STEM Building

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

Hagerstown Community College

Hagerstown, MD

Final Report

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Construction Management

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STEM Building

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

Hagerstown Community College

Hagerstown, MD 21742

Building Statistics

- Building Cost: $15.6 M
- Size: 62, 840 sq. ft.
- Time of Construction: 6/4/10-11/30/10
- Delivery Method: Design-Bid- Build

Architecture

- Laboratories
- Classrooms
- Faculty Offices
- Computer Rooms

Building Envelope

- Glazed Aluminum Curtain Wall System
- Insulated Glass
- Brick Veneer
- Metal Panels
- Anodized Aluminum Storefront

Mechanical

- One Mechanical Room
- One Custom AHU Provides 37,000 CFMs of Outdoor Air
- Cabinet Unit Heaters and Propeller Unit Heaters
- Chilled Water

Structural

- CIP Concrete Footings
- Structural Steel Framing System w/ Shear Connections
- Three Concrete Towers for Lateral Bracing

Electrical

- 1000 KVA Pad Mount Transformer
- 250 KVA, 277/480V, 3 Phase Generator
- 5 Interior Transformers

Lighting

- Skylite 2x2, Skylite 2x4
- Verve III
- Skydome
- Avenue 6
- Zylinder Glass

Executive Summary

This report will cover two breadth studies in the structural and mechanical option. They will also investigate areas of critical industry issue research, value engineering analysis, constructability review and schedule acceleration.

These analyses include:

1. Mat Slab Redesign (Lower Mat Slab and Extend Foundation Walls)
2. Green Roof Redesign (Extensive to Intensive)
3. Curtain Wall Redesign (Stick Built to Unitized)

The first analysis will meet the structural breadth and investigate into value engineering and constructability review. This analysis was chosen when it was discovered that competent rock was found at a lower elevation than planned. An alternative method of lowering the footing will be explored in this analysis.

The second analysis will meet the mechanical breadth and research critical industry issues and value engineering. Redesigning the green roof will lead to lower heating and cooling loads which can provide long term saving for the STEM Building. The long term savings and overall load reduction from installing the green roof will be investigated in this analysis. PV panels and green roof as an educational tool will also be analyzed, specifically how information will be relayed to students.

The third analysis of converting the stick built curtain wall system to a unitized curtain wall system will help cover the constructability review and schedule acceleration requirements. A unitized curtain wall system offers a quicker on site construction time and higher quality product.

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List of Appendices

I. Footing Redesign (Structural Breadth)

A. Background

Prior to the structural design of the STEM Building, a geotechnical report was performed by Triad Engineering, the contracted geotechnical engineer. A total of “eleven (11) structure test borings and three (3) storm water management test borings” were performed to complete their investigation. It was determined that the subsurface of the proposed site was comprised of mainly limestone bedrock. Triad concluded that all foundations were to sit on competent rock and be designed for a bearing pressure of 8000 psf. See note C.1 taken from structural drawing S001 for reference in Figure 1 below.

C. FOUNDATIONS

1. Foundations shall be bearing on competent limestone bedrock and are designed for a bearing pressure of 8000 psf based on a subsurface exploration program conducted by Triad Engineering and described in report dated June 29, 2009. Contractor shall notify the Geotechnical Engineer before placing any footings.

Figure 1: Structural Drawing S001 Note 1

The boring tests also helped determine the expected elevations of competent rock upon which foundations will bear. The depth of auger refusal was used as the approximation factor to identify such elevation.

Throughout the excavation process, competent rock was discovered at a depth significantly lower than expected in one area in particular; the southwest corner of the building where Stair 1 is located. Below in Figure 2, Stair Shaft 1 is highlighted in blue. See Figure 3 (below Figure 2) for a close up of Stair 1.

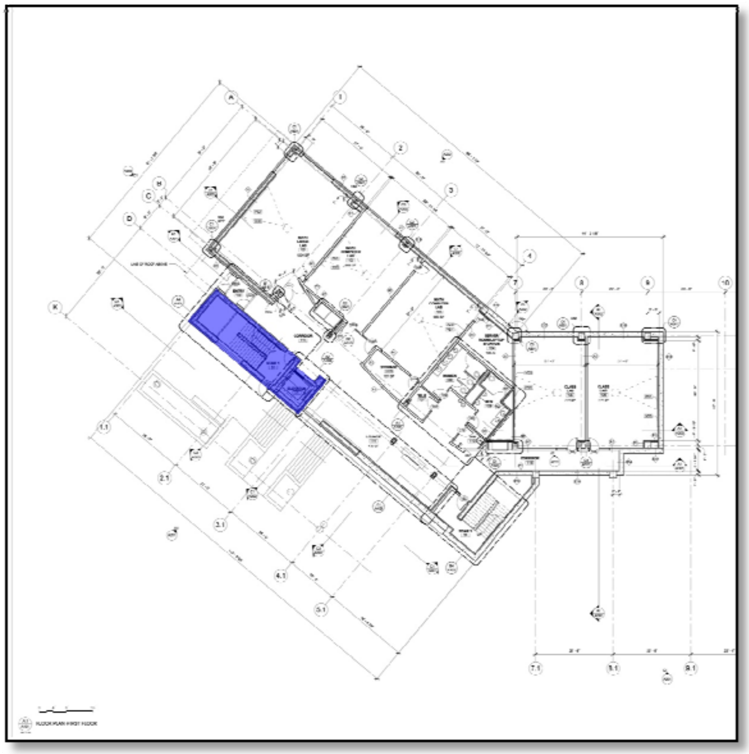


Figure 2: Stair Shaft 1 (Blue)

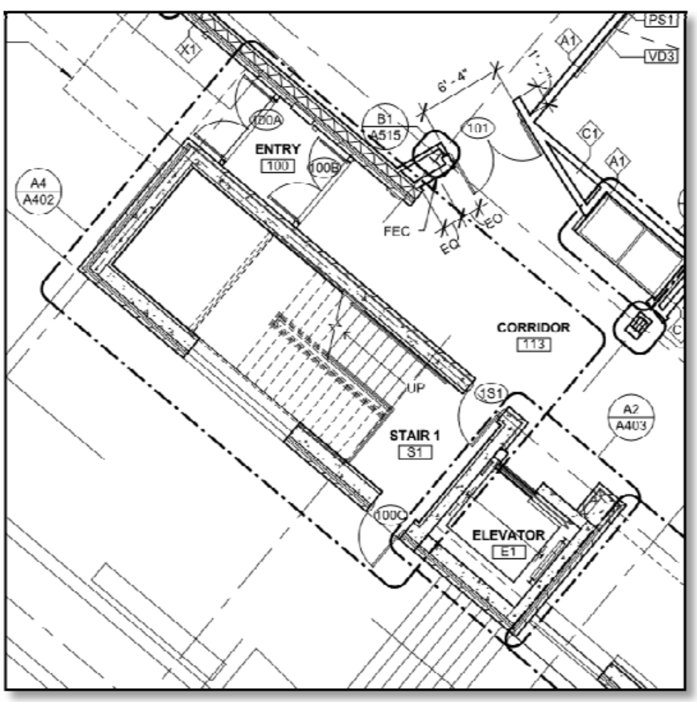


Figure 3: Stair Shaft 1

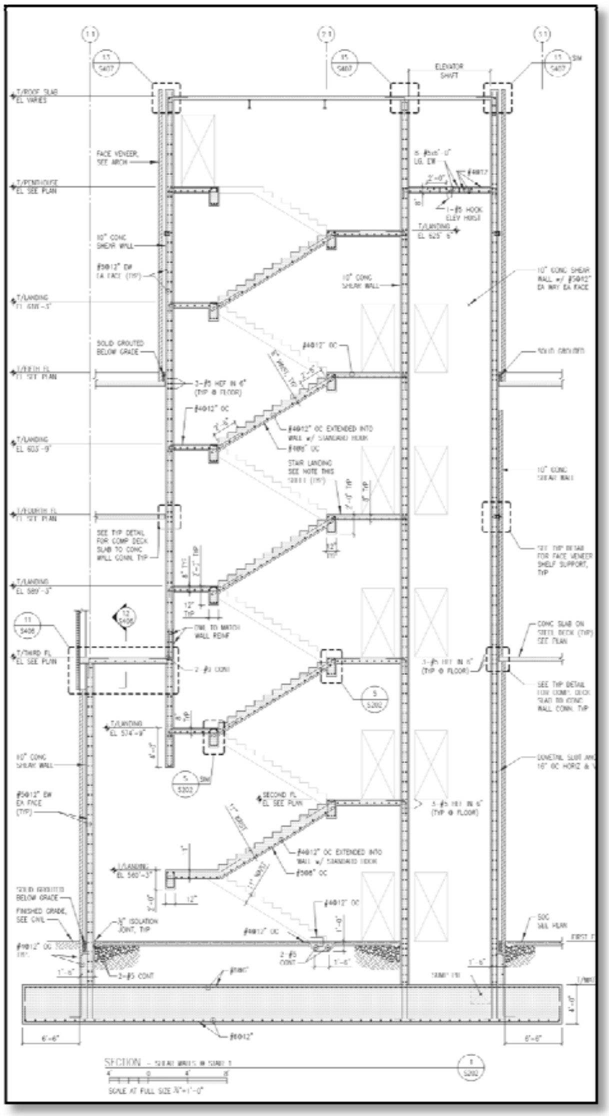


Figure 4: Stair Shaft 1 Structural Section

Stair shaft 1 was designed to bear on a 4’ mat slab at an elevation of 549’ (top of slab) above sea level which would place competent rock at 545’ (549’-4’=545’). During the excavation process, non-competent rock was detected at 545’, forcing further excavation. Competent rock was finally established at 540’. This circumstance brings forth the question of how to compensate for the over excavation.

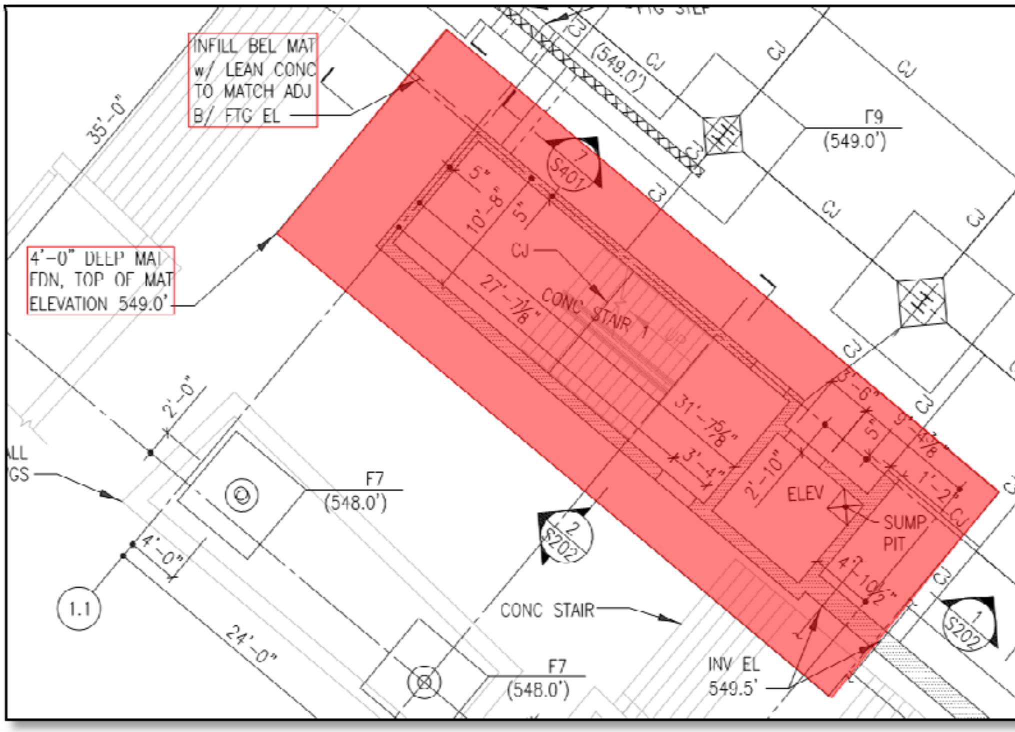


Figure 5: Mat Slab (Red)

B. Goal

The overall goal of this analysis is to determine the best means of ratifying the situation at hand, which is over excavation. Items of higher concern are to keep the cost as low as possible and minimize negative impacts on the schedule. A total of three solutions were devised to rectify the problem of over excavation. The next few paragraphs will outline each of the solutions, as well as their pros and cons.

Triad Engineering has recommended the contractor fill over excavated areas back to the design elevation with lean concrete. See Figure 6 below for reference.

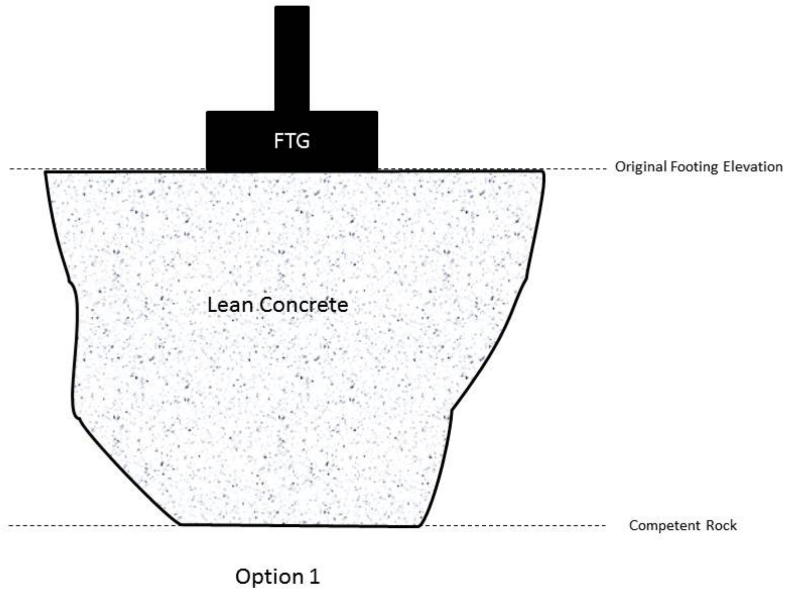


Figure 6: Triad Solution

In small areas this would be acceptable, but in this event, the amount of lean concrete needed would be excessive. While this will be the easiest of all three solutions because it requires little to no labor and no formwork, it will concurrently be the most expensive due to the considerable amount of lean concrete necessary. Below are takeoffs performed to show the cost and time of such work in this instance. Implementing this solution would require 38 truckloads of concrete to complete. A further breakdown of the time and materials is provided in Appendix A

	Triad Solution
Time (hrs)	12.5
Material	$ 23,948.15

Figure 7: Triad Solution Takeoffs

The general contractor has decided to form and place the concrete back to design elevation in order to save on materials. See Figure 7 below for reference.

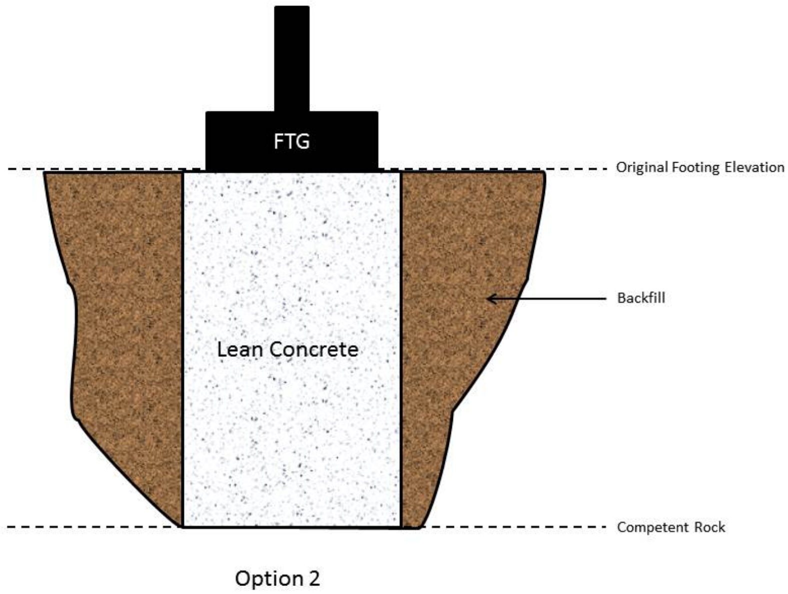


Figure 8: GC Solution

There are noticeable savings from decreasing materials but there is added formwork and labor that accompanies this solution. This solution would require 27 truckloads to complete. Overall it is cheaper than Triad's solution but the gain is minimal. See Figure 8 below for the quantity takeoffs performs for materials, labor and time.

	GC Solution
Time (hrs)	8.7
Material	$ 17,840.25

Figure 9: GC Solution Takeoffs

The third proposed solution is to place a small amount of lean concrete for leveling purposes, and lower the mat slab and foundation to the over excavated elevation. See Figure 9 below for reference.

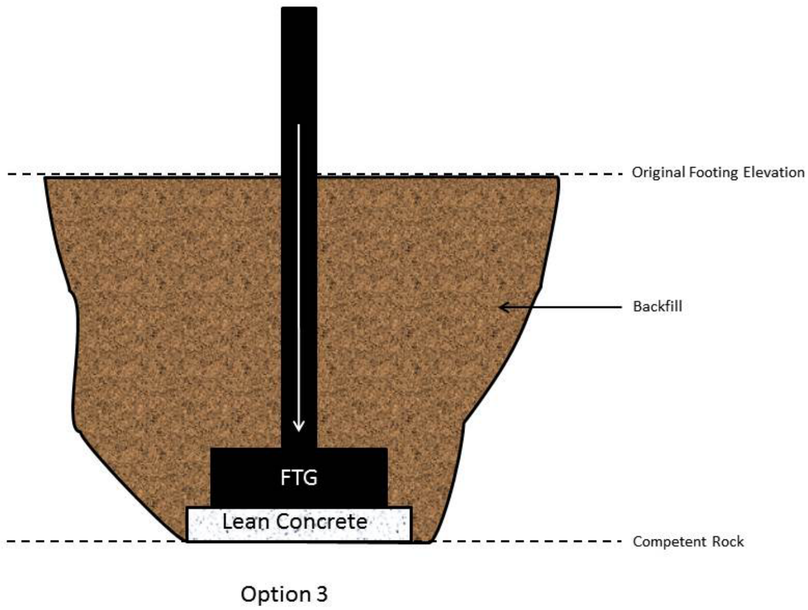


Figure 10: Proposed Solution

Significant savings will be seen on lean concrete while labor costs will be similar to the GC's solution. On the other hand, normal weight reinforced concrete will be increased but the savings from lean concrete will greatly exceed this addition. Only 2 truck loads will be needed for lean concrete and 6 truck loads for normal weight concrete. Formwork will also be similar to the GC solution. Below are the quantity takeoffs shown for this proposed solution.

	Proposed Solution
Time (hrs)	16.9
Material	$ 5,609.17

Figure 11: Proposed Solution Takeoffs

C. Proposed Solution/Mat Slab Redesign

After performing preliminary takeoffs for all three solutions, it is clear that the proposed solution is the most cost efficient and yields comparable impact on the schedule. In order to implement the proposed solution, the structural integrity must be checked for the added foundation wall loads. In order to confirm the structural integrity, the current loads bearing on the mat slab must be calculated and added to the extra loads provided by the extended foundation walls. This total load must be compared against the design load. If the actual load is less than the designed load, no further redesign of the mat slab is necessary. If the actual load is greater than the design load, further redesign of the mat slab will take place. It is predicted that the actual load will be less than the design loads. The mat slab currently supports 5 floors and a penthouse; extending the foundation walls 5' will be a minimal load increase compared to the existing loads.

The total load bearing on the footing is divided in dead loads and live loads. The chart below shows a further break down of the items contained in each load division.

Dead Loads	Live Loads
Compacted Soil	Classroom
Concrete (NW & LW)	Corridors at 3rd Floor & Below
Rebar	Corridors Above 3rd Floor
Steel Beams	Stairs
Stairs	
Curtain Wall & Metal Panels	
Brick Veneer	
Green Roof	
Ceiling	
Partitions	
Elevator	
HVAC & Plumbing	
Cistern	

The dead loads and live loads were summed using the ASCE (American Society of Civil Engineers) Standard, Chapter 2: Minimum Design Loads for Buildings and Other Structures was specifically used. The mat slab was designed using Section 2.4: Combining Nominal Loads Using Allowable Stress Design because the initial allowing bearing pressure was determined by the geotechnical engineer and the structural engineer is to design to that pressure.

Moving forward, loads were summed floor by floor. In general, the criteria for totaling the loads remained similar. Differences arose in dead loads mainly from the enclosure materials of the building: brick veneer, metal panels and curtain wall. The live loads slightly altered floor by floor as determined by the use of the space and the tributary width of which the stair shaft supported. Total live and dead loads are displayed in Figure 12 below.

Dead Loads	
	Total (lbs)
Compacted Soil (4')	496,100
Concrete-Normal Weight (5")	20,834
Concrete-Normal Weight (10")	728,625
Concrete-Normal Weight (12")	498,075
Concrete-Normal Weight (18")	56,306
Concrete-Normal Weight (20")	34,531
Concrete-Light Weight (4 1/4")	251,828
Beams	30,525
Stairs (20")	305,723
Curtain Wall & Metal Panels	23,460
Brick Veneer	92,576
Green Roof	132,688
Ceiling	28,604
Partitions	56,038
HVAC & Plumbing	57,208
Cistern	31,000
Total	2,844,119

Live Loads	
	Total (lbs)
Corridors 3rd Floor & Below	80,990
Corridors Above 3rd Floor	97,188
Classrooms	105,240
Stairs	122,289
Total	405,706

Figure 12: Stair Shaft 1 Live and Dead Loads

Overall the dead and live loads of the stair shaft come to 2,884,199 pounds and 405,706 pound respectively. The loads from the extended foundation walls will need to be added to these totals and are shown in Figure 13 below.

Dead Loads Total	2,844,119
Live Loads Total	405,706
Extended Foundation Wall Loads	139,750
Dead+Live	3,249,826
Dead +Live+Extended	3,389,576
Percentage Increase	4.12%

Figure 13

As the table shows, the total load on the mat slab increases by 4.12%. To establish if this increase in load would necessitate any redesign, the total load was divided by the area of the mat slab. The results can be seen in Figure 14 below.

Total Load (P)	3,389,576
Area (A)	1,128
P/A (lbs/sf)	3,006

Figure 14

The bearing pressure comes to 3,006$\frac{lbs}{sf}$. This is only 38% of the 8000 $\frac{lbs}{sf}$design which confirms that the current mat slab design is adequate. The resulting bearing pressure does seem rather low. It is important to note that when designing structural systems, additional load factors exist: earthquake, snow, wind, rain and snow. These factors will add to this bearing pressure but have been neglected from this analysis.

A meeting was set with the structural engineer to verify the results of this analysis. After the goal of the analysis and its results were explained, the structural engineer confirmed that the current mat slab design would support the increased load. He described that a general rule of thumb for determining if redesigning a structural system such as a stair shaft would begin at about 10-15% load increase. He went on further to explain that structural engineers would not design a structural system within 4.12% of its actual load. Therefore the load increase in this analysis was almost negligible so the current mat slab will suffice.

D. Schedule/Sequence/Coordination

In terms of schedule duration, sequencing and coordination, the three solutions are very similar. Durations for each solution may include just concrete pouring time, concrete/formwork time, or concrete/formwork/rebar time but the difference between the three is less than a day. The same sequencing and coordination applies to all three solutions with respect to other trade work.

