing classroom to the trailer, north of the building. Selecting the south side of the building for the crane simply provided one less obstacle, making it the better choice. In order to overcome the sloping site without damaging the landscape, HESS has provided a stone access ramp for the crane. See Figure 8 below.

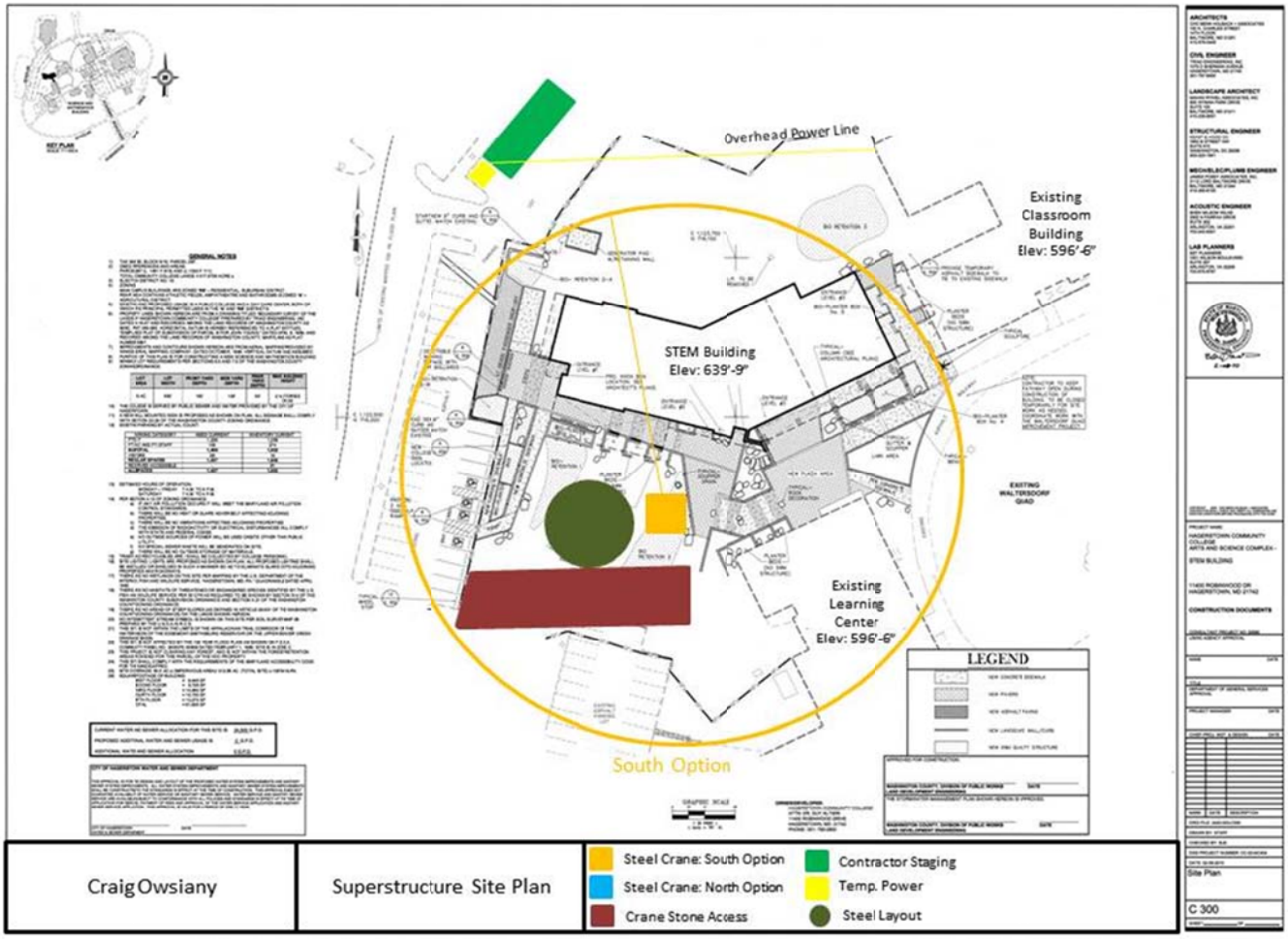

Figure 8: Selected Crane Location

Challenge 3: Excavation to Competent Rock

Excavation to competent rock was identified as a third challenge for this project. While relating to the first challenge of blasting, this is an obstacle in and of itself. After blasting is complete, competent rock must be found. The estimated depth of competent rock can be estimated by the geotechnical report. The problem is that the exact depth is unknown until excavating the rock away. In several areas, competent rock was found five feet below the estimated depth. This leads to the need for more concrete of which Oncore Construction, the concrete subcontractor, did not account for in its bid. HESS identified two options to remedy this situation. The first option is to fill the over excavation with lean concrete back to the original footing elevation. This is the quicker option but also more costly. Option two is to form up the lean concrete back to the original footing elevation and backfill. This will have a longer duration but will be less costly than option one. Hagerstown Community College had the final decision because they are paying for the unforeseen conditions. That being said, the college chose option two because of cost. Seen below, Figure 9 and 10 portray option one and two, respectively.

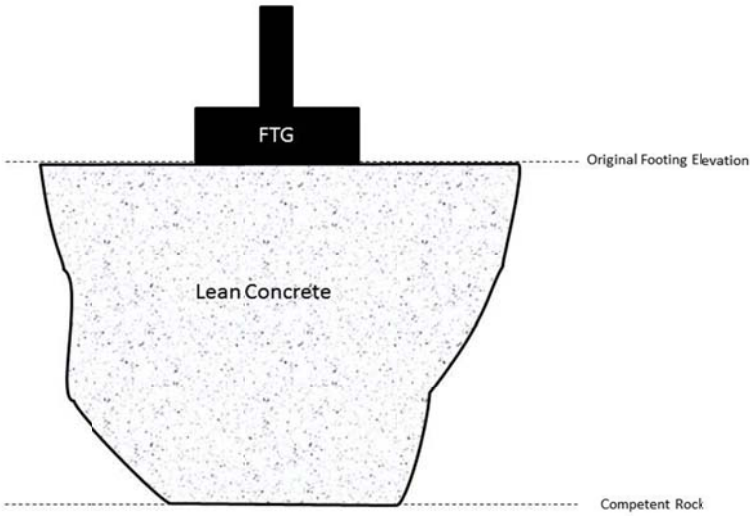

Figure 9: Competent Rock Option 1

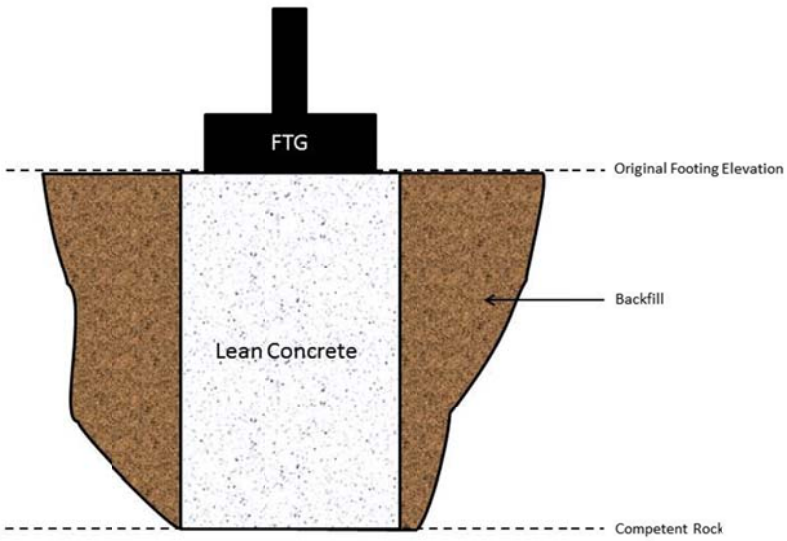

Figure 10: Competent Rock Option 2

Schedule Acceleration Scenarios

The critical path of the STEM Building project begins with the start of footings. Before this point, there were many unknowns related to utility relocation, blasting, excavation and the search for competent rock which provide the greatest risk for the project. Once footings have begun, the project team is in control of construction. Footings and foundations are to be completed by the beginning of January. The project team has designated the start of steel to be the next milestone, commencing in mid-January. Steel is to be completed in six weeks alongside of elevated deck pours. Enclosing the building is the next milestone identified by the project. It is also the area that offers potential schedule acceleration may occur. If the schedule is in jeopardy, the project team proposed to hire extra crews and stack trades if necessary. It is still early in the project and this is the furthest the project team has looked into schedule acceleration scenarios.