E. Estimating

The cost of each of the options will have a noticeable difference. Triad's Solution will be presented first (Figure 15), followed by the GC Solution (Figure 16) and the Proposed Solution (Figure 17). Due to the small size of the spreadsheets, Figure 18 was generated to help view the costs.

Triad Solution Cost									
Materials	LF	$/LF	Sq. Ft.	$/Sq. Ft.	CY	$/CY	Duration	$/Crew	Total
Concrete					299.3	80			$ 23,944.00
Total									$ 23,944.00

Figure 15

GC Solution									
Materials	LF	$/LF	Sq. Ft.	$/Sq. Ft.	CY	$/CY	Duration	$/Crew	Total
Formwork-Lumber	240	0.3							$ 72.00
Formwork-Plywood			755	1.41					$ 1,064.55
Lean Concrete					208.8	80			$ 16,704.00
Backfill									$ -
Crew							1	960	$ 960.00
Total									$ 18,800.55

Figure 16

Proposed Solution									
Materials	LF	$/LF	Sq. Ft.	$/Sq. Ft.	CY	$/CY	Duration	$/Crew	Total
Formwork-Lumber	480	0.3							$ 144.00
Formwork-Plywood			426	1.41					$ 600.66
Lean Concrete					20.9	80			$ 1,672.00
Normal Weight Concrete					34.3	92			$ 3,155.60
Backfill									$ -
Crew							2	960	$ 1,920.00
Total									$ 7,492.26

Figure 17

Totals	
Solution	Cost
Triad	$ 23,944.00
GC	$ 18,800.55
Proposed	$ 7,492.26

Figure 18

As you can see, both the Triad Solution and GC Solution have rather high costs compared to the Proposed Solution. The cost of the proposed solution is far less than that of its competitors at $7,492, making it the easy choice. A savings of $16,451 or $11,308 can be seen by implementing the Proposed Solution.

II. Green Roof Redesign

A. Background

A green roof is being installed on the fifth level of the STEM Building. The area was originally designed to be an aesthetically pleasing area, accessible to students, combining wood panel pavers, concrete tile pavers, stone aggregate and indigenous vegetation. Upon further investigation and a meeting with the owner, it came to light that the area would not be an accessible area for insurance reasons and the school policy/safety plan. In this instance, the current design of the green roof is unjustified.

B. Goal

The Hagerstown Community College regards itself as an outstanding higher education institution and takes great pride in their facilities. They continually look for ways to enhance the learning experience through any means possible. Taking that into account, analysis two will propose to redesign the current green roof and implement an intensive or high profile green roof. The new design will provide heating load reduction in the winter and cooling load reduction in the summer; as well as act as an educational tool.

The heating and cooling load reduction will be performed using the thermodynamic equation for heat flow:

$$\dot{Q} = \frac{A}{R} * \Delta T$$

Equation 1

In order to successfully complete these calculations, it is important to determine whether the materials are in parallel or series. This will affect the R-Value used for the calculation which could drastically change the outcome/results.

Research will be performed to investigate how the green roof can be used as an educational tool. Currently, the green roof will drain into a cistern located on the third floor of the STEM Building. The cistern as a whole can be seen from the 3rd and 4th floor corridors and will have a window to view water levels on the 3rd floor. Although this is one way of relaying information to the students and faculty, analysis two will explore methods of using sensors and monitors to communicate information throughout the entire building. The same sensors and monitors will be taken advantage of for experiments by students in the Alternate Energy Program and Mechanical Engineering Program.

C. Takeoffs

The current design of the green roof features additional architectural facets including concrete pavers, wood pavers and stone aggregate. Shown below in Figure # is the current design layout of the green roof.

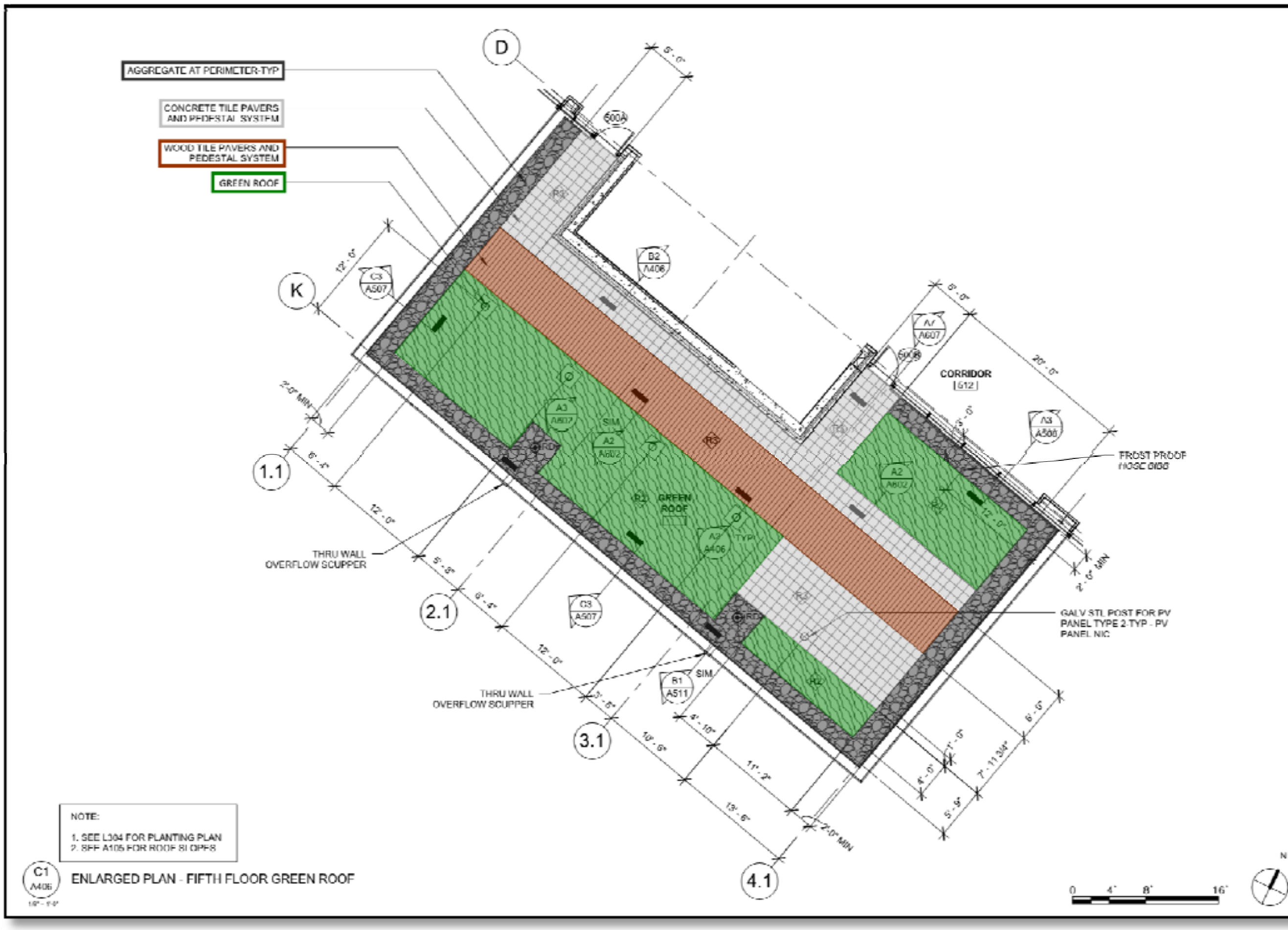


Figure 19

The overall roof area of the STEM Building is 15, 816 ft^2. The green roof accounts for 2022 ft^2, or 12.8%, of that total which is a relatively low portion. Breaking down the green roof even further into its architectural units, the actual "green" roof reduces even further. Shown below is a breakdown of the square footages and percentages of the green roof.

Green Roof Takeoffs		
	SF	%
Aggregate/Stone Gravel	308	15.2%
Concrete Tile Pavers	542	26.8%
Wood Panel Pavers	396	19.6%
Indegenous Vegetation	776	38.4%
Total SF	2022	100.0%

Figure 20

As you can see, only 38.4% of the green roof is actually "green." The other 61.4% is comprised of aggregate, concrete pavers and wood pavers. These materials simply do not provide the same thermal properties as the vegetation and are installed for aesthetic purposes only. Although these facets make the green roof "pretty," they are unnecessary expenses which also bear no educational value. Furthermore, the design intent of the green roof was to be an accessible area for students to eat, relax, study and do homework. Referencing back to a meeting with Dawn Baker, HCC Facilities Project Coordinator, "The green roof is not meant to be accessible to the general student population." This reveals that a conflict exists between the architect's design intent and the owner's usage of the space.

This acquired information acts as the driving factor for the newly proposed green roof design which will be discussed next.

D. Proposed Green Roof Design

The proposed green roof design involves the elimination of the architectural features of the green roof, and replacing the current 3" conventional green roof with a 6" pre-vegetated module system provided by LiveRoof Inc. The new design will cover the entire 5th floor roof, 2022 ft^2. See Figure 21 below for reference.

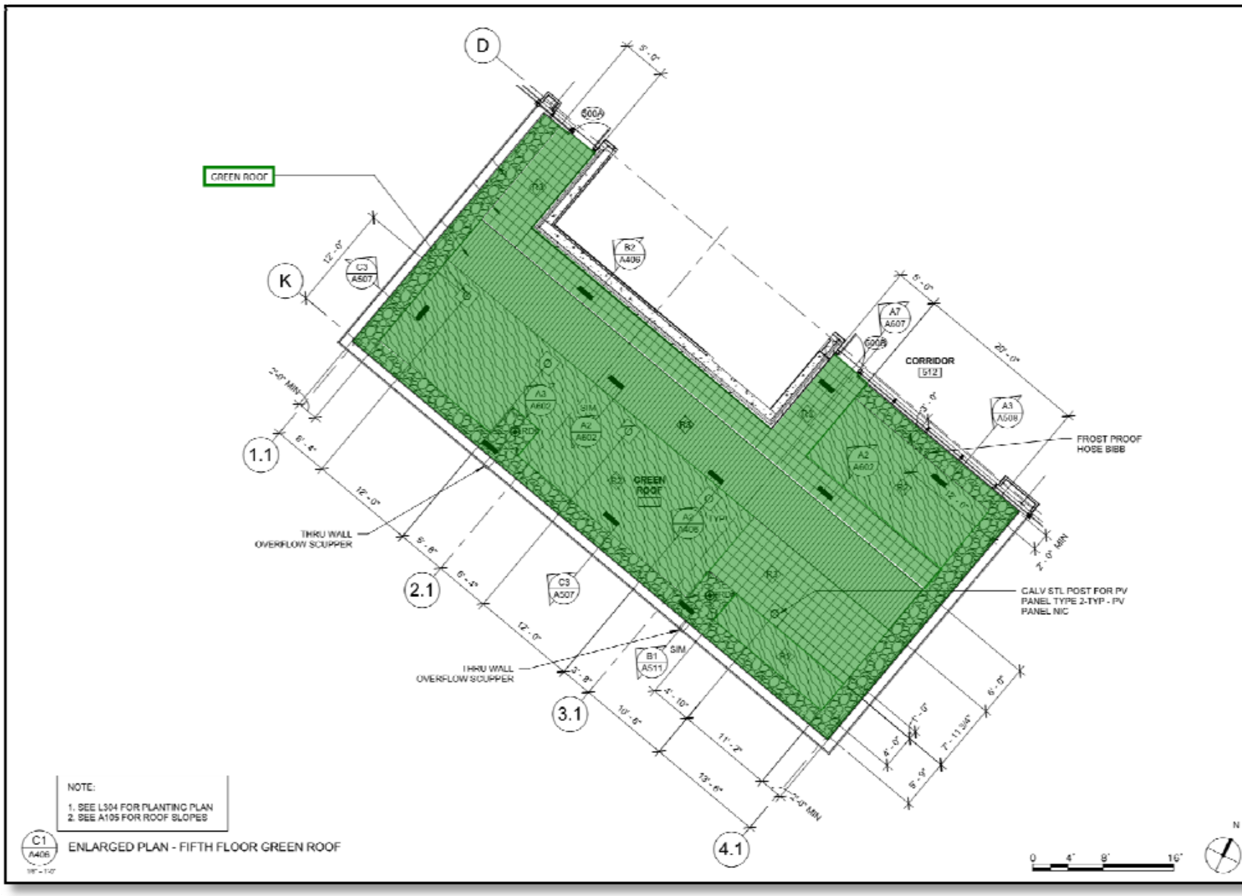


Figure 21

The new design, combined with the modern system, offers benefits in schedule duration (installation time), vegetation time, repair and maintenance cost, thermal values and educational advantages.

Before elaborating on the benefits, an overview of the LiveRoof system is in order. The new system is comprised of pre-vegetated modules which replace conventional green roof underlayment materials such as the drainage channel and filter fabric. Images obtained from a LiveRoof brochure comparing a conventional green roof to the LiveRoof system can be viewed in Figure 22 below.

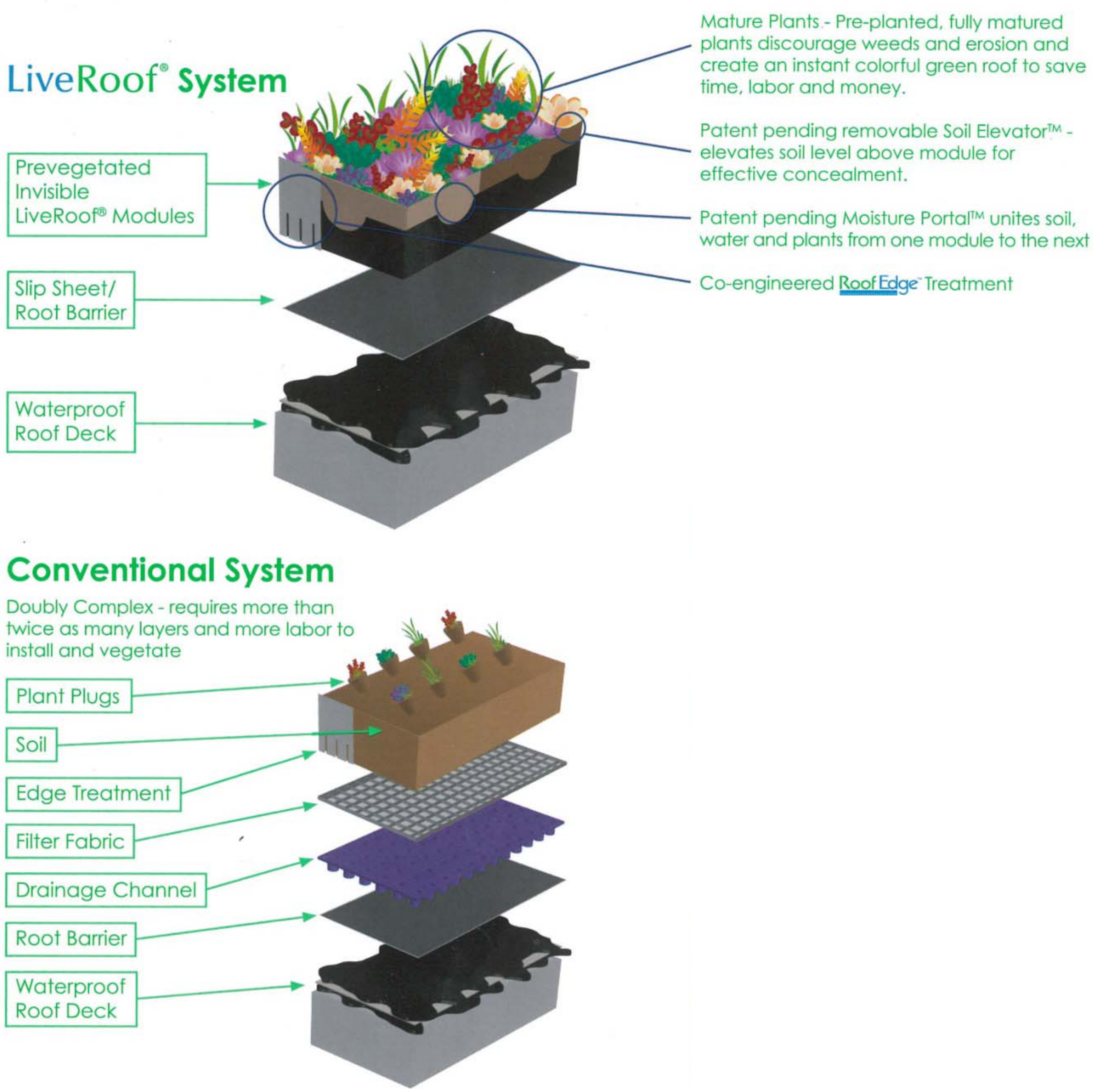


Figure 22

The first benefit arising from the new system is the shortening of installation time. Once the root barrier is installed, the modules will be delivered to the site in specialized trucks. Stacked trays called "HOPPIT"s can be lifted directly from the truck by crane and set on the roof for quick and easy installation. Figure 23 below shows the three simple steps of installation. Total installation time for the green roof of the STEM Building is estimated to be 2 days. A conventional system needs to have the root barrier, drainage board, filter fabric and edge treatment all installed layer by layer prior to placing soil. Additional time is then required to spread and level soil, as well as plant and cultivate seeds and/or bulbs. Although the installation of the green roof is not on the critical path, and therefore will not decrease the overall schedule, it is a bonus to have the flexibility to install the roof in a shortened period.

Figure 23

Owners are always looking for quick building turnover. This leads into the next benefit of the LiveRoof system.

Immediate results are a great advantage the LiveRoof system offers. Unlike the additional months (stuck with a brown roof) required to grow vegetation needed by the conventional system, the LiveRoof modules are pre-vegetated. This means from the minute the modules are set, the vegetation is already grown which immediately reduces the carbon footprint of the building and provides greater insulation on the roof.

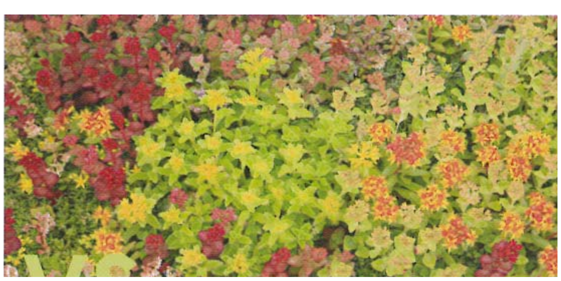


Figure 24: LiveRoof System Day 1

Figure 25: Conventional Green Roof System Day 1

Post installation comes the daunting task of upkeep of the green roof. This is another area of major benefit of the LiveRoof System. Traditional roofs, which require several months to cultivate, suffer from displacement due to wind and animal nuisance. Vegetation and its roots bond to the soil to alleviate the risk of wind displacement. Using the pre-vegetated modules mitigates this risk from day one. The second threat is animal nuisance. Birds feed on the seed used to cultivate the soil of a traditional green roof which consequently necessitates additional seeding. Defecation from birds also holds seeds from other plants and weeds which will grow on the traditional green roof if exposed. The proposed system eliminates the wind displacement effect and greatly reduces the chance of weeds. In the event that weeds or unwanted plants begin to grow, the modules can be lifted from the green roof for maintenance or if need be, a new module can be installed.

E. Schedule/Sequencing/Coordination

In terms of schedule, the proposed green roof system carries similar impacts to the conventional green roof. However, minor changes will be seen in the shortening of the installation process and vegetation period. The lead time for a LiveRoof system is a16 week minimum, considerably higher than the 2-4 conventional green roof lead time. This will be overcome by proper planning.

Coordination and sequencing changes are unnecessary for this activity. Both systems begin with the installation of the root barrier and end with a finished product (or substantially finished product for the conventional roof). The time in between does not require involvement from other trades.

F. Roof System Structural Integrity Verification

A small concern develops in the load increase of the green roof with regard to the structural integrity of the roof. In a meeting with Chris Johnson, Keast & Hood Structural Engineer, this concern was terminated by the design for the green roof. He had explained that when designing the roof system, 12” compacted soil was used to take into account the green roof. Despite the fact that the original design is for a 3” green roof, he explained that it was safer to over design than under design. Per design, compacted soil weighs 110 pcf (factor also used in analysis one) multiplied by the soil depth (12 inches of soil/12 inches in a foot) produces a design load of 110 psf. The maximum weight (saturated weight) of the 6” LiveRoof system is specified to weigh 40-50 psf. The actual weight is only 45% of the design load, which verifies that the current roof system will support the additional load.

G. Estimating

"How much?" The first question every owner asks when making even the slightest change to their building. The LiveRoof system described above is undoubtedly a comparable product to the conventional system, with half the hassle. Without saying, you pay for convenience in today's society and there is no exception with green roofs. Switching from a conventional green roof to LiveRoof's pre-vegetated module green roof doubles the upfront cost. Square footage costs were obtained from CitiRoof Inc., a LiveRoof supplier, and compared to costs designated by a case study performed by the University of Wisonsin. You can visit the website at http://www.glwi.freshwater.uwm.edu/ to reference case study. With the use of simple geometry, the three different payback periods were calculated. See figure 26 below for reference.

Payback Period			
	$ Markup	$ Maintenance Savings	Payback Period (years)
Conventional Low-LiveRoof Low	24264	$ 1,920.90	12.6
Conventional High-LiveRoof High	34374	$ 3,639.60	9.4
Conventional Low-LiveRoof High	46506	$ 1,617.60	28.8

Figure 26

As seen above, the payback period with regards to upfront cost versus maintenance savings from switching from a conventional low profile green roof to the high profile LiveRoof system is 28.8 years. This is substantial time considering the average life cycle of a building is 30 years. The most important component to remember is that this calculation is solely upfront cost versus savings on maintenance. This payback period does not take into account the heat transfer reduction provided by the green roof, where the majority of the savings accumulate. That being said, simply switching from a conventional low profile green roof to the LiveRoof high profile system will pay for itself before the end of the building's lifecycle in maintenance savings alone. Once thermal properties are taken into account and applied to the equations, significant savings will be seen.

H. Heating/Cooling Load Reduction

A green roof is an incredible building feature that offers numerous environmental benefits including:

- Roof Heat Flow/Transfer Reduction
- Storm Water Management
- Carbon Footprint Reduction

This section of the analysis will concentrate mainly on the green roofs ability to reduce heat flow. The original analysis design was intended to be completed with the use of Green Building Studio, a program developed by Autodesk, to determine the heating/cooling load reduction. Unfortunately technical difficulties were experienced when trying to export the .rvt file to a ,gbxml and this approach was abandoned.

Lessons learned in AE310 HVAC Fundamentals and ME201 Thermal Sciences will be used to complete this section of the analysis. In particular, the equation for heat transfer will be applied which is shown below in Equation 1 and Equation 2.

$$\dot{Q} = \frac{A}{R} * \Delta T$$

Equation 2

$$Building\ Heat\ Loss = \frac{Total\ Surface\ Area}{Surface\ Area\ R - Value} \times Change\ in\ Temperature$$

Equation 3

The following units will be used for each term:

- $Building\ Heat\ Loss = \frac{BTUs}{Hr}$
- $Total\ Surface\ Area = Sq.Ft.$
- $R - Value = \frac{\mathrm{Ft^2 \cdot {}^\circ F \cdot Hr}}{BTU}$
- $Change\ in\ Temperature = {}^\circ F$

Only the square footage for the fifth floor green roof will be utilized for this analysis. This decision was made in order to help show the effects of the green roof for a localized area of the building. Since the green roof only covers 12.8% of the total roof area, negligible results would be seen if using the total roof area.

First the R-Values will be determined for the conventional building materials and square footages assigned. The R-Values for a conventional roofing system were determined through the specifications and drawings. They are displayed in Figure 27 below.

Conventional Roof	
Material	R-Value
Modified SBS Cap Sheet	0.70
Modified SBS Base-Ply Sheet	0.70
R-30 Insulation	30.00
Decking/Concrete	0.43
Total (BTU/hr)	31.83

Figure 27

Next the change in temperature will need to be determined. Online weather databases and the drawings will be used for this effort. Citing mechanical drawing, M001, in Figure 28 below shows the building design criteria.

BUILDING DESIGN CRITERIA

INTERIOR:	SUMMER	75°F
	WINTER	68°F
EXTERIOR:	SUMMER	91°F DBT/74°F WBT
	WINTER	10°F
INTERIOR LOAD:	LIGHTING – 1.5 WATTS/SQ. FT.	
	MISCELLANEOUS – 1.0 WATTS/SQ. FT.	
VENTILATION:	ASHRAE 62.1-2007/IMC 2006	
MAX WALL "U" COEFFICIENT:	0.104 BTU/(HR)(SQ. FT.)(DEG. F)	
MAX ROOF "U" COEFFICIENT:	0.048 BTU/(HR)(SQ. FT.)(DEG. F)	
MAX GLASS TRANSMISSION COEFFICIENT:	0.29 BTU/(HR)(SQ. FT.)(DEG. F)	
MAX GLASS SHADING COEFFICIENT:	0.32	

Figure 28

The difference between the interior design temperatures and the actual average temperature will be used for T. The local Hagerstown weather station provides an online database of weather conditions, http://i4weather.net/index.html.

```
AVERAGE SPRING   52.4 F.
AVERAGE SUMMER   73.4 F.
AVERAGE FALL     55.3 F.
AVERAGE WINTER   33.0 F.
```

Figure 29

Now that all factors are accounted for, heat loss can be calculated. The heat transfer for a total of four roof scenarios will be calculated. The roof scenarios are as follows:

- Conventional Roof
- 3” Architectural Green Roof (current design)
- 6” All Green Roof (proposed design)
- ½ 6” Green Roof, ½ Conventional Roof (educational design)

The first three scenarios were present in my proposal, with the fourth scenario being discovered as part of my research into green building aspects as educational factors.

The first of four calculations for the conventional roof are shown in Figure 30 below.

Conventional Roof				
Materials	Sq. Ft.	R-Value	Summer: Q=A(To-Ti)/R	Winter: Q=A(Ti-To)/R
Modified SBS Cap Sheet	2022.00	0.70		
Modified SBS Base-Ply Sheet	2022.00	0.70		
R-30 Insulation	2022.00	30.00		
Decking/Concrete	2022.00	0.43		
Conventional Roof Total (BTU/hr)	2022.00	31.83	101.66	2223.72

Figure 30

In the summer months, a solar gain of 101.66 BTUs/hr will be seen while a heat loss of 2223.72 BTUs/hr will be experienced in the winter. The noticeable variation in heat transfer between the two seasons arises from the difference of the design temperature to actual average. ΔT for the summer is only 1.6°F while ΔT for the winter is 33°F.

Next the calculations for the current design of the green roof will be presented.

Current Green Roof							
Materials	Sq. Ft.	Lb./Sq. Ft.	R-Value	Conventional Roof R-Value	Total R-Value	Summer: Q=A(To-Ti)/R	Winter: Q=A(Ti-To)/R
Stone Aggregate	308.00	31.25	0.15	31.83	31.98	15.41	337.14
Wood Pavers	396.00	6.13	2.13	31.83	33.95	18.66	408.25
Concrete Pavers	542.00	23.00	0.65	31.83	32.48	26.70	584.14
3" Conventional Green Roof	776.00	23.44	1.43	31.83	33.25	37.34	816.84
Vegetation							
Soil							
Filter Fabric							
Drainage Channel							
Root Barrier							
Architectural Roof Total						98.12	2146.37

Figure 31

ΔT will remain constant through all calculations. However R-values and roof areas will need to be adjusted accordingly. An R-value of .475 per inch will be defined as the standard for the green roof. An important note when dealing with R-values is to properly delineate whether materials are in parallel or series. All the materials in the conventional roof are in series and therefore R-values need to be summed before applying to the heat transfer equation. In the current green roof design, there is a combination of materials in series and parallel. This is why an R-value and Total R-Value column can be seen in Figure 31 above. The architectural green roof will have 98.12 BTUs/hr of heat gain in the summer and 2146.37 BTUs/hr of heat loss in the winter.

The calculations for the proposed green roof design will be presented next. It is expected that the heat transfer allowed by this design will be the lowest of the scenarios. This prediction is based on the detail that this design possesses the largest green area on the roof; see Figure 32 below.

Proposed Green Roof System						
Materials	Sq. Ft.	R-Value	Conventional Roof R-Value	Total R-Value	Summer: Q=A(To-Ti)/R	Winter: Q=A(Ti-To)/R
6" LiveRoof System	2022.00	2.85	31.83	34.68	93.30	2040.95
Prevegetated Modules						
Root Barrier						
All Green Roof Total					93.30	2040.95

Figure 32

Figure 32 above, conveniently shows the lowest heat transfer rates of the scenarios presented thus far. Heat gain in the summer equates to 93.3 BTUs/hr and heat loss comes to 2040.95 BTUs/hr in the winter.

The fourth green roof scenario/design consists of half green roof and half conventional roof. Elaboration on this design and its intent will take place in the next section of this analysis: Educational Tools. Only heat transfer calculations will be presented at this point. See Figure 33 below.

New Green Roof Design							
Materials	Sq. Ft.	Lb./Sq. Ft.	R-Value	Conventional Roof R-Value	Total R-Value	Summer: Q=A(To-Ti)/R	Winter: Q=A(Ti-To)/R
1/2-6" LiveRoof System	1011.00	46.88	2.85	31.83	34.68	46.65	1020.48
Prevegetated Modules							
Root Barrier							
1/2-Conventional Roof	1011.00				31.83	50.83	1111.86
Educational Roof Total						97.48	2132.34

Figure 33

The heat transfer outcome is obviously less than the proposed green roof because the vegetation is cut in half. However, the heat transfer is still less than that of the conventional roof and architectural roof.

The heat transfer reduction achieved by the green roof scenarios did not meet expectations based on research of case studies and green roof projects. At a minimum, a 25% reduction in heat transfer was desired which is still rather modest. Currently the maximum heat transfer reduction shown by this analysis is 8.2%.

Due to the undesirable outcome of this analysis, areas of possible discrepancy will be investigated and presented at this time.

After much research, it has been determined that the discrepancy with this analysis occurs with the R-value. An R-value is a means of measuring heat flow resistance, and resistance only. This is only one means of how the green roof reduces heat transfer. The vegetation existing on a green roof is a living entity. It does not just sit there resisting heat flow. The plants literally collect, process, and release energy according to their immediate need the same as humans.

Think of the last sunny day when you were outside and began to sweat. This is your body's way of compensating for overheating. You probably proceeded to get a nice cold drink to cool down and replenish. Plants perform in the same way through a process called evapotranspiration. This is the plants means of "sweating" to cool down. Water is sucked from the soil by the roots and transferred to tiny stomatal openings. These microscopic openings allow the plant to release water to cool itself, just like the pores in our skin. So how do you put an R-value on a living organism? You can't.

Plants compensate for heat through convection, radiation and thermal mass. Mathematically, the equations that describe energy transfer through evapotranspiration, convection, radiation, and thermal mass are far beyond my scope of knowledge. This is a task that should be left for the experts to conquer. Shown below in Figure 34 is an image explaining the relationship between the green roof's layers and the different means of energy control.

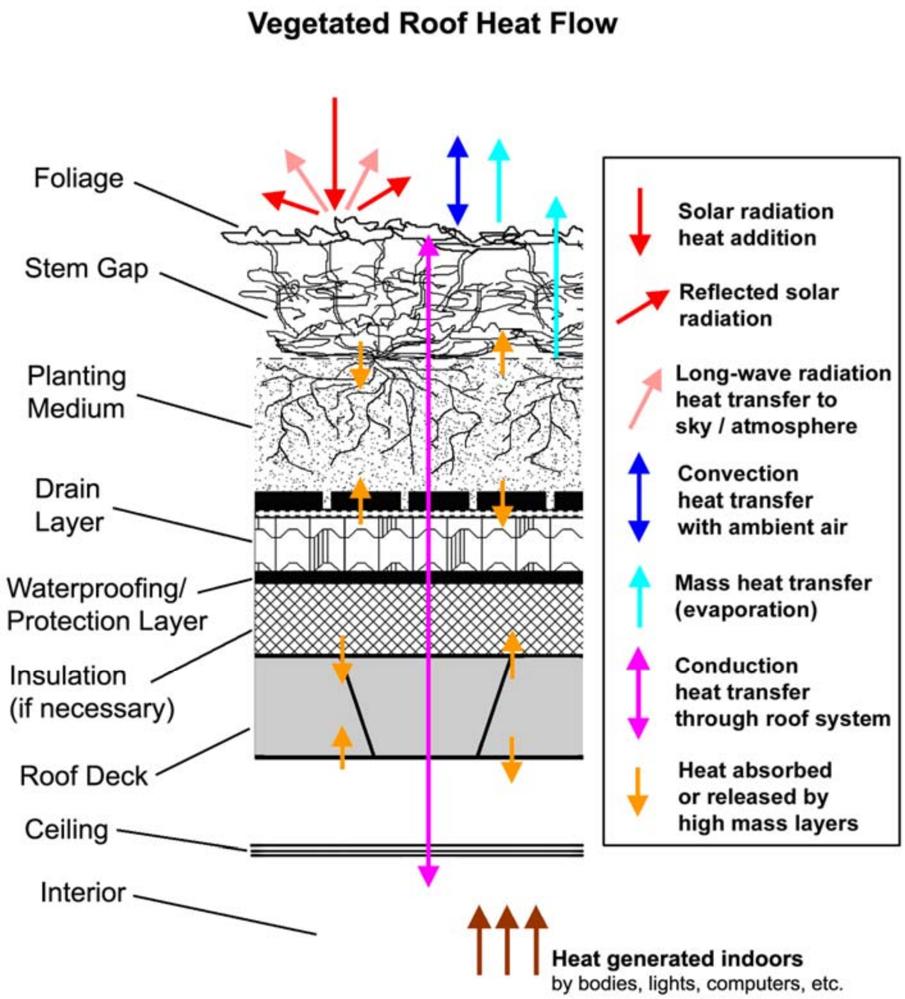


Figure 34: Image provided by www.greenroofs.com

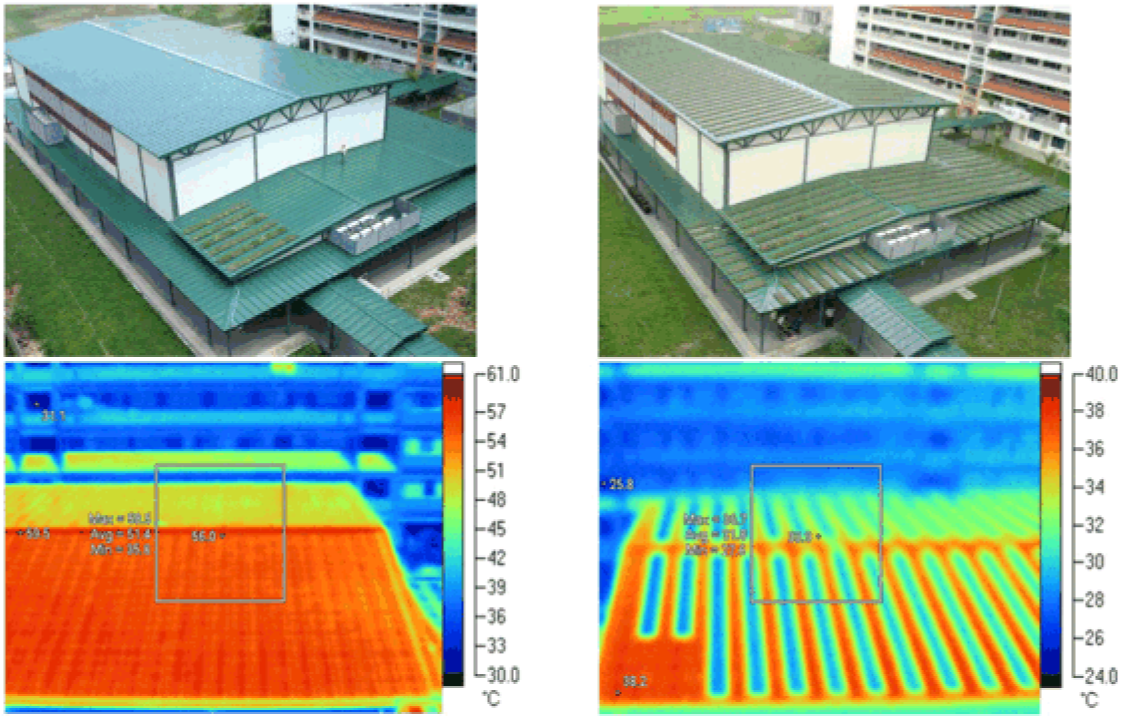
As you can see, the long pink line represents the conduction heat factor which is accounted for by the R-value. Overall, the analysis performed fails to include the living benefits of the vegetation and its ability to react to its environment. Once these factors are calculated into the equation, sizeable heat flow reductions will be experienced upon which a faster payback period can be determined. For now, placing an R-value alone on a living organism is a faulty means of calculating heat flow but at the same time will still pay for itself before the end of the buildings life cycle.

I. Educational Tool

Photovoltaic (PV) panels and a green roof exist on the STEM Building to act as educational tools for the Hagerstown Community College. With little knowledge of how the information will be relayed to the student body and used within the classroom, research will be conducted to maximize the learning experience. First the green roof will be addressed, followed by the PV panels.

The green roof is installed primarily for aesthetics; offering minimal thermal benefits and minute educational value. So the task at hand becomes answering how the aesthetic green roof will be altered into an educational green roof. As mentioned in the Heating/Cooling Load Reduction section of this analysis, scenario four is presented as the educational design. This design was discovered through R-value research during which a similar study was performed by the University of Central Florida. Appendix F includes the UCF case study.

The educational design proposed delegates half of the roof to be green and half of the roof to be conventional. The usage space below the roof is two classrooms with mirror images; one located beneath the green roof; one located beneath the conventional roof. Heat sensors will be installed on the ceiling of the classrooms and on the roof (under the green roof). Heat readings will be used by Mechanical Engineering students to calculate the heat transfer through the roof. The use of thermal cameras will be used to visually show the student the temperature difference between the roofs. Below in Figure 35, is an example of thermal imaging. This case study was executed by Cleens, Inc.



Name	Temperature	Emissivity
Centerpoint	56.0° C	0.95
Hot	59.5° C	0.95
Cold	31.1° C	0.95

Prior laying of Green Roof System - (56.0ºc)

Name	Temperature	Emissivity
Centerpoint	30.3° C	0.95
Hot	41.4° C	0.95
Cold	26.7° C	0.95

After laying of Green Roof System - (26.0ºc)

Figure 35: Cleens Inc. Case Study Thermal Imaging (Singapore)

This green roof was installed in rows while the STEM Building will demonstrate two separate solid areas of green and conventional roof.

The proposed green roof design also allows these sensors to be installed at a later date with minimal cost impact.

Unlike the green roof which was in the design from the schematic design phase, the PV panels were a late addition. A grant was received from the state to fund higher education for the college's Alternate Energy Program. The college has decided to place the PV panels on the green roof. Figure 36 below displays the PV panel location.

Figure 36

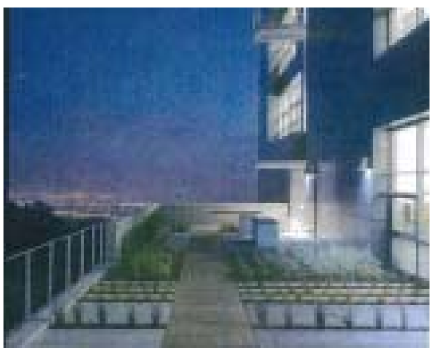


Figure 37

Figure 38

A meeting was held with Tony Valente, HCC Alternate Energy Program professor, to gain some insight on the educational value the PV Panels will offer. During this meeting, Tony stated that sensors and monitors will be used throughout the building to relay information to students. Coincidentally this was also presented in my proposal. However it was still unclear as to the software which would be used to complete this task. Tony provided several examples of larger companies offering renewable energy solutions. The company which stood above the rest was Power-One.

Power-One is a worldwide leader in power conversion and power management solutions. Power-One offers many products but my main focus will be geared to their Fat Spaniel software and its implementation into the STEM Building. Fat Spaniel can both record and calculate the energy produced by the PV panels. The software then uses a web based database to communicate the information.

The photovoltaic panels made up of individual cells convert solar radiation into electricity. When the sun shines on the modules, the cells produce a stream of direct current (DC) electricity and send it to an inverter. The inverter converts the DC electricity from the solar array into alternating current (AC) electricity. Most electrical devices such as lights and computers use AC electricity. The electric meter measures electrical energy produced by the PV panels in kilowatt-hours. Electricity generated by the PV panels, combined with the electricity from the electric utility company is then routed to the building.

A data acquisition system combines electrical generation data from the inverter, usage data from the electric panel, air and cell temperatures from a thermistor, and sunlight from a pyranometer. Once collected, the information is published to the internet. Both the pyranometer and thermistor are used to measure the available sunlight, air and cell temperature. Once on the internet, live performance of the energy system can be viewed remotely on any computer with internet access, using Fat Spaniel monitoring and visualization software.

Monitors will be set throughout the STEM Building to view this information through an interactive format. The Fat Spaniel database has links to demonstration websites; one of which can be viewed in Figure 39 below.

Figure 39

Touch screen monitors will be installed in the STEM Building to allow occupants the ability to browse through the green information similar to the site above.

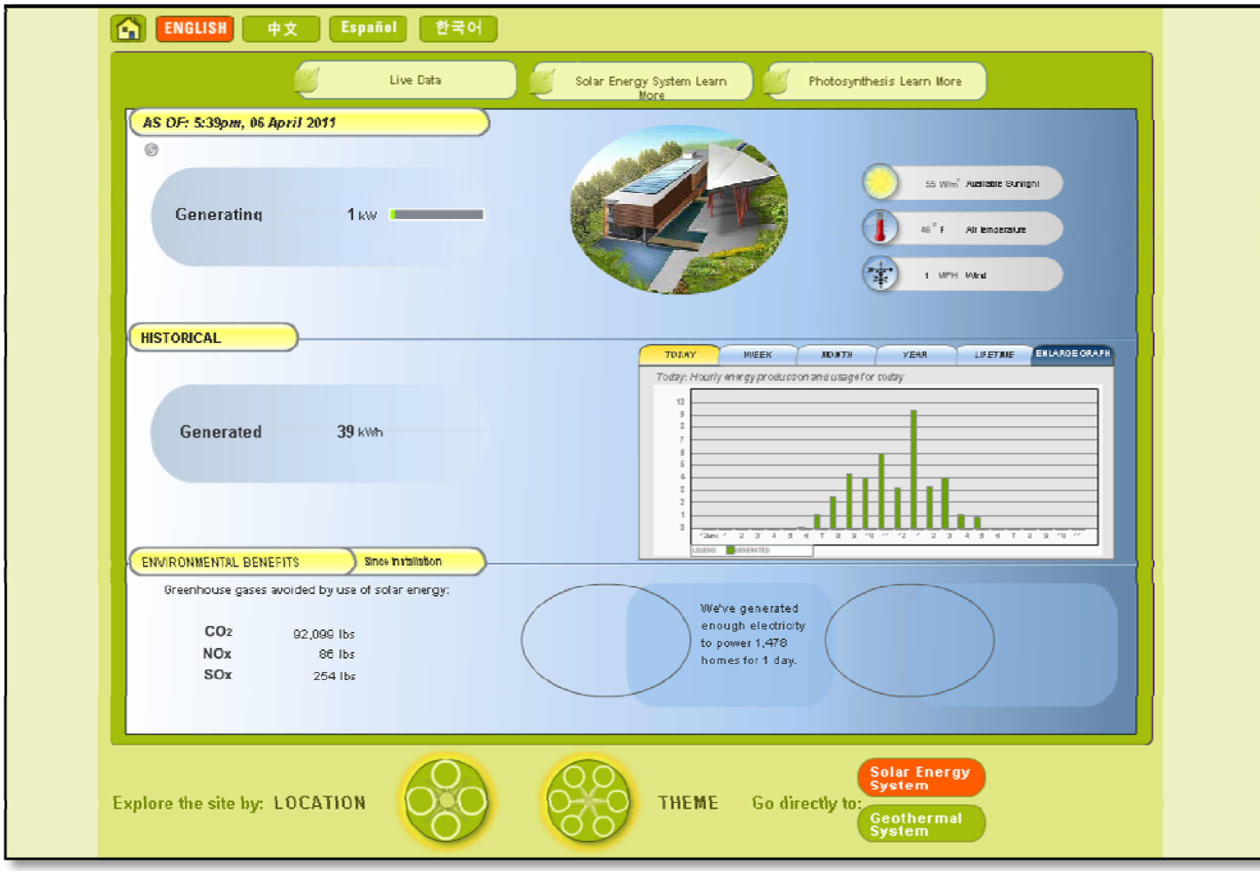


Figure 40

The Fat Spaniel software can track and display various features such as temperature, greenhouse gases avoided, wind and total energy generated.

III. Curtain Wall Redesign

A. Background

The enclosure of the STEM Building is comprised of three architectural features: brick veneer, metal panels and curtain wall. Each accounts for approximately 1/3 of the envelope. This can be seen in the rendering shown below in Figure 41.

Figure 41

One aspect of the curtain wall, which sets it apart from the brick veneer and metal panels, is its ability to reduce the schedule. This is based on the information obtained in a meeting with the general contractor where it was stated that the curtain wall (also including windows and storefront) is the last activity performed before the building is deemed water tight. Traditionally waterproofing and blue skin would need to be applied to the substrates of the brick veneer and metal panels to achieve a water tight building; but the STEM Building will utilize spray foam insulation which will also act as the water tight seal.

Achieving an earlier water tight date allows the finish trades to access the building sooner. In the same meeting with the general contractor, stacking rough-in and finish trades was determined to be the greatest area for acceleration. Theoretically, stacking trades should double their output. Unfortunately the working space will be dense with activity and efficiency will suffer. Therefore a time savings factor of 1.5 can be used for everyday the finish trades can access the area ahead of schedule. This leads as the basis of design of the analysis and its goals presented next.

B. Goal

Currently the STEM Building construction is set for 18 months from notice to proceed to substantial completion. The substantial completion date will be used for this analysis because it acts as the start date of owner move-in.

In an effort to accelerate the schedule and provide a higher quality product (VE), an analysis will be completed to show the impact of replacing the originally designed stick built curtain wall system with a unitized (modular) curtain wall system. The advantages of the unitized system derive from the more reliable seals achievable from factory construction and the reduced cost of labor in the factory versus that of field labor. Units can be assembled in a factory while the structural frame of the building is being constructed. Where stick systems require multiple steps to erect and seal the wall, unitized curtain walls arrive on the site completely assembled allowing the floors to be closed in more quickly. Unitized systems also require less space on site for layout thus providing an advantage for sites with space limitations.