Value Engineering Topics

The project team for the STEM Building has not performed any value engineering for the project. When asked, "Why?" the project team stated that Hagerstown Community College (HCC) is a very experienced owner and worked with an incredible architect. HCC knew exactly what they wanted and at what cost. The architect, Cho Benn Holback + Associates, delivered on all of HCC's requests according to HESS.

Problem Identification

An area of interest that may offer a reduction in cost may exist in altering the resolution for setting footings on competent rock. The current resolution is to form up lean concrete to the original footing elevation, backfill and set the footing on top of the concrete. This can be seen in Figure 10 on the previous page. A third option may be to form a small amount of concrete for leveling purposes, place the footing on the lean concrete and lengthen the foundation wall down to the footing (Figure 3). Money can be saved on the reduction of concrete.

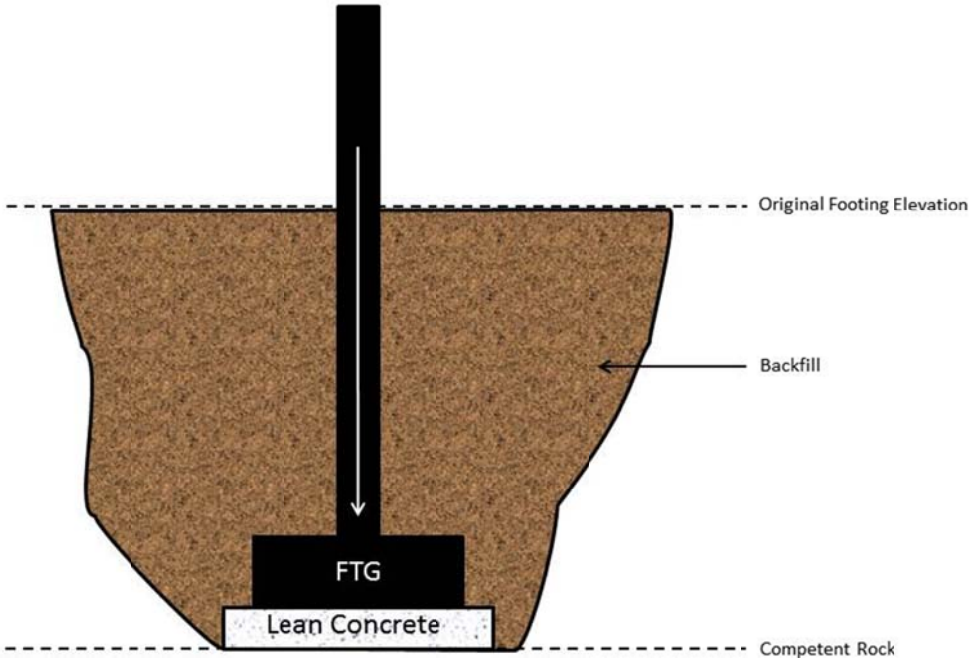

Figure 11: Competent Rock Option 3

Technical Analysis Topics

Analysis 1: Lowering foundation walls to footings

As previously stated, money savings can be accrued through a reduction of concrete when implementing "Competent Rock Option 3." This analysis will have two parts. Part one will entail calculations to determine the total amount of concrete, and the reduction in cost that can be expected. Part two will be an analysis on the structural integrity of the foundation wall and footing. Lengthening the foundation wall will add more load which may cause an increase in reinforcing and/or enlarging the footing. This analysis will be completed by calculating the total load the footing was originally designed to support. The load from the lengthened foundation wall will be added to the previous load. If the new load is less than the designed load, savings are viable.