C. Takeoffs

Quantity takeoffs were performed for the curtain wall to determine the total number of pieces that will need to be set on the STEM Building. These takeoffs also include the exterior windows/storefront as well. Curtain wall was dissected into pieces by rule of thumb that the maximum size allowable based on the 30’ x 12’ flatbed trucks used to deliver the walls. Floors of the STEM Building elevate by 14.5 feet which allows the subcontractor to prefabricate curtain walls in 2-story spans. Using Microsoft Excel, the total number of curtain wall pieces were totals; reference Figure 42 below.

Curtain Wall Takeoffs	
	Pieces
North Elevation	4
South Elevation	58
East Elevation	8
West Elevation	13
Total	83

Figure 42

Total piece count comes to 83 for the STEM Building with majority of the curtain wall seen on the south elevation. Shown below in Figure 43 is a south view rendering of the STEM Building.

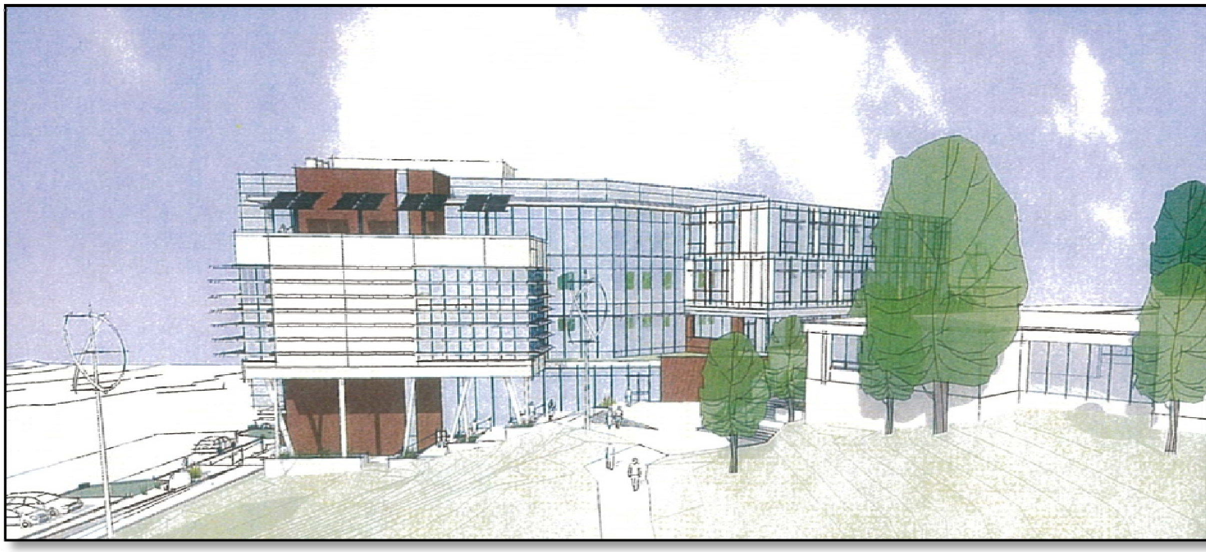


Figure 43

D. Schedule (Acceleration)

Defining the duration of the proposed unitized curtain wall system will be the next step in this analysis. A standard will need to be set relating total of pieces of curtain wall set per crew per day. A visit to the contracted curtain wall subcontractor's shop, Accent Metals Inc., was performed to establish general guidelines with regard to durations, lead time, cost estimates, means and methods (how the curtain wall is installed) and size of deliveries.

The original duration allotted for the installation of the stick built curtain wall system was 40 days; running from April 14, 2011 to June 17, 2011. This can be seen in Figure 44 below. The same schedule generated in Technical Assignment 2 will be referenced for this analysis but will be displayed in P3; working remotely provided limited access to Microsoft Project.

ENCLOSURE & SITE FINISHES					
SUMMARY ENCLOSURE					
SUM90100	PERIMETER CMU/STUDS/SHEATHING	25	18MAR11	29APR11	1
SUM90000	ROOF PARAPETS/BLOCKING/DRAINS	15	25MAR11	19APR11	0
SUM90300	EXTERIOR BRICK FACADE	15	28MAR11	21APR11	1
SUM90200	ROOFING FOR DRY-IN	15	04APR11	28APR11	0
SUM90400	INSTALL WINDOWS	25	05APR11	17MAY11	1
SUM90500	INSTALL CURTAIN WALLS & STOREFRONTS	40	14APR11	17JUN11	2

Figure 44

The analysis at hand will propose to cut this duration by 50% and show the impacts on the schedule, sequencing and estimating; but first the curtain wall duration needs to be addressed.

Comparing the installation process of a stick built system versus a unitized system is imperative and will be shown in the table below. For this analysis, it is assumed that exterior wall framing and flashing will be installed before delivery of curtain wall materials.

Table 1

Stick Built System	Unitized System
1. Deliver Materials 2. Shakeout 3. Install Sills and Jambs 4. Install Mullions 5. Glaze 6. Caulk	1. Deliver Modules 2. Set Module 3. Caulk

As seen by showing the two processes side by side, the unitized system takes advantage of prefabricating curtain wall modules, consolidating steps 2-6 of the stick built installation process down to one. The prefabrication process occurs indoors where temperatures are controlled and the risk of weather days eliminated. The stable working environment also allows for higher quality seals and greater cut precision. Once these modules are set in place, caulking is applied around the perimeter for waterproofing and air barrier purposes; presenting the final product.

The downside of the new design is the lengthy lead time. The table below will define lead times as established by the contracted curtain wall subcontractor for both curtain wall systems.

Table 2: Lead Time

Week	Stick Built System	Unitized System
1-6	Obtain materials	Obtain materials
7	Fabricate/Deliver	Fabricate/Deliver
8	Fabricate/Deliver	Fabricate/Deliver
9-12		Fabricate/Deliver

While both systems take equal time to obtain materials, a project the size of the STEM Building would require 4-6 weeks for fabrication and delivery for a unitized system; compared to the 1-2 week fabrication and delivery period of the stick built system. At first site this is a major deterrent of the unitized system; but with proper planning and a proactive approach, lead time does not enter the design intent equation.

Table 3 below will elaborate on the installation process defined in Table 1 and assign durations. Again, durations are based on a meeting with the curtain wall subcontractor. Durations have been reviewed with the GC project manager to verify accuracy. The overlap between Table 2: Lead Time and Table 3: Installation Time occurs over the delivery period. Delivery is displayed in both tables because both fabrication and installation overlap this activity.

Table 3: Installation Time

Week	Stick Built System	Unitized System
1	Deliver/Frame	Deliver/Install/Caulk
2	Deliver/Frame/Dimension	Deliver/Install/Caulk
3	Deliver/Frame/Dimension	Deliver/Install/Caulk
4	Deliver/Frame/Dimension/Glaze/Caulk	Deliver/Install/Caulk
5	Deliver/Frame/Dimension/Glaze/Caulk	
6	Deliver/Frame/Dimension/Glaze/Caulk	
7	Glaze/Caulk	
8	Glaze/Caulk	

Table 3 clearly exhibits the 50% reduction of installation time achieved by the unitized system. To further back up this statement, the total pieces of curtain wall was divided by 20 days. The result came to setting an average 4.15 pieces per day which is more than achievable.

The downfall of the stick built system is the added steps which need to be completed on site before caulking. The stick built system requires field dimensioning for glazing after frames (sills and jambs) are installed. Once ordered, the glazing has its own 2 week lead time. This results in a minimum 3 week period before the first piece of glazing is set. The lead time also adds 2 weeks to the installation time from the last day frames are set. Overall, a general rule of thumb is that the installation time for a unitized curtain wall system is approximately one half that of its stick built competitor.

The curtain wall system must start being designed much earlier in the design process when acceleration plans are the last thought on an architect’s and contractor’s minds. Through a meeting with the curtain wall subcontractor, it was determined that the lead time for a project of this size would be approximately 12 weeks. This is a substantial increase compared to the standard 6 week lead time which a stick built system offers.

The simple solution to overcome such a lead time is to be proactive and implement the design early in construction. For the STEM Building project, the activity which offers the greatest risk for schedule delays is excavation. The STEM Building rests upon a limestone land mass which brings great difficulty for excavation and uncertainty when determining durations. Looking back at the detailed schedule produced in Technical Assignment 2, the end of excavation is scheduled 12 weeks prior to the installation of curtain wall. Although still a late change in the construction means and methods, the proposed accelerator is entirely feasible.

Remember that cutting the duration of the curtain wall system is just one step in this acceleration process. The main reason of striving for an earlier water tight date is to allow the finish trades earlier access to the building. Where is the benefit of having a water tight building in which finish trades cannot work? The benefit is now lost; potential days saved are left on the table. The next step in this analysis is to take a deeper look into the schedule and determine the trades and activities in need of re-sequencing. Once identified, the objective is to sequence these trades in a fashion to keep pace with the curtain wall installation and in turn, allow the finish trades to start the day after curtain wall completion (aka water tight date).

Preface to Sequencing: In the event that a schedule acceleration plan is necessary to recover time, there is one crucial point to remember when dealing with subcontractors, "Never call the schedule acceleration plan, a schedule acceleration plan!" The first thought that comes to mind when the word "acceleration" is spoken, is money. Subcontractors mold this word to portray that you are pushing them faster than originally planned and they should be compensated. This becomes the job of the GC to take the word "acceleration" and mold it back. Delivery should be along the lines of:

"We are sequencing trades in a manner to produce the maximum output for all involved."

For the purpose of this analysis, schedule acceleration will still be used. However, in a real world application it is critical to remember that the plan is only as effective as its execution.

E. Sequencing

The sequencing plan will need to work backwards starting with the reduction in curtain wall duration. Since the goal at hand is to allow earlier access to the finish trades, further analysis will look into its predecessors: MEP Rough Ins.

MEP rough ins are now placed on the critical path due to the reduction in curtain wall installation. To remedy this, MEP rough-in activities will need to be brought on site at an earlier date. By reducing the curtain wall duration to 20 days, the MEP rough ins will need to begin a week ahead of schedule.

MEP trades will begin being stacked on the 3^{rd}, 4^{th} and 5^{th} floor for rough ins and finishes. Although this is an unfavorable condition, this was the means of acceleration stated by the GC and provided in the Schedule Acceleration section of Technical Assignment 3.

Overall the schedule will be reduced by 44 days. See Appendix H for the accelerated schedule and Appendix I for the accelerated schedule critical path.

F. Constructability

The installation of the curtain wall system is straightforward: executed elevation by elevation. Installing curtain wall floor by floor was contemplated at first which would allow finish trades even earlier access to the building. This option was quickly discredited when the thought of multiple crews, multiple cranes or multiple crane moves were considered. The cost increase would not justify the schedule acceleration. Returning to the original sequence of installing curtain wall elevation by elevation was selected as the best option.

Installation will begin on the west elevation of the STEM Building and continue counterclockwise to the south elevation where majority of the curtain exists. See Figure 45 for reference below which was modified from the enclosure site plan generated for Technical Assignment Two.

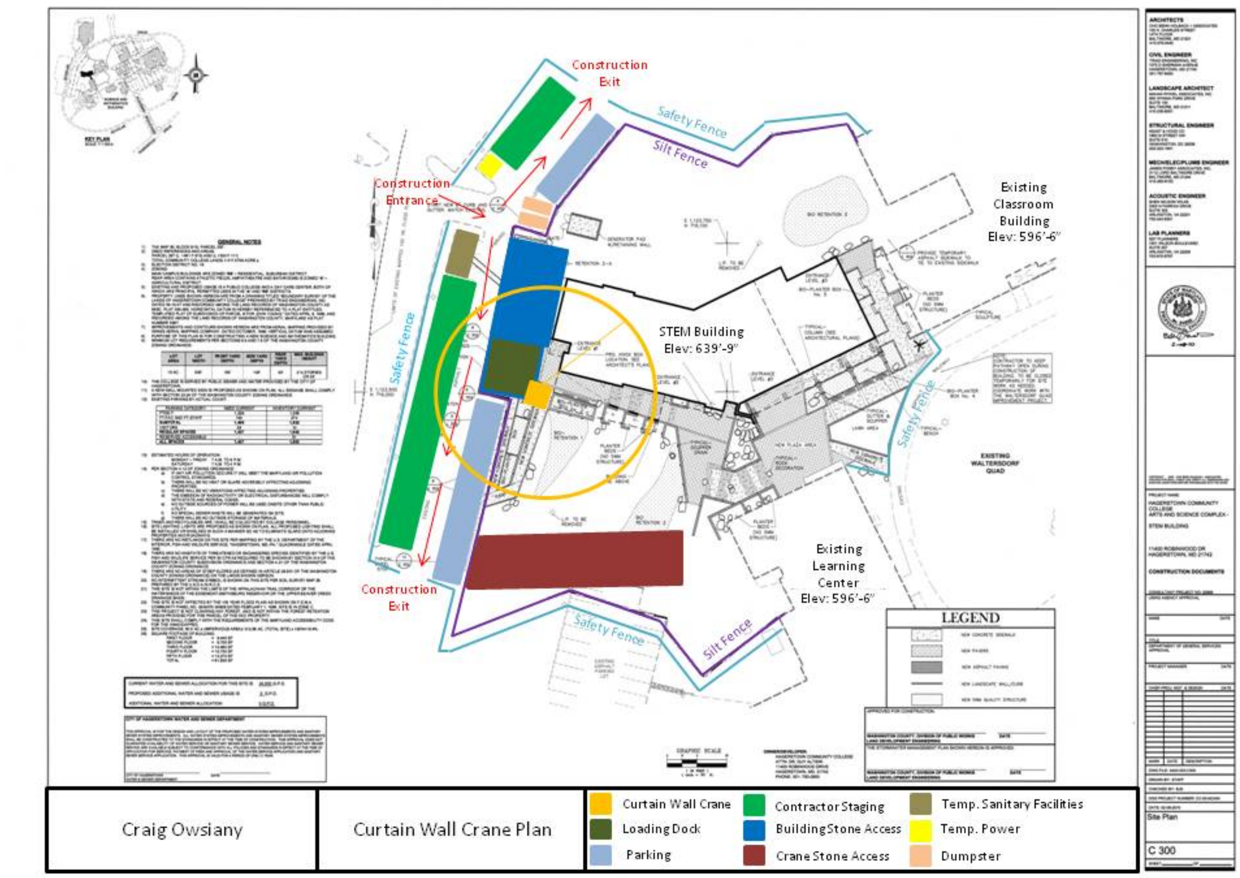


Figure 45: Curtain Wall Crane Starting Location

Six crane moves will be necessary to complete the installation of the curtain wall. Images displaying these locations can be seen in Appendix E. The question may be asked as to why the installation cannot be completed with only four crane moves. The answer is in the means and methods of installation. A crane will be used with suction cups to lift the modules into place. Therefore, the crane must be on the same side of the building as the installation. In addition, installers will be in a bucket lift at the perimeter of the building for installation. Crane picks over workers is an unfavorable situation and should be avoided if possible for safety measures.

The decision to start on the west elevation was determined by the jobsite entrance location. In order to keep crane moves minimal, it is best to have installation commence at the area of where the crane enters the site. The crane will make a full lap around the building and be able to leave the site in the same fashion; completing the curtain wall installation.

G. Coordination

The coordination involved for installing a unitized system is the same as the stick built system. However attention to detail may shift in some areas. One change arises amongst the allowable tolerances of the two systems and their neighboring enclosure materials. The next is site logistics.

Throughout the STEM Building, curtail wall will be set in CMU openings, concrete openings and cold-formed metal framing (exterior metal framing) openings. These materials have a lower tolerance when installing a unitized system compared to the stick built system. The stick built system offers a little more flexibility since the framing is performed in the field where adjustments can be made. The unitized system requires the concrete, CMU and exterior framing to be installed with high precision since all framing is performed in shop where dimension are off of shop drawings.

Site logistics are of higher concern for the unitized system because of site access. First off, a larger truck will need to be used to deliver the modules. A larger crane will also need to be used due to the weight of the system. Both of these factors need to be accounted for to ensure enough site access and staging is available.

H. Estimating

The unitized system proposed in this analysis does, however, bear a higher upfront cost compared to the stick built system. Typically, a unitized system will cost approximately 10% more than a stick built system. This number was generated using knowledge provided by Hess' estimating department and Greg Ramirez, Hess Senior Project Manager for the STEM Building.

The increase in cost is easily justified by the higher quality of the end product and reductions in schedule. Stick built systems have a much greater chance of leakage than the unitized system. The cost of repair will far exceed that of the 10% increase. The even greater benefit lies in the schedule reduction. Each day reduced from the overall schedule is a substantial cost saving to all involved. Finishing a project ahead of schedule can greatly enhance your chances of performing future work for the same owner. Now that you are tried and tested, the owner will feel comfortable using your services again.

Appendix A

Stair Shaft 1 Cost Calculations

• John Alexander from TBH concrete
∟ 410-848-9030 ext 231

Concrete Prices

Lean $80 CY 2000 psi - state tax
Normal Weight $92 4000psi - state tax

- winter service charge $3 yard
- non chloride accel. 1% added
  ∟ 40s & 50's
  ∟ 2%

$5 per yard per percent

- retarding admixtures

- adding ice to concrete
to keep below 90°

40lb bag in a yard $12 per bag
$.30/lb
1 bag lowers a ~3 few degrees

380
380

How many CY per lift?

Mat Slab Redesign

- Schedule
- Sequencing
- Coordination
- Estimating - savings on concrete
- Structural Breadth - only .07% increase in weight (minimal) - compared to design load

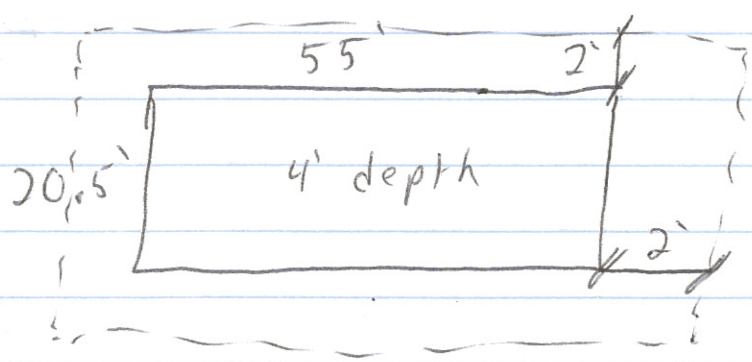
8000 psf for competent rock
? psf for compacted soil
? psf for stone backfill

Cost of lean concrete - ~ ~~$126~~ $80/CY 2000 psi
Cost of normal weight concrete - $92 4000 psi

4 x 55 x 20.5' = 4510 ft³
↳ 167 CY

1 CY = 27 ft³

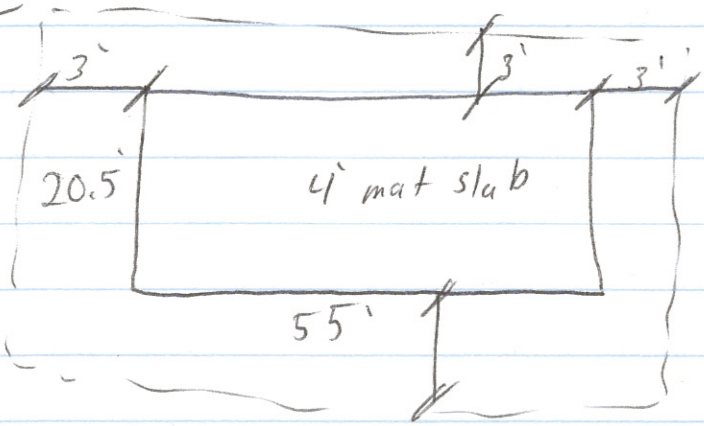
5' x 55' x 20.5' = 5637.5
↳ 209 CY



~~Pro~~

Triad Solution

Materials



5' lower than expected

$(55+6) \times (20.5+6') \times 5 = 8082.5/27 = 299.3$

~ 300 CY

~~8~~ 300 CY × 1 truck load / 8 CY = 37.5 truck loads

how many lifts?

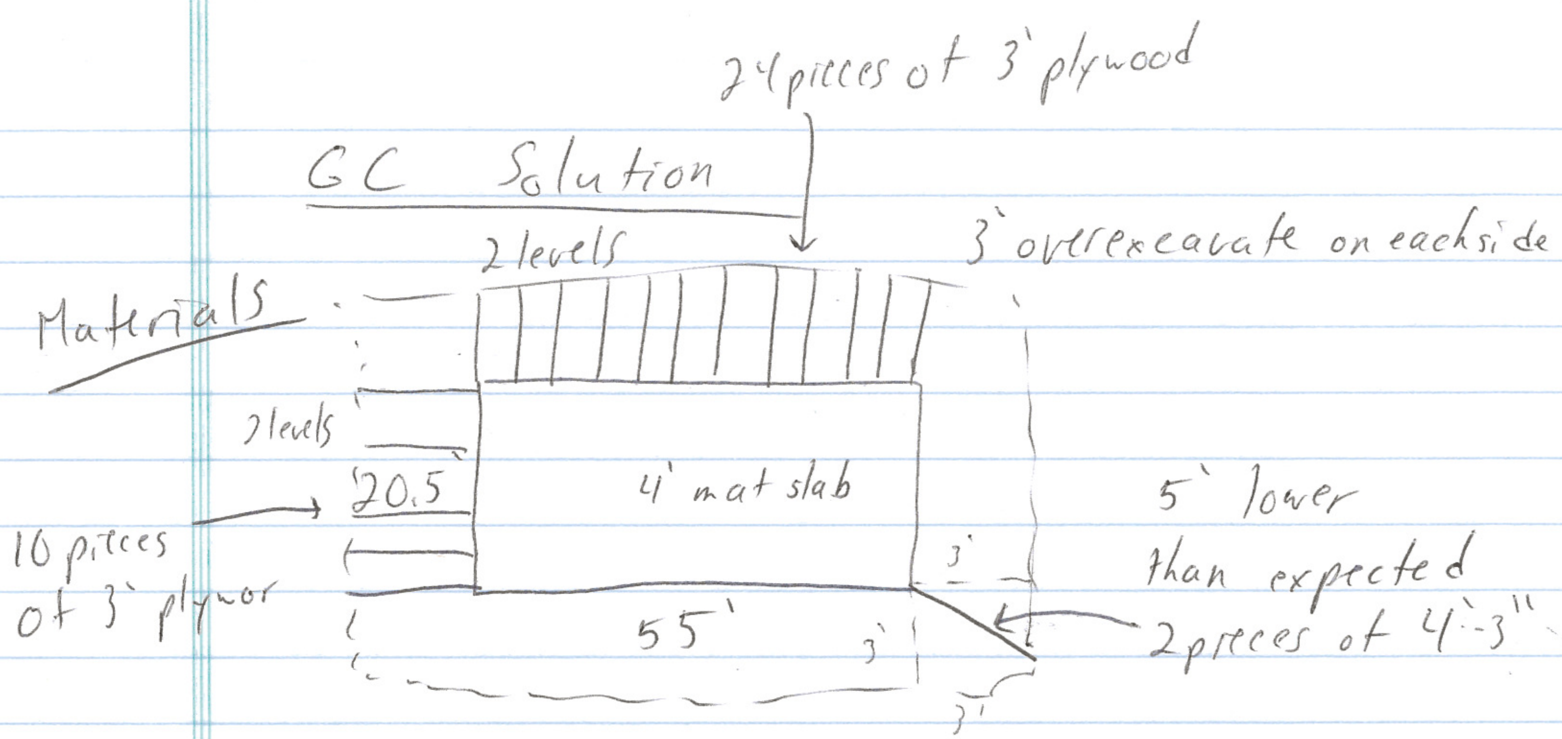
- add winter fee
- ~~add~~ - cold admixtures
- base cost
- time of travel

300 CY × $126 / 1 CY = $37800

Labor Cost ....

GC Solution

Materials



Lean

$20.5 \times 55 \times 5 = 5637.5 / 27 = 208.8 \sim 209\ CY$

$209\ CY \times \frac{1\ \text{truck load}}{8\ CY} = 26.125 \sim$ (27 truck loads)

$\boxed{209\ CY} \times \frac{\$126}{1\ CY} =$ ($26,334)

how many lifts

Formwork

plywood, lumber, nails, ties

~~$(20.5 \times 2) + 55$~~

Plywood → $(20.5' \times 5' \times 2) + (55' \times 5' \times 2) = 755\ ft^2$ plywood

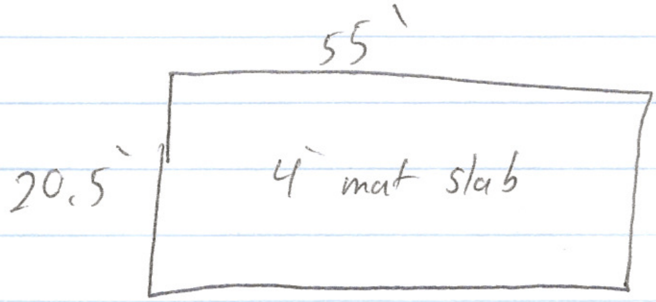
Lumber → $(24 \times 2 \times 3') + (10 \times 2 \times 3') + (8 \times 4.25') = 238$ ft lumber

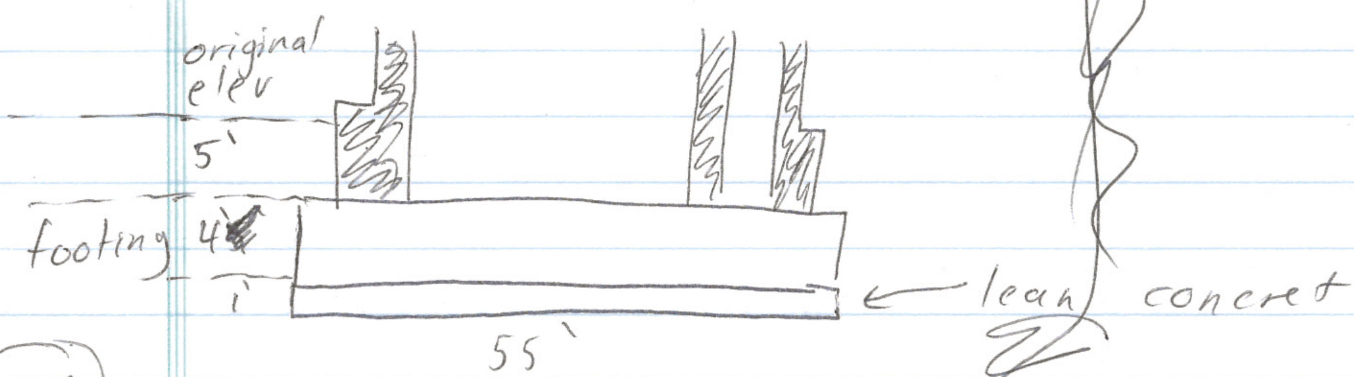
$755\ ft^2 \times \frac{\$1.41}{ft^2} =$ ($1064.55) $238\ ft$ (2x4s) $\times \frac{\$.30}{ft} =$ ($71.4)

Labor Cost - - -

~~recalculate length ~ 125 ft~~

Proposed Solution



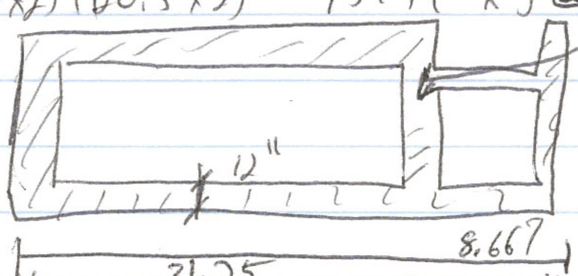


Lean → formwork

1' × 55' × 20.5' = 1127.5 ft³/27 = 42 CY/8 = 5.25 ~ 6 (6 truck loads)

1(55×2) + (20.5×2) = 151 ft² × 5

42 CY × $126/CY = $5292



Form work
42.583 × 2 × 5'
= 426 ft²

NW 1'-8" foundation wall

length = 1' + 31'-3" + .833' + 8'-8" + .833
= 42.583' (42'-7")

44.583' × 1.667' × 5' = 372 ft³ × 150 lbs/ft³ = 55800 lbs
length width depth

1'-6" foundation wall

length = 10.833 + .667 + 31.25 + .667 + 10.883 + 8.667 + 11'
= 74.017

74.017' × 1.5' × 5' = 555 ft³ × 150 lbs/ft³ = 83250 lbs

Appendix B

Stair Shaft 1

Live and Dead Load Calculations

1st Floor

Dead Loads					
	Square Feet	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Compacted Soil (4')	1127.5	4510.0	440.0	110.0	496100.0
Concrete-Normal Weight (5")	333.3	138.9	62.5	150.0	20834.0
Concrete-Normal Weight (10")	64.2	930.4	2175.0	150.0	139562.5
Concrete-Normal Weight (12")	42.5	616.3	2175.0	150.0	92437.5
Concrete-Normal Weight (18")	115.5	375.4	487.5	150.0	56306.3
Concrete-Normal Weight (20")	70.8	230.2	487.5	150.0	34531.3
Stairs (20")	222.3	370.6	250.0	150.0	55585.9
Curtain Wall & Metal Panels	100.0		10.0		1000.0
Brick Veneer	1002.0		22.0		22044.0

Live Loads					
	Square Feet	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Stairs	222.3		100.0		22234.4

2nd Floor

Dead Loads					
	Square Feet	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Concrete-Normal Weight (10")	64.2	930.4	2175.0	150.0	139562.5
Concrete-Normal Weight (12")	42.5	616.3	2175.0	150.0	92437.5
Concrete-Light Weight (4 1/4")	404.9		41.3	110.0	16704.1
Beams	404.9		5.0		2024.7
Stairs (20")	222.3		250.0	150.0	55585.9
Curtain Wall & Metal Panels	100.0		10.0		1000.0
Brick Veneer	1002.0		22.0		22044.0
Ceiling	404.9		5.0		2024.7
Partitions	404.9		15.0		6074.2
HVAC & Plumbing	404.9		10.0		4049.5

Live Loads					
	Square Footage	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Corridors 3rd Floor & Below	404.9		100.0		40494.8
Stairs	222.3		100.0		22234.4

3rd Floor

Dead Loads					
	Square Footage	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Concrete-Normal Weight (10")	51.7	749.2	2175.0	150.0	112375.0
Concrete-Normal Weight (12")	36.0	522.0	2175.0	150.0	78300.0
Concrete-Light Weight (4 1/4")	1609.9		41.3	110.0	66410.4
Beams	1609.9		5.0		8049.7
Stairs (20")	222.3		250.0	150.0	55585.9
Curtain Wall & Metal Panels	435.0		10.0		4350.0
Ceiling	1609.9		5.0		8049.7
Partitions	1609.9		15.0		24149.2
HVAC & Plumbing	1609.9		10.0		16099.5
Cistern		500.0		62.0	31000.0

Live Loads					
	Square Feet	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Corridors 3rd Floor & Below	404.9		100.0		40494.8
Classrooms	1315.5		40.0		52620.0
Stairs	222.3		100.0		22234.4

4th Floor

Dead Loads					
	Square Footage	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Concrete-Normal Weight (10")	51.7	749.2	2175.0	150.0	112375.0
Concrete-Normal Weight (12")	36.0	522.0	2175.0	150.0	78300.0
Concrete-Light Weight (4 1/4")	1720.9		41.3	110.0	70989.1
Beams	1720.9		5.0		8604.7
Stairs (20")	222.3		250.0	150.0	55585.9
Curtain Wall & Metal Panels	435.0		10.0		4350.0
Ceiling	1852.9		5.0		9264.7
Partitions	1720.9		15.0		25814.2
HVAC & Plumbing	1852.9		10.0		18529.5

Live Loads					
	Square Feet	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Corridors Above 3rd Floor	404.9		80.0		32395.9
Classrooms	1315.5		40.0		52620.0
Stairs	222.3		100.0		22234.4

5th Floor

Dead Loads					
	Square Footage	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Concrete-Normal Weight (10")	51.7	749.2	2175.0	150.0	112375.0
Concrete-Normal Weight (12")	36.0	522.0	2175.0	150.0	78300.0
Concrete-Light Weight (4 1/4")	1852.9		41.3	110.0	76434.1
Beams	1852.9		5.0		9264.7
Stairs (20")	222.3		250.0	150.0	55585.9
Curtain Wall & Metal Panels	638.0		10.0		6380.0
Brick Veneer	1102.0		22.0		24244.0
Green Roof	1447.5		91.7	110.0	132687.5
Ceiling	1852.9		5.0		9264.7
Partitions	1852.9		15.0		27794.2
HVAC & Plumbing	1852.9		10.0		18529.5

Live Loads					
	Square Footage	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Corridors Above 3rd Floor	404.9		80.0		32395.9
Stairs	222.3		100.0		22234.4

Roof

Dead Loads					
	Square Footage	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Concrete-Normal Weight (10")	51.7	749.2	2175.0	150.0	112375.0
Concrete-Normal Weight (12")	36.0	522.0	2175.0	150.0	78300.0
Concrete-Light Weight (4 1/4")	516.1		41.3	110.0	21290.0
Beams	516.1		5.0		2580.6
Stairs (20")	111.2		250.0	150.0	27793.0
Curtain Wall & Metal Panels	638.0		10.0		6380.0
Brick Veneer	1102.0		22.0		24244.0

Live Loads					
	Square Footage	Cubic Feet	Load (psf)	Load (pcf)	Total (lbs)
Corridors Above 3rd Floor	404.9		80.0		32395.9
Stairs	111.2		100.0		11117.2

Appendix C

ASCE Minimum Design Loads for Buildings and Other Structure

Chapter 2: Combination of Loads

Page 5

ASCE STANDARD

ASCE/SEI 7–05

Includes Supplement No. 1 and Errata

Minimum Design Loads for Buildings and Other Structures

This document uses both the International System of Units (SI) and customary units

ASCE

SEI
Structural Engineering Institute
of the American Society of Civil Engineers

Chapter 2
COMBINATIONS OF LOADS

2.1 GENERAL

Buildings and other structures shall be designed using the provisions of either Section 2.3 or 2.4. Either Section 2.3 or 2.4 shall be used exclusively for proportioning elements of a particular construction material throughout the structure.

2.2 SYMBOLS AND NOTATION

D = dead load
D_i = weight of ice
E = earthquake load
F = load due to fluids with well-defined pressures and maximum heights
F_a = flood load
H = load due to lateral earth pressure, ground water pressure, or pressure of bulk materials
L = live load
L_r = roof live load
R = rain load
S = snow load
T = self-straining force
W = wind load
W_i = wind-on-ice determined in accordance with Chapter 10

2.3 COMBINING FACTORED LOADS USING STRENGTH DESIGN

2.3.1 Applicability. The load combinations and load factors given in Section 2.3.2 shall be used only in those cases in which they are specifically authorized by the applicable material design standard.

2.3.2 Basic Combinations. Structures, components, and foundations shall be designed so that their design strength equals or exceeds the effects of the factored loads in the following combinations:

1. $1.4(D + F)$
2. $1.2(D + F + T) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R)$
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.8W)$
4. $1.2D + 1.6W + L + 0.5(L_r \text{ or } S \text{ or } R)$
5. $1.2D + 1.0E + L + 0.2S$
6. $0.9D + 1.6W + 1.6H$
7. $0.9D + 1.0E + 1.6H$

EXCEPTIONS:

1. The load factor on L in combinations (3), (4), and (5) is permitted to equal 0.5 for all occupancies in which L_o in Table 4-1 is less than or equal to 100 psf, with the exception of garages or areas occupied as places of public assembly.
2. The load factor on H shall be set equal to zero in combinations (6) and (7) if the structural action due to H counteracts that due to W or E. Where lateral earth pressure provides resistance to structural actions from other forces, it shall not be included in H but shall be included in the design resistance.
3. In combinations (2), (4), and (5), the companion load S shall be taken as either the flat roof snow load (p_f) or the sloped roof snow load (p_s).

Each relevant strength limit state shall be investigated. Effects of one or more loads not acting shall be investigated. The most unfavorable effects from both wind and earthquake loads shall be investigated, where appropriate, but they need not be considered to act simultaneously. Refer to Section 12.4 for specific definition of the earthquake load effect E.[1]

2.3.3 Load Combinations Including Flood Load. When a structure is located in a flood zone (Section 5.3.1), the following load combinations shall be considered:

1. In V-Zones or Coastal A-Zones, $1.6W$ in combinations (4) and (6) shall be replaced by $1.6W + 2.0F_a$.
2. In noncoastal A-Zones, $1.6W$ in combinations (4) and (6) shall be replaced by $0.8W + 1.0F_a$.

2.3.4 Load Combinations Including Atmospheric Ice Loads. When a structure is subjected to atmospheric ice and wind-on-ice loads, the following load combinations shall be considered:

1. $0.5(L_r \text{ or } S \text{ or } R)$ in combination (2) shall be replaced by $0.2D_i + 0.5S$.
2. $1.6W + 0.5(L_r \text{ or } S \text{ or } R)$ in combination (4) shall be replaced by $D_i + W_i + 0.5S$.
3. $1.6W$ in combination (6) shall be replaced by $D_i + W_i$.

2.4 COMBINING NOMINAL LOADS USING ALLOWABLE STRESS DESIGN

2.4.1 Basic Combinations. Loads listed herein shall be considered to act in the following combinations; whichever produces the most unfavorable effect in the building, foundation, or structural member being considered. Effects of one or more loads not acting shall be considered.

1. $D + F$
2. $D + H + F + L + T$
3. $D + H + F + (L_r \text{ or } S \text{ or } R)$
4. $D + H + F + 0.75(L + T) + 0.75(L_r \text{ or } S \text{ or } R)$
5. $D + H + F + (W \text{ or } 0.7E)$
6. $D + H + F + 0.75(W \text{ or } 0.7E) + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$
7. $0.6D + W + H$
8. $0.6D + 0.7E + H$

[1] The same E from Section 12.4 is used for both Sections 2.3.2 and 2.4.1. Refer to the Chapter 11 Commentary for the Seismic Provisions.

Appendix D

Design Information Material Properties

APPENDIX B

Design Information Material Properties

Table B.1 Dead Loads for Masonry Walls

Solid Masonry Units	Weight per inch of wall thickness				
Clay Masonry	10 lb./ft^2				
Concrete Masonry					
Light Weight	5 lb./ft^2				
Medium Weight	8 lb./ft^2				
Normal Weight	10 lb./ft^2				
Hollow Masonry Unit (Ungrouted)*	**Weight per ft.^{2} of wall area**				
Thickness	4 in.	6 in.	8 in.	10 in.	12 in.
Clay Masonry	22	27	35	43	52
Concrete Masonry					
Light Weight	18	21	28	33	37
Medium Weight	22	26	34	41	47
Normal Weight	30	36	46	56	64
Hollow Masonry Units (Fully Grouted)*	**Weight per ft.^{2} of wall area**				
Thickness	4 in.	6 in.	8 in.	10 in.	12 in.
Clay Masonry	42	65	90	112	135
Concrete Masonry					
Light Weight	26	46	66	82	96
Medium Weight	34	58	82	100	115
Normal Weight	43	71	91	119	140

* For partially grouted masonry, weight of masonry shall be determined on the basis of linear interpolation between hollow units that are ungrouted and fully grouted based on amount of grouting.

Note: 1 in. = 25.4 mm 1 lb/ft^2 = 4.88 kg/m^2

Curtain Wall and Metal Panels → 10 psf combined

Cistern - 110 psf x total Volume

Appendix E

Green Roof Case Study

University of Central Florida

Photo 1 (left): Green roof on April 28, 2005. Photo 2 (right): Green roof on Aug. 18, 2005.

Evaluating Green Roof Energy Performance

Summertime data indicate significantly lower peak roof surface temperatures and higher nighttime surface temperatures for the green roof. The maximum average day temperature seen for the conventional roof surface was 130°F (54°C) while the maximum average day green roof surface temperature was 91°F (33°C), or 39°F (22°C) lower than the conventional roof.

By Jeff Sonne

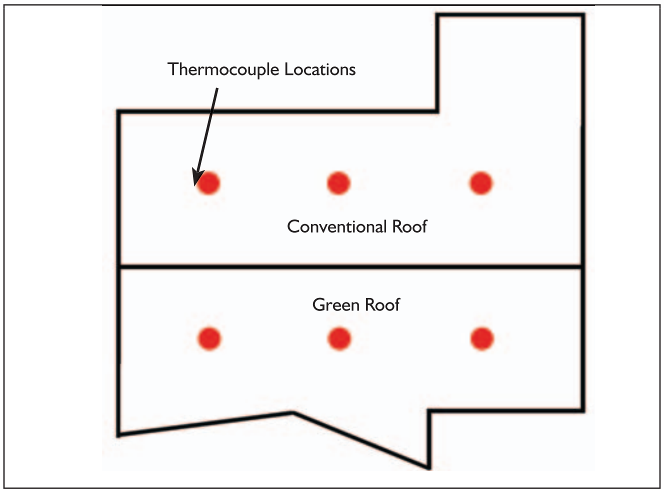
Green or vegetated roofs are becoming more popular in the United States. High profile examples of U.S. green roofs include the Chicago City Hall and Ford Motor Company Dearborn truck plant that has a total green roof area of more than 10 acres (4 ha). Chicago has begun issuing grants to help residential and small commercial building owners install green roofs.

Green roofs have been in use in Europe for centuries and are a more recent phenomenon in the U.S. Germany has emerged as a leader in modern green roof technology and usage where it's estimated that there are more than 800 green roofs that comprise 10% of all flat roofs.[1,2]

In addition to rainwater runoff reduction and aesthetic benefits, studies have found that green roofs significantly reduce roof surface temperatures and heat flux rates. A study in Toronto found that two green roofs with minimal vegetation reduced peak summertime roof membrane temperatures of a gymnasium by more than 35°F (1.6°C) and summertime heat flow through the roof by 70% to 90% compared with a conventional roof on the same building[3]. Simulations also indicate cooling load reductions from green roofs ranging from 1% to 25% depending on building specifics and characteristics of the green roof.[4,5]

This column evaluates a study of a green roof installed on a two-story building addition completed in June at the University of Central Florida. This project is led by the University of Central Florida's Stormwater Management Academy through a grant from the Florida Department of Environmental Protection. The department, through a U.S. Department of Energy State Energy Program grant, also is funding the author to compare the energy performance of the green and conventional roofs.

One half of this project's 3,300 ft^2 (307 m^2) roof is a conventional, light colored membrane roof (*Photos 1* and *2*). The project half has the same membrane with a green roof of grasses and small plants covering the project surface. It consists of 6 in. to 8 in. (0.15 m to 0.2 m) of plant media and a variety of primarily native Florida vegetation up to approximately 2



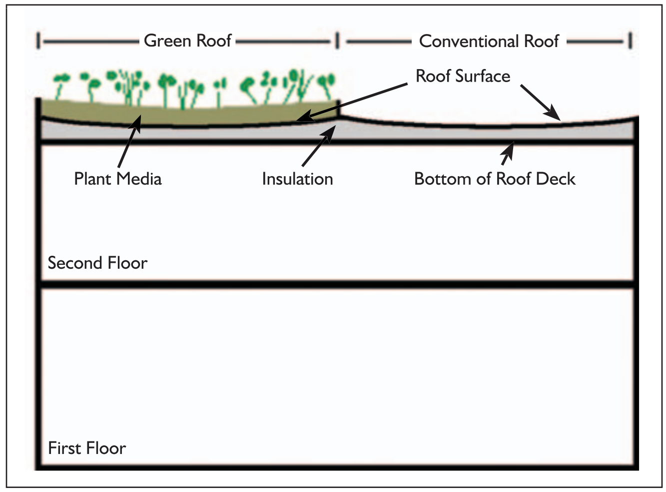


Figure 1 (left): Roof diagram with sensor locations. Figure 2 (right): Building section diagram.

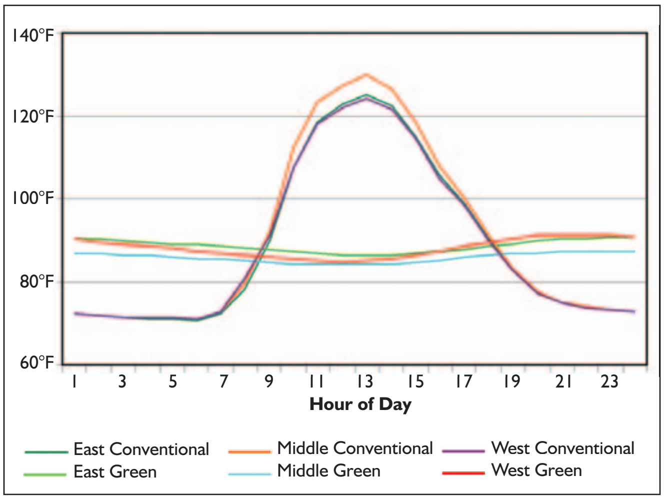


Figure 3: Comparison of average roof surface temperatures.

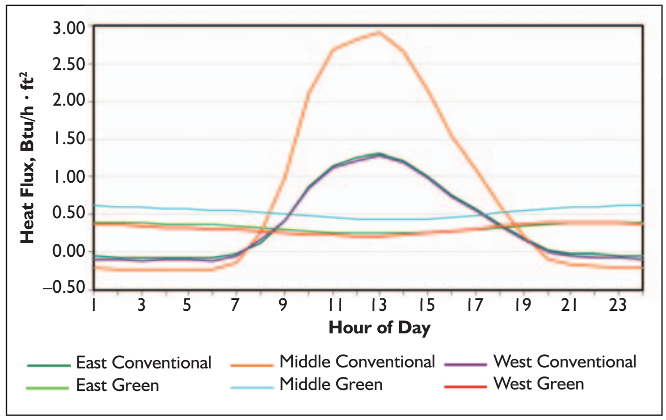


Figure 4: Comparison of average roof heat fluxes.

ft (0.6 m) in height. The green roof is irrigated twice a week for approximately 15 minutes each time, with collected rainwater when available. Roof surface solar reflectance tests were conducted Aug. 18 for the conventional and green roofs according to ASTM Standard E1918-97 methodology.[6] The conventional and green roof reflectances were found to be 58% and 12%, respectively.