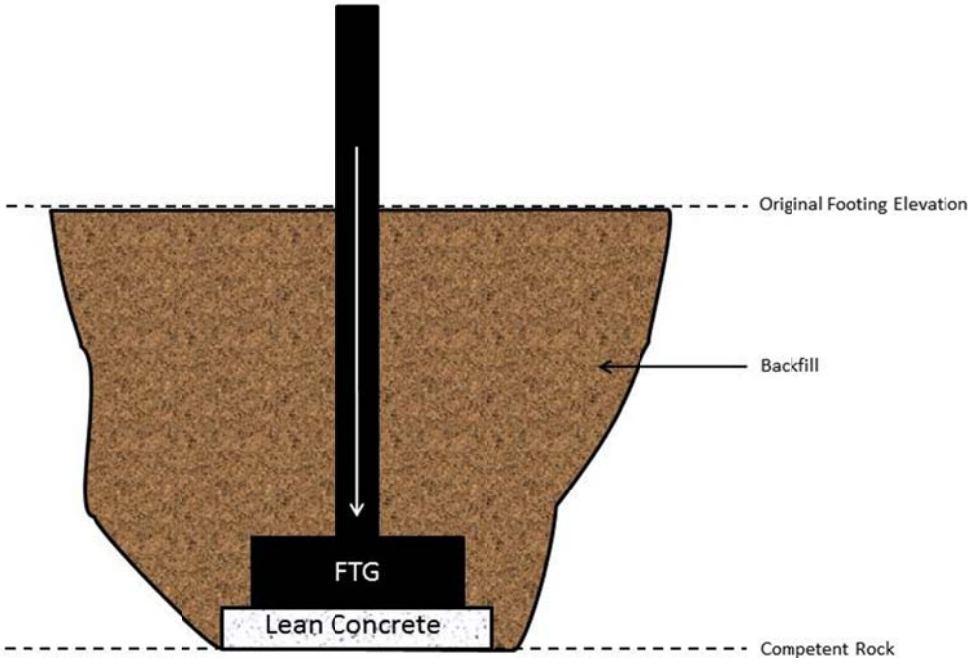

Figure 12: Competent Rock Option 3

Analysis 2: Expanding the green roof

The STEM Building has areas of roofing at various levels: third floor, fifth floor, lower roof, upper roof and penthouse. Currently the STEM Building is boasting a green roof at two locations on the building: third floor and fifth floor (shown below in Figure 12 and 13, respectively).