The energy aspects of this study focus on roof temperature and heat flux comparisons between the conventional, light-colored membrane half of the roof and the green roof. Roof geometry and drainage were designed to allow both the conventional and green roofs to have similar "mirror image" insulation levels and corresponding temperature sensor locations as shown in the roof surface and building section diagrams (*Figures 1* and *2*).

Temperature measurements include the roof surface, bottom of roof deck, interior air and green roof plant media surface. Meteorological measurements include ambient air temperature, total horizontal solar radiation, rainfall, wind speed and wind direction. All sensors are sampled every 15 seconds and measurements are averaged or totaled every 15 minutes. Monitoring began in July 2005 and will continue through July 2006.

Summertime data indicate significantly lower peak roof surface temperatures and higher nighttime surface temperatures for the green roof. *Figure 3* compares the conventional and green roof surface temperatures for each of the six measurement locations (three conventional roof and three green roof) between July 4 and Sept. 1. The maximum average day temperature seen for the conventional roof surface was 130°F (54°C) while the maximum average day green roof surface temperature was 91°F (33°C), or 39°F (22°C) lower than the conventional roof. A significant shift occurs during peak temperature time periods. Peak surface temperatures for the conventional roof occur around 1 p.m. while the peak green roof surface temperatures occur around 10 p.m.

The minimum average roof surface temperature was 71°F (22°C) for the conventional roof and 84°F (29°C) for the green roof. The conventional roof's lower nighttime temperatures are due to its surface being directly exposed to the night sky while the green roof surface is covered with plants.

Initial heat flux estimates have also been made for each of the six roof measurement locations for the same period. Heat flux is

Location	Approx. R-Value	Avg. Green Roof Flux, Btu/h · ft²	Avg. Conventional Roof Flux, Btu/h · ft²
East	38	0.33	0.36
Middle	17	0.53	0.74
West	38	0.31	0.34

Table 1: Average heat flux estimates for July 4, 2005, through Sept. 1, 2005.

calculated from roof surface and bottom of roof deck temperature measurements and estimated insulation R-values, which because of drainage taper, range from approximately R-15 at the drains to R-60 at the east and west ends of each roof. *Figure 4* shows roof heat flux rates for the average day. Heat flux rates for the conventional roof peak in the early afternoon at approximately 2.9 Btu/h · ft² (9.15 W/m²) (at the middle sensor location) while the green roof peaks around midnight at approximately 0.6 Btu/h · ft² (1.89 W/m²) (also at the middle sensor location).

Table 1 shows average heat flux rates over the July 4 through September 1 monitored period. The weighted average heat flux rate over the period for the green roof is 0.39 Btu/h · ft² (1.23 W/m²) or 18.3% less than the conventional roof's average heat flux rate of 0.48 Btu/h · ft² (1.51 W/m²), with the most significant differences occurring near the middle of the roofs at the points of lowest insulation.

Estimating building energy use impacts from green roofs is somewhat involved and dependant on individual building characteristics such as size, use, number of stories and roof/attic design. Side-by-side monitoring studies often are further complicated by submetering issues, since it usually is difficult to separate out HVAC power use for sections of the building under the conventional roof vs. sections under the green roof.

As a rough estimate, assuming all heat gain through the roof must be removed by the AC system, an air-conditioning system efficiency of 10 Btu/h (3 W) per Watt (including fan power and distribution losses) and a total roof area of 3,300 ft² (307 m²), the average energy use to remove the additional heat gain from the conventional roof over the monitored summer period is approximately 700 Watt-hours per day.

Most commercial low slope roofs are darker than the conventional roof used in this study.[7] Thus, if the conventional roof color were more typical, benefits of the green roof would be greater than those seen here. Over time, the green roof's vegetative canopy will continue to spread and likely reduce heat gains while the conventional roof will darken somewhat and absorb more heat. Another solar reflectance test is planned for next summer to document reflectivity changes of both the conventional and green roofs. Additional temperature and heat flux comparisons will also be made at that time to look at corresponding roof performance changes.

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Jeff Sonne is senior research engineer with the Florida Solar Energy Center, Buildings Research Division, in Cocoa.

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Appendix F

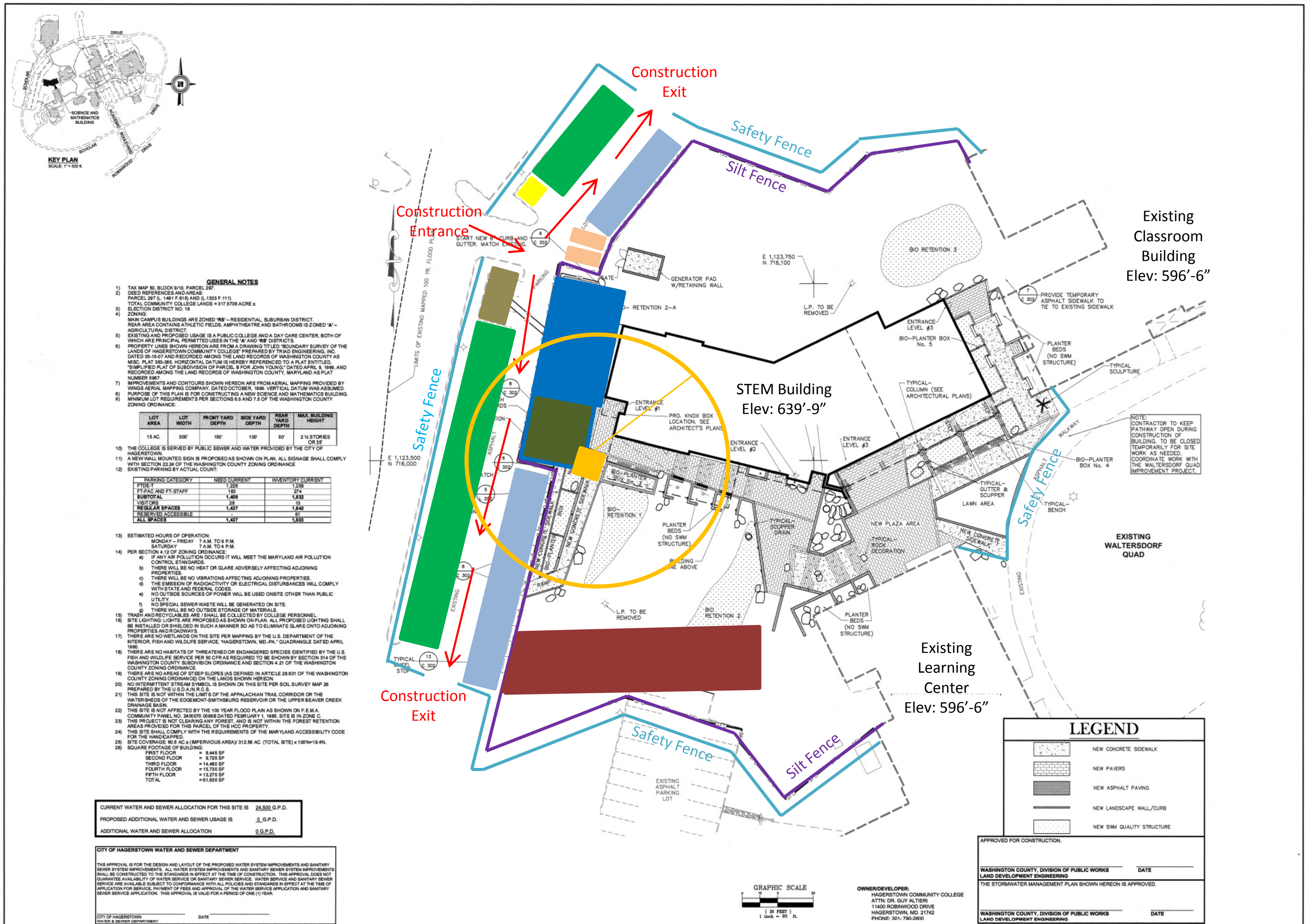
Curtain Wall Takeoffs

Curtain Wall Takeoffs-Pieces								
TYPE	A1/A201 SOUTH PARTIAL	C1/A201 SOUTH PARTIAL	A3/A201 EAST PARTIAL	C3/A201 WEST PARTIAL	A1/A202 NORTH	C1/A202 WEST	C3/A202 EAST	PIECES
W1A						1		1
W1B	2							2
W2	1							1
W3	3							3
W4A	4							4
W4B		6						6
W5A						3		3
W5B	1							1
W6A			6					6
W6B	1							1
W9						2		2
W10					4			4
W11							1	1
W12	2							2
W13	1							1
W13A			6			6		12
W13B			1			1		2
W14		4		2			2	8
W14B							2	2
W15		2		1			1	4
W16		2					1	3
W17		5		1				6
W18							1	1
W19				1				1
W20		2						2
W21		2						2
W22		2						2
Total	15	25	13	5	4	13	8	83

Curtain Wall Takeoffs-SF										
TYPE	SF	A1/A201 SOUTH PARTIAL	C1/A201 SOUTH PARTIAL	A3/A201 EAST PARTIAL	C3/A201 WEST PARTIAL	A1/A202 NORTH	C1/A202 WEST	C3/A202 EAST	TOTAL PIECES	TOTAL SF
W1A	493.2						1		1	493.2
W1B	376.8	1							1	376.8
W2	101.2	1							1	101.2
W3	654.1	1							1	654.1
W4A	602	1							1	602
W4B	1268.5		1						1	1268.5
W5A	616.6						1		1	616.6
W5B	199.3	1							1	199.3
W6A	616.6			1					1	616.6
W6B	199.3	1							1	199.3
W9	440.1						1		1	440.1
W10	888.3					1			1	888.3
W11	186.7							1	1	186.7
W12	215	1							1	215
W13	201.7	1							1	201.7
W13A	5.4			6			6		12	64.8
W13B	5.4			1			1		2	10.8
W14	31.3		4		2			2	8	250.4
W14B	31.3							2	2	62.6
W15	62.5		2		1			1	4	250
W16	93.8		2					1	3	281.4
W17	93.8		5		1				6	562.8
W18	125							1	1	125
W19	125				1				1	125
W20	156.3		1						1	156.3
W21	156.3		1						1	156.3
W22	156.3		1						1	156.3
Total										9261.1

Appendix G

Crane Locations for Curtain Wall Installation



Craig Owsiany	Curtain Wall Crane Plan

Curtain Wall Crane	Contractor Staging	Temp. Sanitary Facilities
Loading Dock	Building Stone Access	Temp. Power
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PROJECT NAME:
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ARTS AND SCIENCE COMPLEX -
STEM BUILDING

11400 ROBINWOOD DR
HAGERSTOWN, MD 21742

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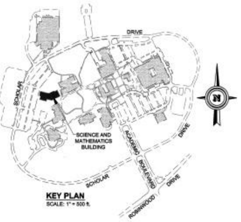
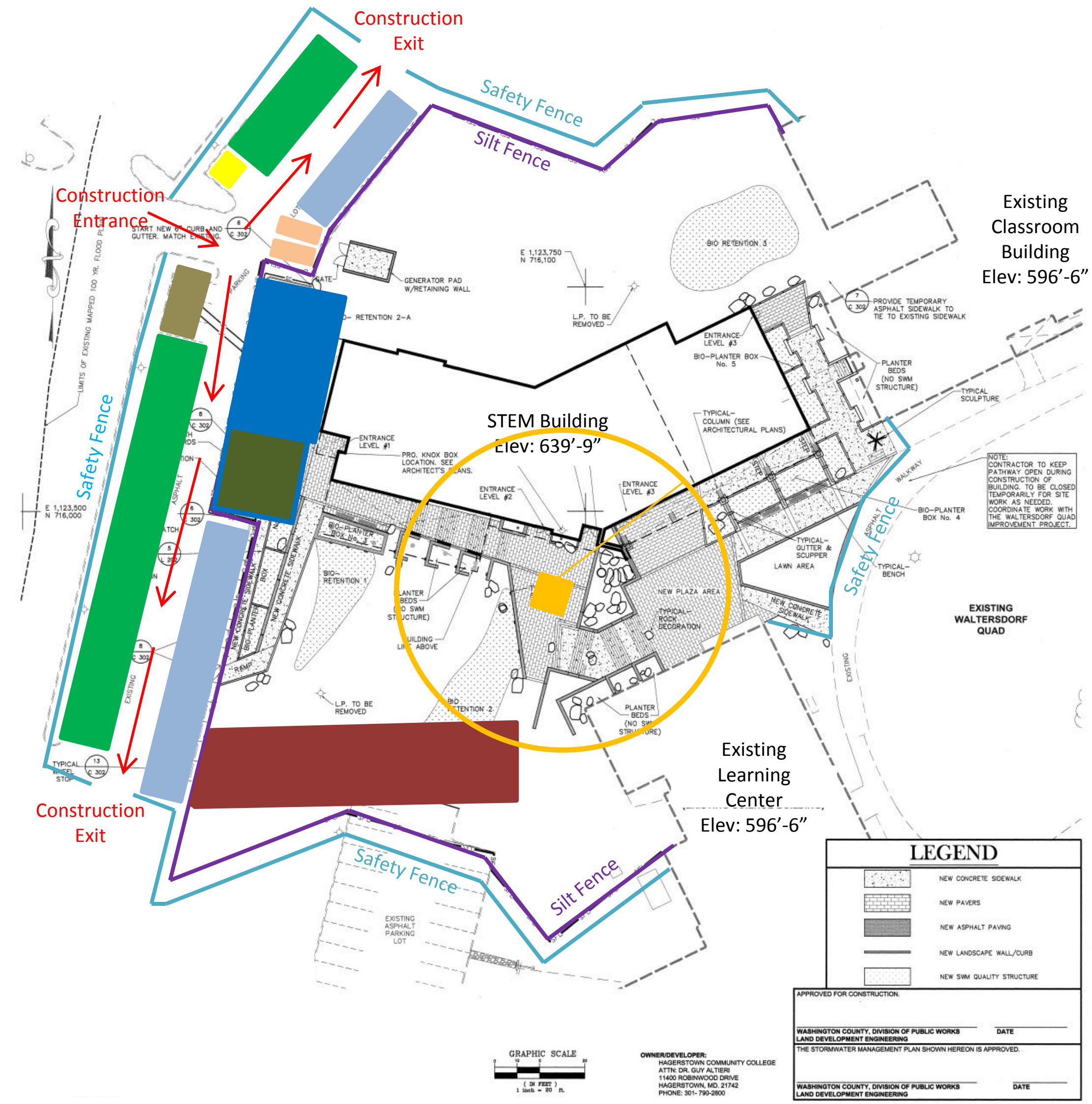
Site Plan

C 300

SHEET____ OF ____





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e) NO OUTSIDE SOURCES OF POWER WILL BE USED ONSITE OTHER THAN PUBLIC UTILITY.
f) NO SPECIAL SEWER WASTE WILL BE GENERATED ON SITE.
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TOTAL = 61,635 SF

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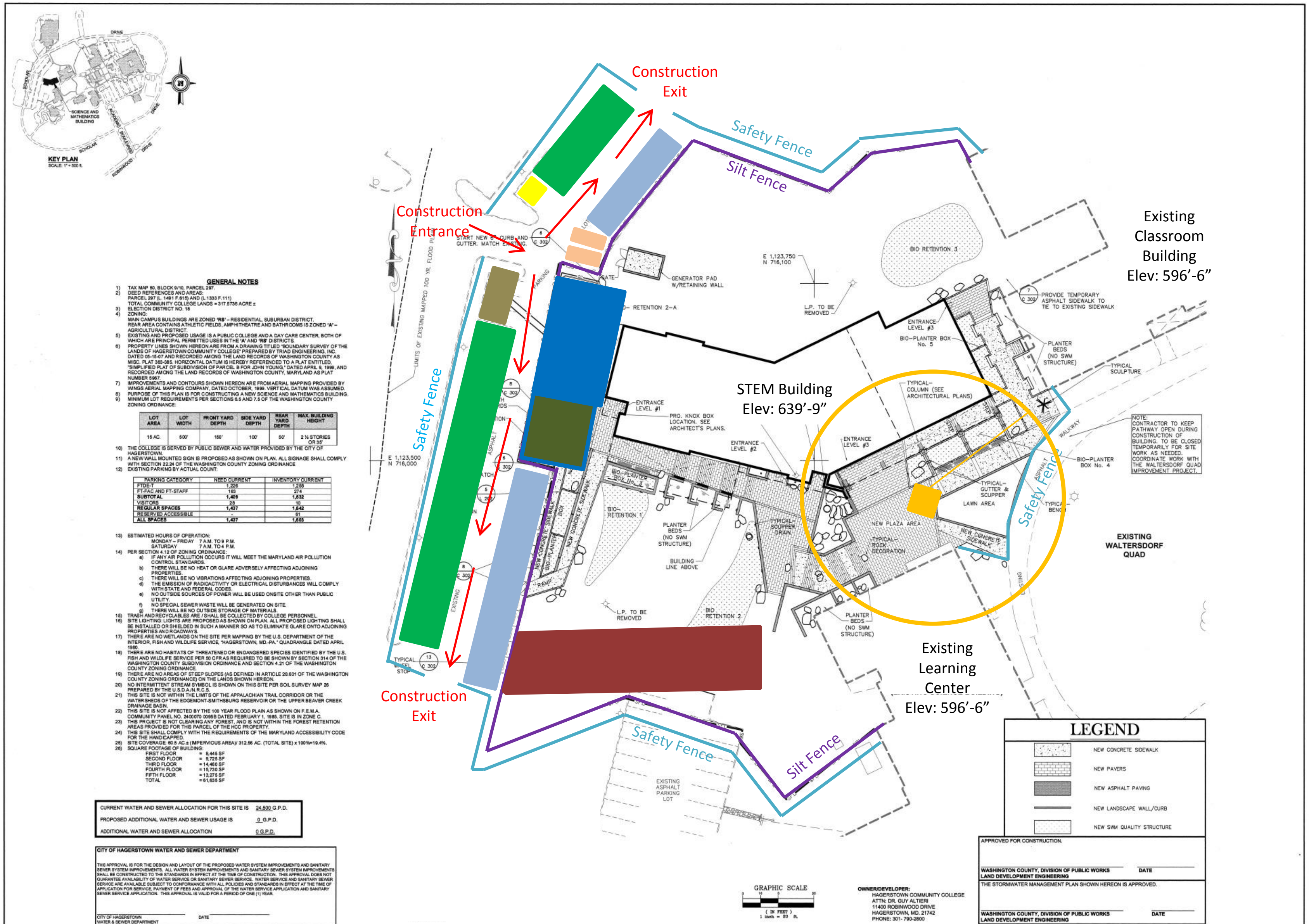

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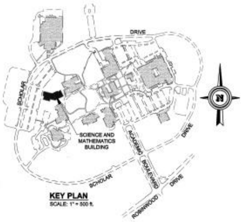

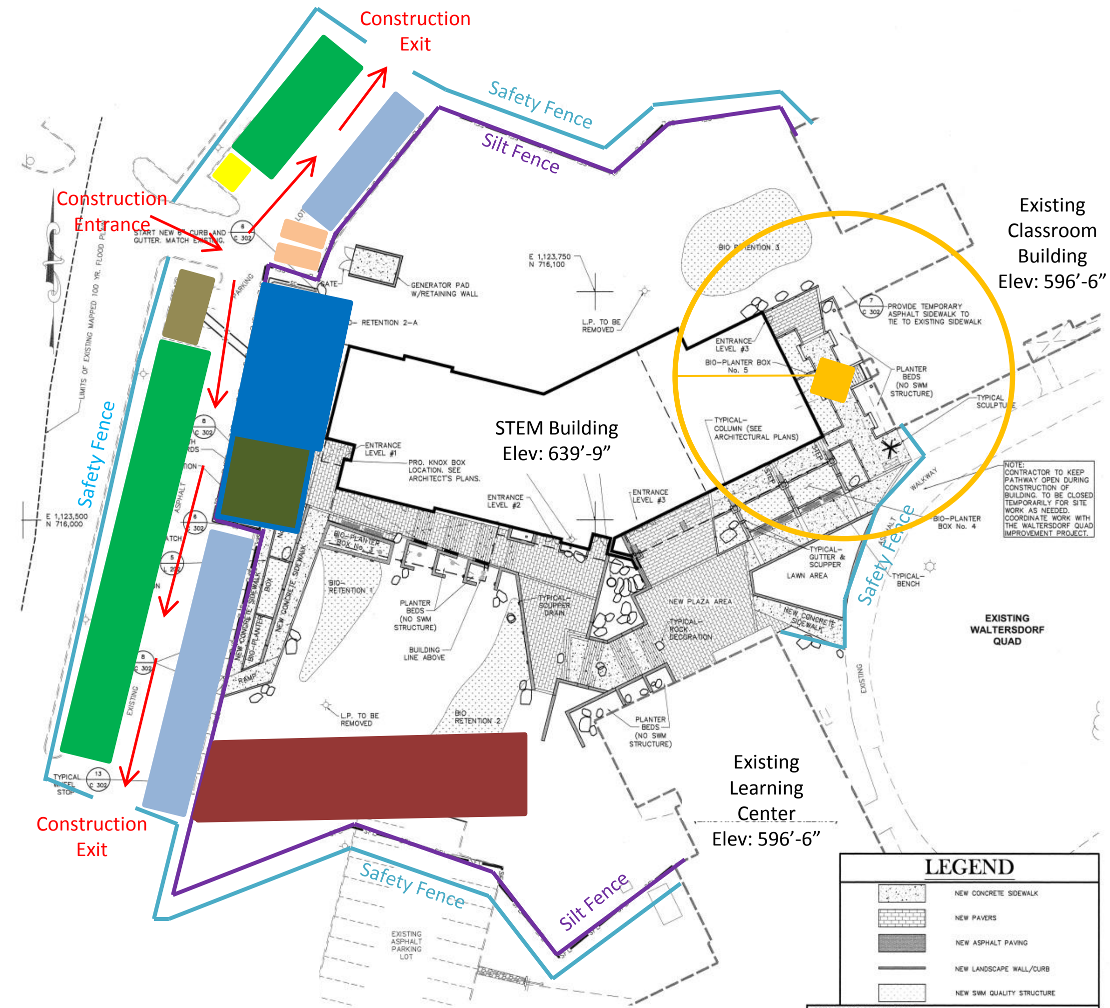

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CITY OF HAGERSTOWN WATER & SEWER DEPARTMENT ____ DATE ____

OWNER/DEVELOPER:
HAGERSTOWN COMMUNITY COLLEGE
ATTN: DR. GUY ALTIERI
11400 ROBINWOOD DRIVE
HAGERSTOWN, MD. 21742
PHONE: 301-790-2800

APPROVED FOR CONSTRUCTION.

WASHINGTON COUNTY, DIVISION OF PUBLIC WORKS LAND DEVELOPMENT ENGINEERING ____ DATE

THE STORMWATER MANAGEMENT PLAN SHOWN HEREON IS APPROVED.

WASHINGTON COUNTY, DIVISION OF PUBLIC WORKS LAND DEVELOPMENT ENGINEERING ____ DATE

Craig Owsiany	Curtain Wall Crane Plan	Curtain Wall Crane	Contractor Staging	Temp. Sanitary Facilities	
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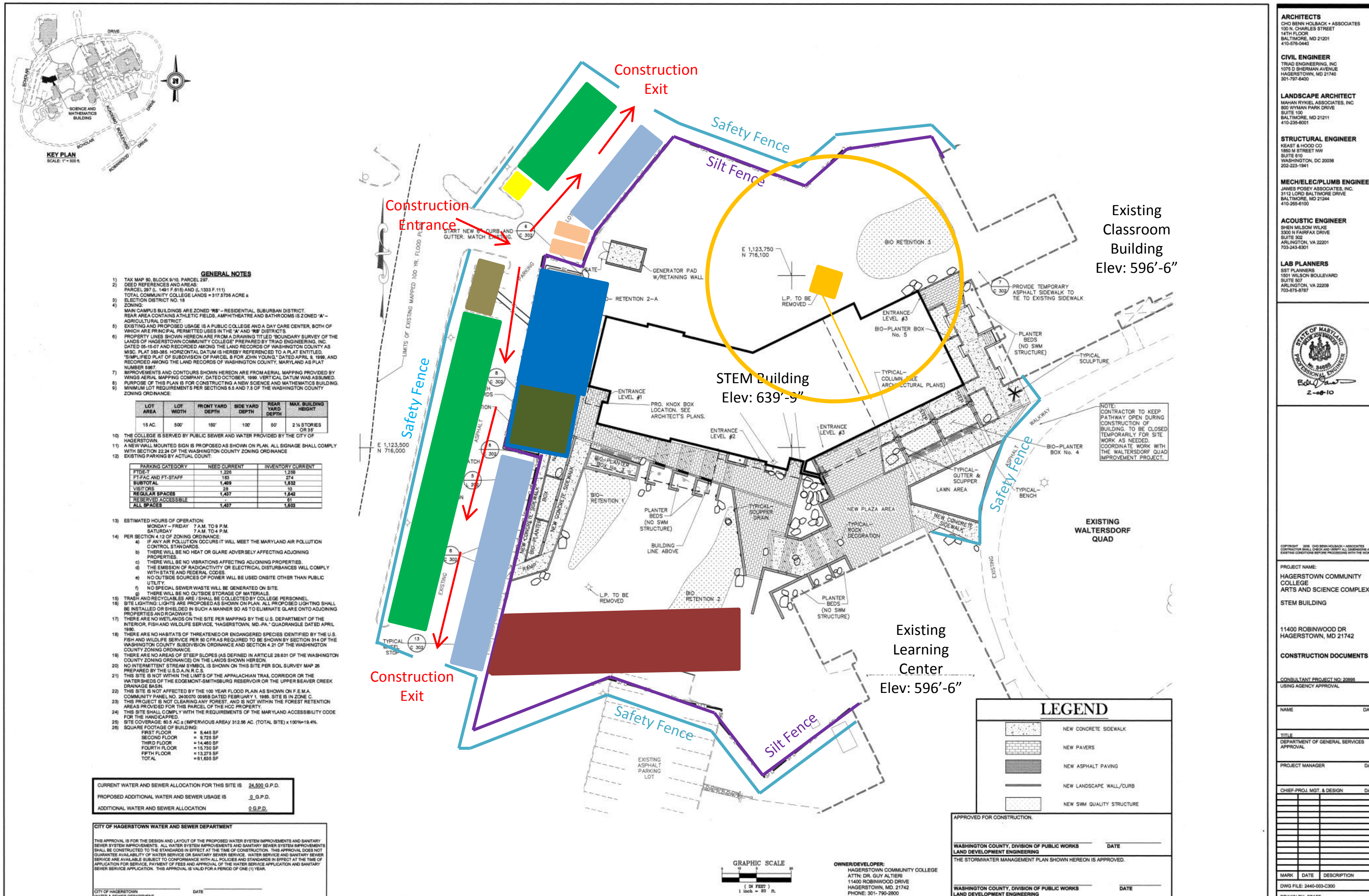

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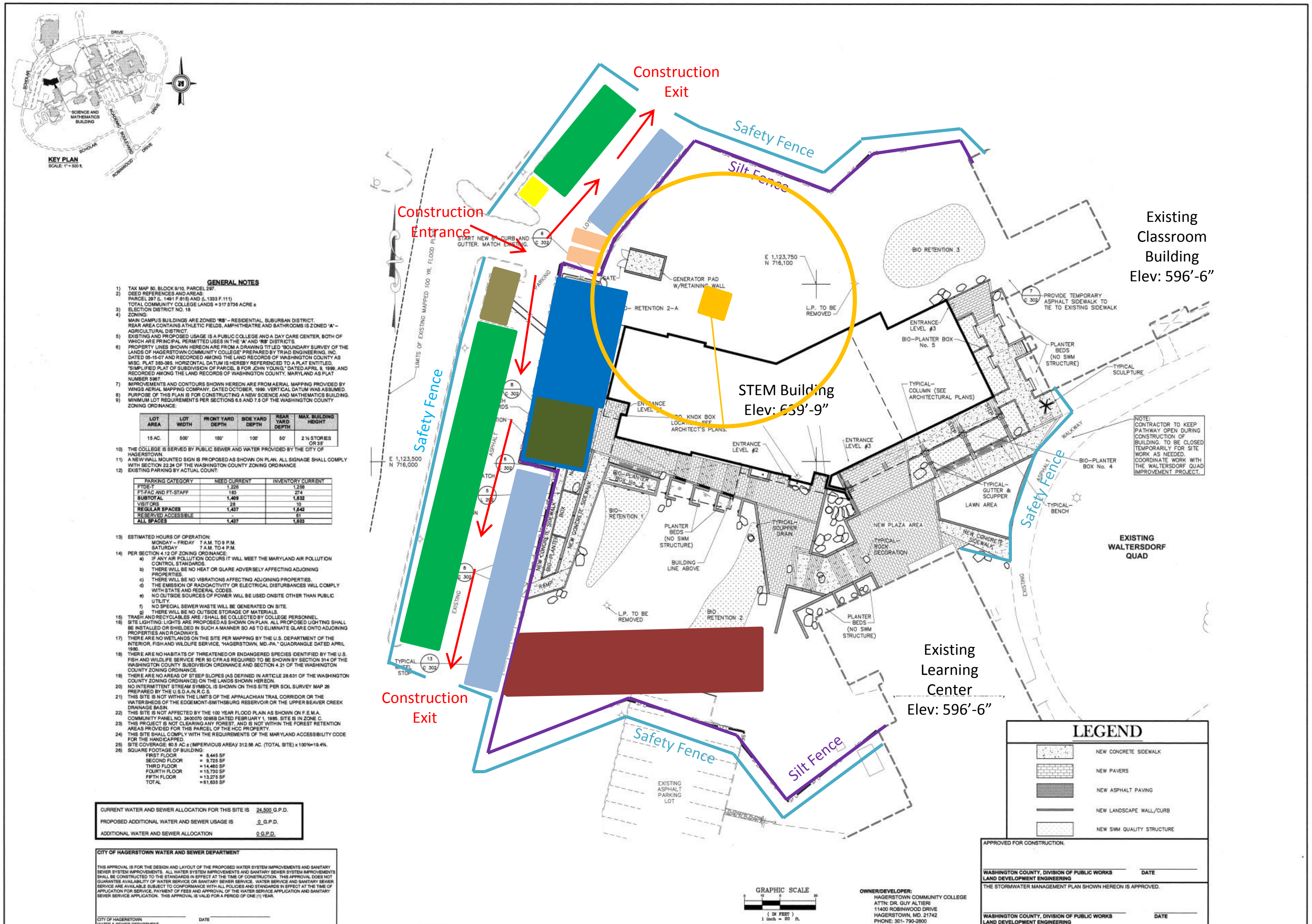

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PROJECT MANAGER DATE
CHIEF-PROJ. MGT. & DESIGN DATE

MARK	DATE	DESCRIPTION

DWG FILE: 2440-003-C300
DRAWN BY: STAFF
CHECKED BY: BJS
DGS PROJECT NUMBER: CC-02-MC404
DATE: 02-08-2010

Site Plan

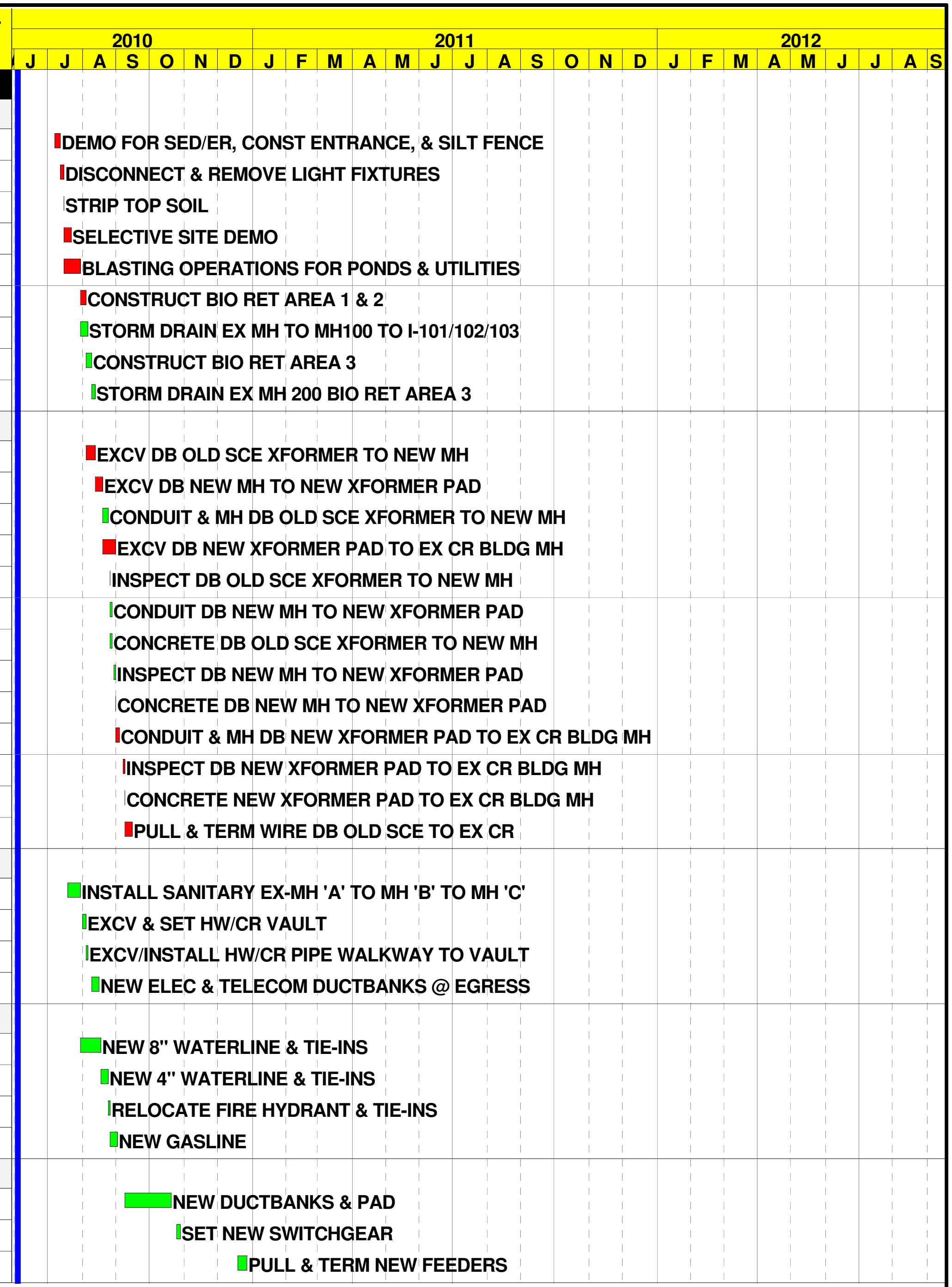
C 300

SHEET ____ OF ____

Appendix H

Accelerated Schedule

Activity ID	Activity Description	OD	ES	EF	TF
INITIAL SITEWORK					
INIITAL SITE DEMO & SED/ER CONTROL					
4000	DEMO FOR SED/ER, CONST ENTRANCE, & SILT FENCE	4	07JUL10	12JUL10	1
4010	DISCONNECT & REMOVE LIGHT FIXTURES	2	13JUL10	14JUL10	1
4030	STRIP TOP SOIL	1	15JUL10	15JUL10	1
4020	SELECTIVE SITE DEMO	6	15JUL10	22JUL10	1
4035	BLASTING OPERATIONS FOR PONDS & UTILITIES	10	16JUL10	29JUL10	1
4040	CONSTRUCT BIO RET AREA 1 & 2	4	30JUL10	04AUG10	1
4050	STORM DRAIN EX MH TO MH100 TO I-101/102/103	5	30JUL10	05AUG10	6
4070	CONSTRUCT BIO RET AREA 3	3	05AUG10	09AUG10	5
4090	STORM DRAIN EX MH 200 BIO RET AREA 3	3	10AUG10	12AUG10	5
POWER RELOCATION @ NEW BUILDING PAD					
4200	EXCV DB OLD SCE XFORMER TO NEW MH	5	05AUG10	12AUG10	1
4250	EXCV DB NEW MH TO NEW XFORMER PAD	4	13AUG10	18AUG10	1
4210	CONDUIT & MH DB OLD SCE XFORMER TO NEW MH	4	19AUG10	24AUG10	2
4300	EXCV DB NEW XFORMER PAD TO EX CR BLDG MH	7	19AUG10	30AUG10	1
4220	INSPECT DB OLD SCE XFORMER TO NEW MH	1	26AUG10	26AUG10	6
4260	CONDUIT DB NEW MH TO NEW XFORMER PAD	2	26AUG10	27AUG10	2
4230	CONCRETE DB OLD SCE XFORMER TO NEW MH	1	27AUG10	27AUG10	6
4270	INSPECT DB NEW MH TO NEW XFORMER PAD	1	30AUG10	30AUG10	5
4280	CONCRETE DB NEW MH TO NEW XFORMER PAD	1	31AUG10	31AUG10	5
4310	CONDUIT & MH DB NEW XFORMER PAD TO EX CR BLDG MH	4	31AUG10	03SEP10	1
4320	INSPECT DB NEW XFORMER PAD TO EX CR BLDG MH	1	07SEP10	07SEP10	1
4330	CONCRETE NEW XFORMER PAD TO EX CR BLDG MH	1	08SEP10	08SEP10	1
4350	PULL & TERM WIRE DB OLD SCE TO EX CR	5	09SEP10	15SEP10	1
NEW UTILITIES @ EGRESS BETWEEN EXISTING BULDINGS					
4400	INSTALL SANITARY EX-MH 'A' TO MH 'B' TO MH 'C'	8	19JUL10	29JUL10	1
4420	EXCV & SET HW/CR VAULT	2	02AUG10	03AUG10	11
4440	EXCV/INSTALL HW/CR PIPE WALKWAY TO VAULT	3	04AUG10	06AUG10	11
4460	NEW ELEC & TELECOM DUCTBANKS @ EGRESS	5	09AUG10	16AUG10	11
NEW WATERLINE & GAS LINE					
4500	NEW 8" WATERLINE & TIE-INS	12	30JUL10	17AUG10	1
4520	NEW 4" WATERLINE & TIE-INS	4	18AUG10	23AUG10	1
4540	RELOCATE FIRE HYDRANT & TIE-INS	2	24AUG10	26AUG10	1
4600	NEW GASLINE	4	27AUG10	01SEP10	1
NEW POWER SERVICE NEAR CAREER BUILDING					
4900	NEW DUCTBANKS & PAD	25	09SEP10	19OCT10	34
4910	SET NEW SWITCHGEAR	2	26OCT10	28OCT10	30
4920	PULL & TERM NEW FEEDERS	5	20DEC10*	27DEC10	2



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Early Bar
Progress Bar
Critical Activity

STEM
Sheet 1 of 11

HESS CONSTRUCTION + ENGINEERING SERV
ARTS + SCIENCE COMPLEX
PRELIMINARY
AREA EARLY DATES

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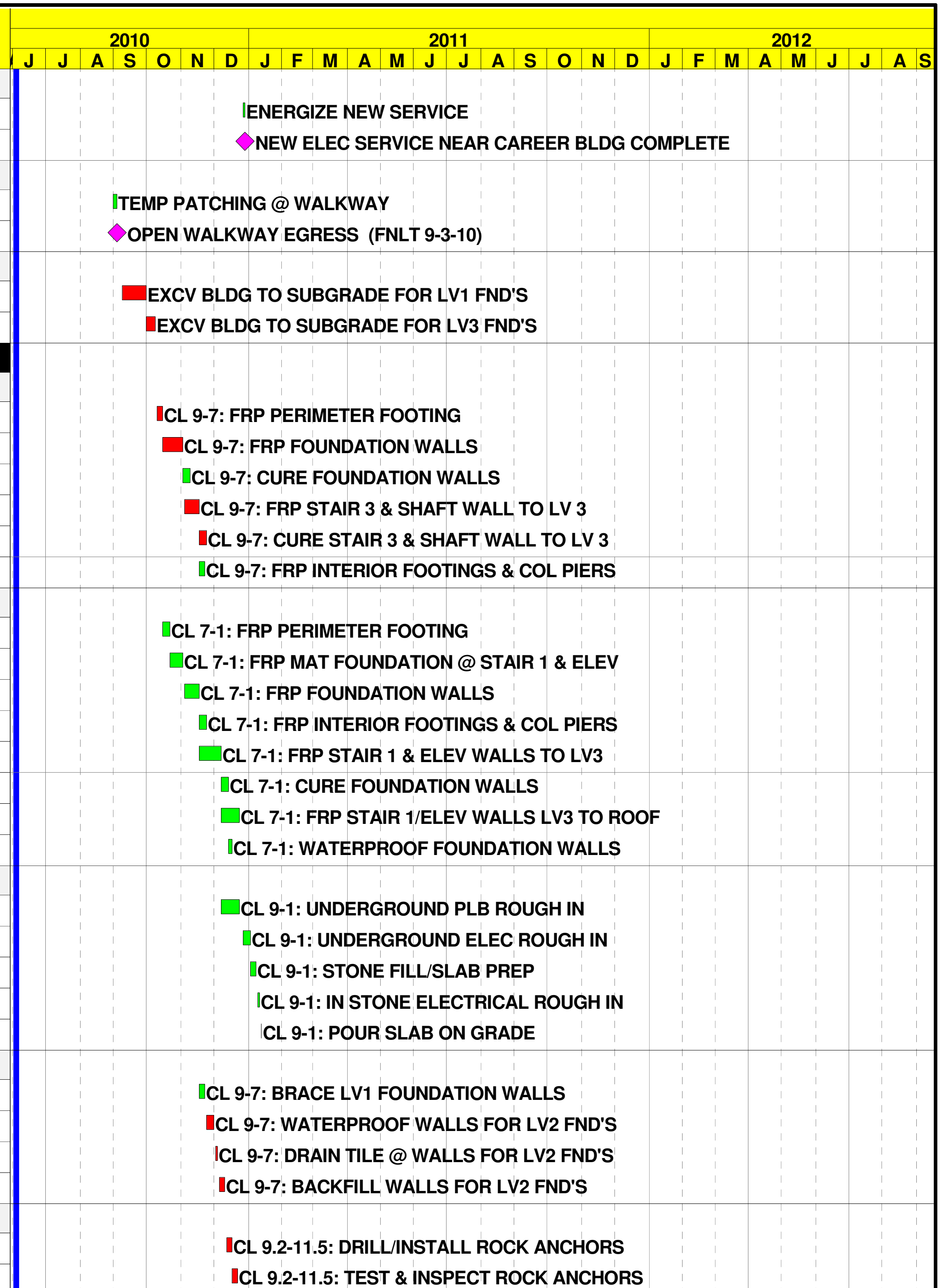
Activity ID	Activity Description	OD	ES	EF	TF
NEW POWER SERVICE NEAR CAREER BUILDING					
4930	ENERGIZE NEW SERVICE	1	28DEC10	28DEC10	2
4940	NEW ELEC SERVICE NEAR CAREER BLDG COMPLETE	0		28DEC10	2
OPEN WALKWAY EGRESS (FNLT 8-31-10)					
4950	TEMP PATCHING @ WALKWAY	2	01SEP10	02SEP10	1
4990	OPEN WALKWAY EGRESS (FNLT 9-3-10)	0		02SEP10	1
BUILDING PAD EXCAVATION					
5100	EXCV BLDG TO SUBGRADE FOR LV1 FND'S	15	08SEP10	30SEP10	0
5120	EXCV BLDG TO SUBGRADE FOR LV3 FND'S	5	01OCT10	08OCT10	0
SUBSTRUCTURE					
CL 9-7 LV1 SUBSTRUCTURE					
6010	CL 9-7: FRP PERIMETER FOOTING	3	11OCT10	14OCT10	0
6020	CL 9-7: FRP FOUNDATION WALLS	12	15OCT10	02NOV10	0
6030	CL 9-7: CURE FOUNDATION WALLS	7	03NOV10	09NOV10	14
6040	CL 9-7: FRP STAIR 3 & SHAFT WALL TO LV 3	8	04NOV10	16NOV10	0
6050	CL 9-7: CURE STAIR 3 & SHAFT WALL TO LV 3	7	17NOV10	23NOV10	0
6120	CL 9-7: FRP INTERIOR FOOTINGS & COL PIERS	3	18NOV10	22NOV10	10
CL 7-1 LV1 SUBSTRUCTURE					
6210	CL 7-1: FRP PERIMETER FOOTING	5	15OCT10	21OCT10	12
6220	CL 7-1: FRP MAT FOUNDATION @ STAIR 1 & ELEV	6	22OCT10	01NOV10	12
6230	CL 7-1: FRP FOUNDATION WALLS	8	04NOV10	16NOV10	8
6300	CL 7-1: FRP INTERIOR FOOTINGS & COL PIERS	5	18NOV10	24NOV10	8
6250	CL 7-1: FRP STAIR 1 & ELEV WALLS TO LV3	10	18NOV10	06DEC10	3
6270	CL 7-1: CURE FOUNDATION WALLS	7	07DEC10	13DEC10	21
6260	CL 7-1: FRP STAIR 1/ELEV WALLS LV3 TO ROOF	10	07DEC10	23DEC10	7
6290	CL 7-1: WATERPROOF FOUNDATION WALLS	3	14DEC10	17DEC10	10
9-1 LV1 SLAB ON GRADE					
6400	CL 9-1: UNDERGROUND PLB ROUGH IN	10	07DEC10	23DEC10	3
6420	CL 9-1: UNDERGROUND ELEC ROUGH IN	4	27DEC10	03JAN11	3
6430	CL 9-1: STONE FILL/SLAB PREP	3	04JAN11	07JAN11	3
6440	CL 9-1: IN STONE ELECTRICAL ROUGH IN	2	10JAN11	11JAN11	3
6450	CL 9-1: POUR SLAB ON GRADE	1	13JAN11	13JAN11	3
9-7 WALL BRACING/WP/BACKFILL FOUNDATION WALLS					
6600	CL 9-7: BRACE LV1 FOUNDATION WALLS	3	18NOV10	22NOV10	6
6620	CL 9-7: WATERPROOF WALLS FOR LV2 FND'S	3	24NOV10	30NOV10	0
6630	CL 9-7: DRAIN TILE @ WALLS FOR LV2 FND'S	2	02DEC10	03DEC10	0
6640	CL 9-7: BACKFILL WALLS FOR LV2 FND'S	4	06DEC10	10DEC10	0
CL 9.2-11.5: LV3 SUBSTRUCTURE					
6700	CL 9.2-11.5: DRILL/INSTALL ROCK ANCHORS	3	13DEC10	16DEC10	0
6710	CL 9.2-11.5: TEST & INSPECT ROCK ANCHORS	3	17DEC10	21DEC10	0