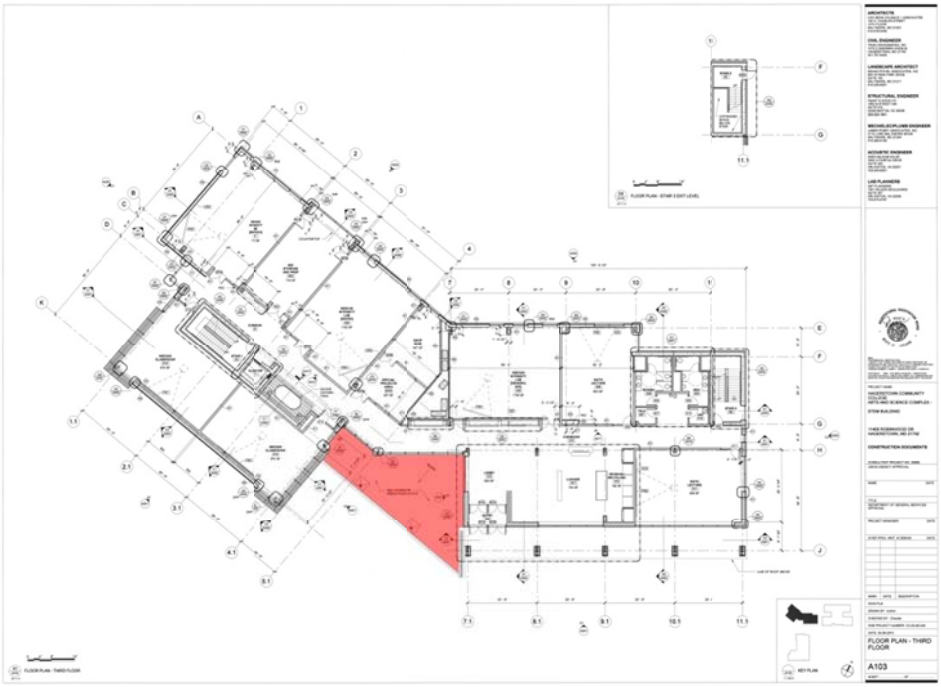

Figure 13: Third Floor Green Roof

Figure 14: Fifth Floor Green Roof

An analysis will be performed to explore the effects of expanding the green roof to the lower roof as well. The proposed green roof can be seen below in Figure 14.

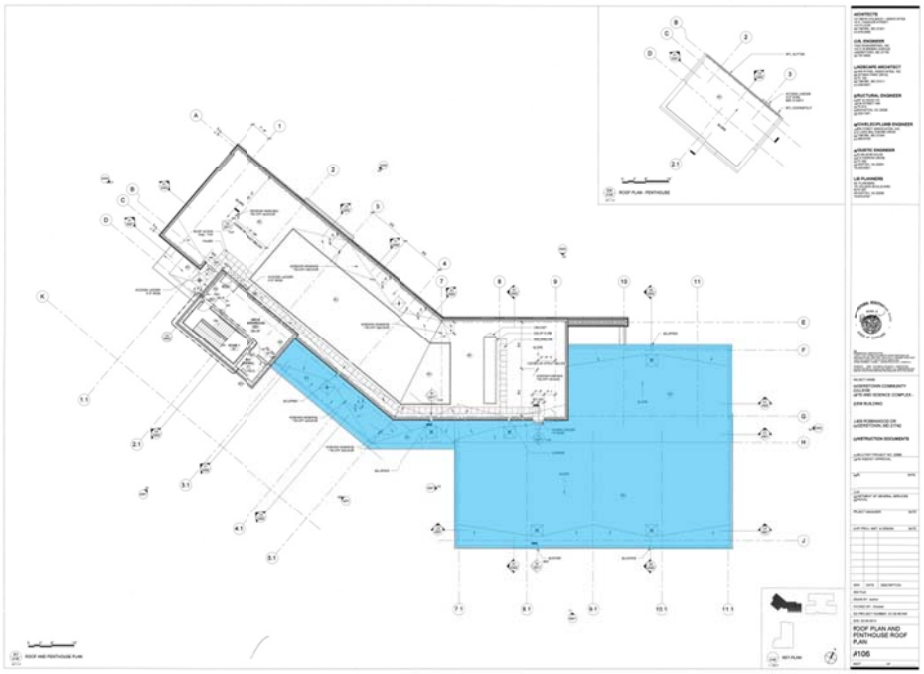

Figure 15: Lower Roof Green Roof

This section of the roof covers the offices and conference rooms of the STEM Building. Expanding the green roof will provide more efficient cooling and heating for the building. Calculations will be performed to determine the reduction of heating and cooling loads. If load reduction is sufficient, the air handling units may be able to be downsized. The expanded green roof can also add further collection of rainwater to the cistern. This leads to the next analysis.

Analysis 3: Cistern design

Expanding the green roof will lead to additional rain water collection. An analysis will be performed to calculate the amount of additional rain water being collected and compared to the volume the current cistern can hold. There is plenty of room to expand the cistern vertically if needed. In addition, an architectural design may be proposed for the cistern. After speaking to the project team and reviewing the drawings, there is still little known about the cistern. The only information obtained is that the cistern is stainless steel. There is a possibility to implement a concrete cistern which will be constructed within the building. Concrete tanks offer a flexible design compared to the prefabricated steel cylindrical tank. A concrete tank will also remove the lead time for the steel cistern and may have a positive impact on the schedule.

Analysis 4: Structural integrity for green roof and cistern

Adding the green roof and redesigning the cistern will have an impact on the structural system of the building. An analysis will be perform to evaluate the additional loads being applied and compared to whether or not the original structural design will support these loads. If not, calculations will be performed to resize the beams.