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Early Bar
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HESS CONSTRUCTION + ENGINEERING SERV
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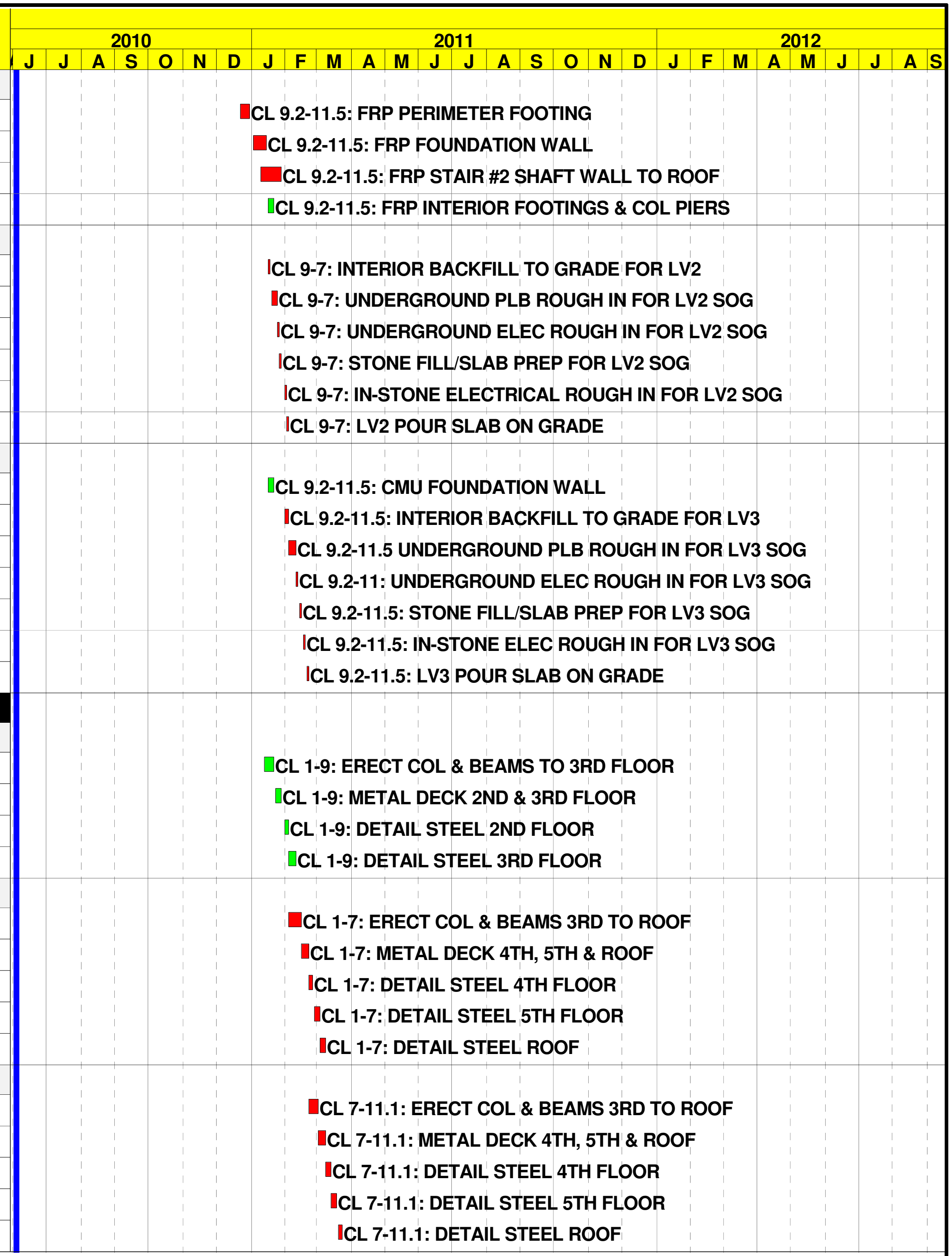
CL 9.2-11.5: LV3 SUBSTRUCTURE					
6720	CL 9.2-11.5: FRP PERIMETER FOOTING	4	23DEC10	30DEC10	0
6730	CL 9.2-11.5: FRP FOUNDATION WALL	8	03JAN11	14JAN11	0
6740	CL 9.2-11.5: FRP STAIR #2 SHAFT WALL TO ROOF	12	10JAN11	28JAN11	0
6750	CL 9.2-11.5: FRP INTERIOR FOOTINGS & COL PIERS	4	17JAN11	21JAN11	4
7-9 LV2 SLAB ON GRADE					
6800	CL 9-7: INTERIOR BACKFILL TO GRADE FOR LV2	2	17JAN11	18JAN11	0
6820	CL 9-7: UNDERGROUND PLB ROUGH IN FOR LV2 SOG	3	20JAN11	24JAN11	0
6840	CL 9-7: UNDERGROUND ELEC ROUGH IN FOR LV2 SOG	1	25JAN11	25JAN11	0
6850	CL 9-7: STONE FILL/SLAB PREP FOR LV2 SOG	2	27JAN11	28JAN11	0
6860	CL 9-7: IN-STONE ELECTRICAL ROUGH IN FOR LV2 SOG	2	31JAN11	01FEB11	0
6880	CL 9-7: LV2 POUR SLAB ON GRADE	1	03FEB11	03FEB11	0
CL 9.2-11.5: LV3 SLAB ON GRADE					
6900	CL 9.2-11.5: CMU FOUNDATION WALL	3	17JAN11	20JAN11	5
6910	CL 9.2-11.5: INTERIOR BACKFILL TO GRADE FOR LV3	3	31JAN11	03FEB11	0
6920	CL 9.2-11.5 UNDERGROUND PLB ROUGH IN FOR LV3 SOG	3	04FEB11	09FEB11	0
6940	CL 9.2-11: UNDERGROUND ELEC ROUGH IN FOR LV3 SOG	1	11FEB11	11FEB11	0
6950	CL 9.2-11.5: STONE FILL/SLAB PREP FOR LV3 SOG	2	14FEB11	15FEB11	0
6960	CL 9.2-11.5: IN-STONE ELEC ROUGH IN FOR LV3 SOG	2	17FEB11	18FEB11	0
6980	CL 9.2-11.5: LV3 POUR SLAB ON GRADE	1	21FEB11	21FEB11	0
SUPERSTRUCTURE STEEL					
STEEL LEVEL 2 & 3					
7000	CL 1-9: ERECT COL & BEAMS TO 3RD FLOOR	5	14JAN11	21JAN11	3
7020	CL 1-9: METAL DECK 2ND & 3RD FLOOR	4	24JAN11	28JAN11	3
7030	CL 1-9: DETAIL STEEL 2ND FLOOR	3	31JAN11	03FEB11	6
7040	CL 1-9: DETAIL STEEL 3RD FLOOR	3	04FEB11	09FEB11	6
STEEL WEST SIDE LV3 TO ROOF					
7100	CL 1-7: ERECT COL & BEAMS 3RD TO ROOF	5	04FEB11	14FEB11	0
7110	CL 1-7: METAL DECK 4TH, 5TH & ROOF	4	15FEB11	21FEB11	0
7120	CL 1-7: DETAIL STEEL 4TH FLOOR	3	22FEB11	25FEB11	0
7130	CL 1-7: DETAIL STEEL 5TH FLOOR	3	28FEB11	03MAR11	0
7140	CL 1-7: DETAIL STEEL ROOF	3	04MAR11	08MAR11	0
STEEL EAST SIDE LV 3 TO ROOF					
7200	CL 7-11.1: ERECT COL & BEAMS 3RD TO ROOF	5	22FEB11	01MAR11	0
7210	CL 7-11.1: METAL DECK 4TH, 5TH & ROOF	4	03MAR11	08MAR11	0
7220	CL 7-11.1: DETAIL STEEL 4TH FLOOR	3	10MAR11	14MAR11	0
7230	CL 7-11.1: DETAIL STEEL 5TH FLOOR	3	15MAR11	18MAR11	0
7240	CL 7-11.1: DETAIL STEEL ROOF	3	21MAR11	24MAR11	0



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Early Bar
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HESS CONSTRUCTION + ENGINEERING SERV
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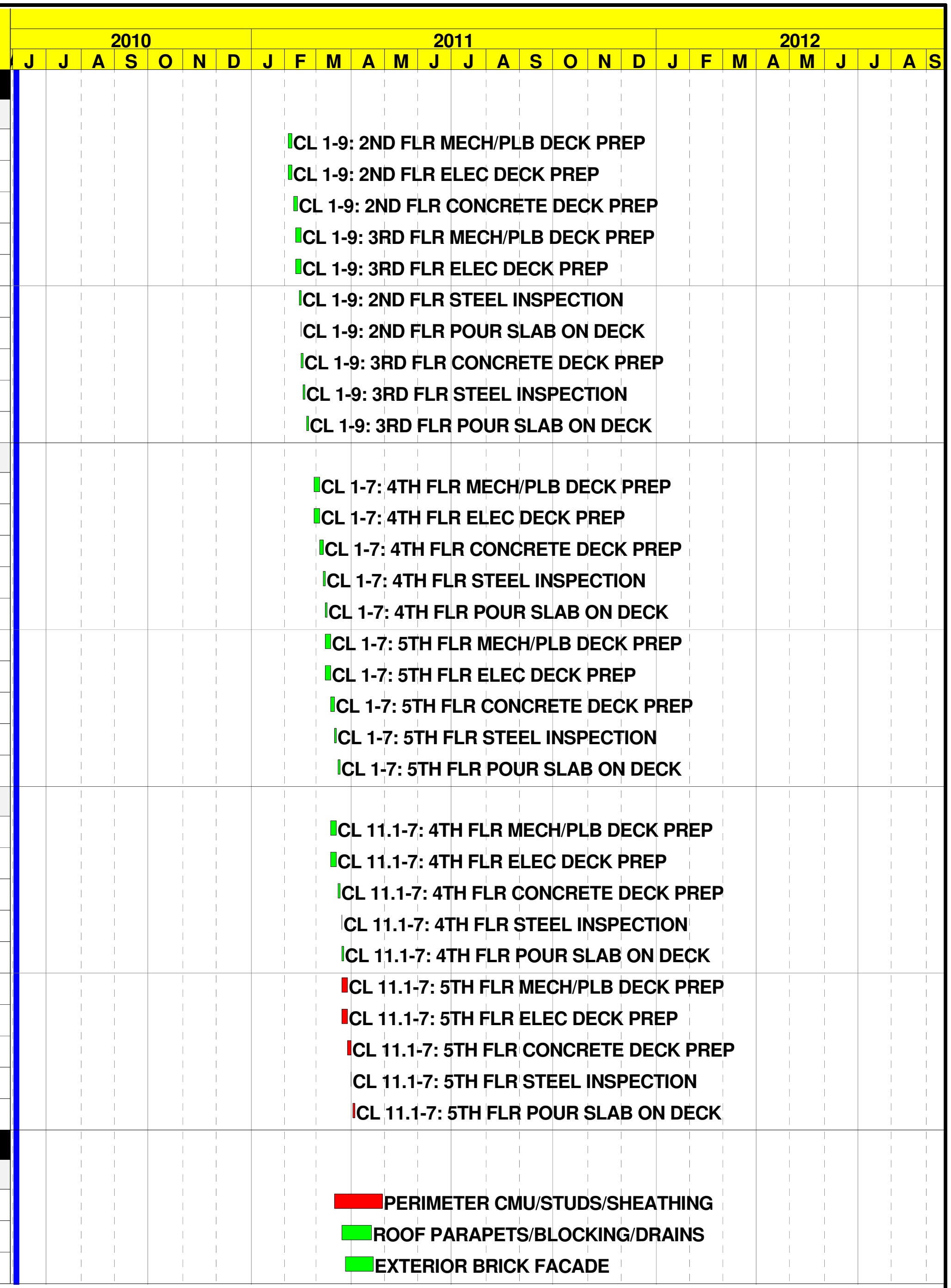
Activity ID	Activity Description	OD	ES	EF	TF
SLAB ON DECK PLACEMENTS					
LEVEL 2 & 3 SLAB ON DECT PLACEMENTS					
8000	CL 1-9: 2ND FLR MECH/PLB DECK PREP	2	04FEB11	07FEB11	10
8010	CL 1-9: 2ND FLR ELEC DECK PREP	2	04FEB11	07FEB11	10
8020	CL 1-9: 2ND FLR CONCRETE DECK PREP	2	09FEB11	11FEB11	10
8100	CL 1-9: 3RD FLR MECH/PLB DECK PREP	2	11FEB11	14FEB11	9
8110	CL 1-9: 3RD FLR ELEC DECK PREP	2	11FEB11	14FEB11	9
8030	CL 1-9: 2ND FLR STEEL INSPECTION	1	14FEB11	14FEB11	11
8040	CL 1-9: 2ND FLR POUR SLAB ON DECK	1	15FEB11	15FEB11	11
8120	CL 1-9: 3RD FLR CONCRETE DECK PREP	2	15FEB11	17FEB11	9
8130	CL 1-9: 3RD FLR STEEL INSPECTION	1	18FEB11	18FEB11	9
8140	CL 1-9: 3RD FLR POUR SLAB ON DECK	1	21FEB11	21FEB11	9
WEST LEVEL 4 & 5 SLAB ON DECK PLACEMENTS					
8200	CL 1-7: 4TH FLR MECH/PLB DECK PREP	3	28FEB11	03MAR11	10
8210	CL 1-7: 4TH FLR ELEC DECK PREP	3	28FEB11	03MAR11	10
8220	CL 1-7: 4TH FLR CONCRETE DECK PREP	2	04MAR11	07MAR11	11
8230	CL 1-7: 4TH FLR STEEL INSPECTION	1	08MAR11	08MAR11	12
8240	CL 1-7: 4TH FLR POUR SLAB ON DECK	1	10MAR11	10MAR11	12
8300	CL 1-7: 5TH FLR MECH/PLB DECK PREP	3	10MAR11	14MAR11	7
8310	CL 1-7: 5TH FLR ELEC DECK PREP	3	10MAR11	14MAR11	7
8320	CL 1-7: 5TH FLR CONCRETE DECK PREP	2	15MAR11	17MAR11	7
8330	CL 1-7: 5TH FLR STEEL INSPECTION	1	18MAR11	18MAR11	7
8340	CL 1-7: 5TH FLR POUR SLAB ON DECK	1	21MAR11	21MAR11	7
EAST LEVEL 4 & LEVEL 5 SLAB ON DECK PLACEMENTS					
8400	CL 11.1-7: 4TH FLR MECH/PLB DECK PREP	3	15MAR11	18MAR11	3
8410	CL 11.1-7: 4TH FLR ELEC DECK PREP	3	15MAR11	18MAR11	3
8420	CL 11.1-7: 4TH FLR CONCRETE DECK PREP	2	21MAR11	22MAR11	3
8430	CL 11.1-7: 4TH FLR STEEL INSPECTION	1	24MAR11	24MAR11	4
8450	CL 11.1-7: 4TH FLR POUR SLAB ON DECK	1	25MAR11	25MAR11	4
8500	CL 11.1-7: 5TH FLR MECH/PLB DECK PREP	2	25MAR11	28MAR11	0
8510	CL 11.1-7: 5TH FLR ELEC DECK PREP	2	25MAR11	28MAR11	0
8520	CL 11.1-7: 5TH FLR CONCRETE DECK PREP	2	29MAR11	31MAR11	0
8530	CL 11.1-7: 5TH FLR STEEL INSPECTION	1	01APR11	01APR11	0
8550	CL 11.1-7: 5TH FLR POUR SLAB ON DECK	1	04APR11	04APR11	0
ENCLOSURE & SITE FINISHES					
SUMMARY ENCLOSURE					
SUM90100	PERIMETER CMU/STUDS/SHEATHING	25	18MAR11	29APR11	0
SUM90000	ROOF PARAPETS/BLOCKING/DRAINS	15	25MAR11	19APR11	5
SUM90300	EXTERIOR BRICK FACADE	15	28MAR11	21APR11	1



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Early Bar
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Critical Activity

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HESS CONSTRUCTION + ENGINEERING SERV
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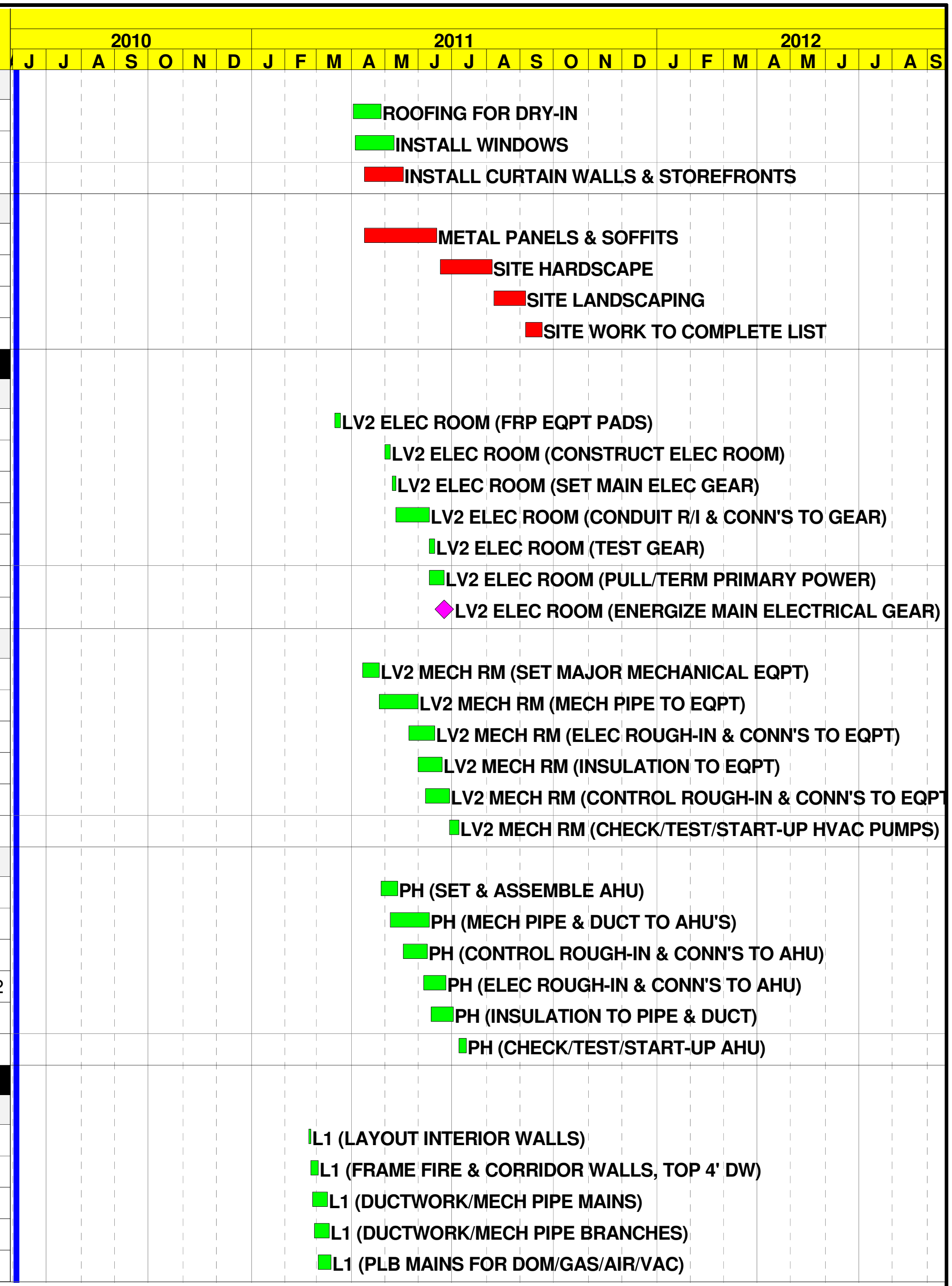
AREA EARLY DATES

Date	Revision	Checked	Approved

Activity ID	Activity Description	OD	ES	EF	TF
SUMMARY ENCLOSURE					
SUM90200	ROOFING FOR DRY-IN	15	04APR11	28APR11	5
SUM90400	INSTALL WINDOWS	20	05APR11	09MAY11	1
SUM90500	INSTALL CURTAIN WALLS & STOREFRONTS	20	14APR11	17MAY11	0
SITE FINISHES					
SUM91000	METAL PANELS & SOFFITS	40	14APR11	17JUN11	0
SUM91100	SITE HARDSCAPE	30	20JUN11	05AUG11	0
SUM91200	SITE LANDSCAPING	20	08AUG11	05SEP11	0
SUM91300	SITE WORK TO COMPLETE LIST	10	06SEP11	20SEP11	0
MAIN MECHANICAL & ELECTRICAL ROOMS					
LV2 MAIN ELECTRICAL ROOM					
SUM5000	LV2 ELEC ROOM (FRP EQPT PADS)	2	18MAR11	21MAR11	38
SUM5005	LV2 ELEC ROOM (CONSTRUCT ELEC ROOM)	5	02MAY11	06MAY11	9
SUM5010	LV2 ELEC ROOM (SET MAIN ELEC GEAR)	3	09MAY11	11MAY11	9
SUM5030	LV2 ELEC ROOM (CONDUIT R/I & CONN'S TO GEAR)	20	12MAY11	09JUN11	9
SUM5050	LV2 ELEC ROOM (TEST GEAR)	3	10JUN11	14JUN11	16
SUM5080	LV2 ELEC ROOM (PULL/TERM PRIMARY POWER)	10	10JUN11	23JUN11	9
SUM5090	LV2 ELEC ROOM (ENERGIZE MAIN ELECTRICAL GEAR)	0		23JUN11	9
LV2 MECHANICAL ROOM					
SUM5500	LV2 MECH RM (SET MAJOR MECHANICAL EQPT)	10	12APR11	25APR11	6
SUM5520	LV2 MECH RM (MECH PIPE TO EQPT)	25	26APR11	31MAY11	6
SUM5560	LV2 MECH RM (ELEC ROUGH-IN & CONN'S TO EQPT)	15	24MAY11	14JUN11	6
SUM5540	LV2 MECH RM (INSULATION TO EQPT)	15	01JUN11	21JUN11	11
SUM5570	LV2 MECH RM (CONTROL ROUGH-IN & CONN'S TO EQPT)	15	08JUN11	28JUN11	6
SUM5580	LV2 MECH RM (CHECK/TEST/START-UP HVAC PUMPS)	5	29JUN11	06JUL11	6
PENTHOUSE					
SUM6000	PH (SET & ASSEMBLE AHU)	10	29APR11	12MAY11	8
SUM6520	PH (MECH PIPE & DUCT TO AHU'S)	25	06MAY11	10JUN11	8
SUM6570	PH (CONTROL ROUGH-IN & CONN'S TO AHU)	15	18MAY11	08JUN11	25
SUM6560	PH (ELEC ROUGH-IN & CONN'S TO AHU)	15	06JUN11	24JUN11	292
SUM6540	PH (INSULATION TO PIPE & DUCT)	15	13JUN11	01JUL11	8
SUM6580	PH (CHECK/TEST/START-UP AHU)	5	07JUL11	13JUL11	6
INTERIOR ROUGH-INS & FINISHES					
LEVEL 1 ROUGH-INS & FINISHES					
SUM10000	L1 (LAYOUT INTERIOR WALLS)	2	22FEB11	23FEB11	12
SUM10050	L1 (FRAME FIRE & CORRIDOR WALLS, TOP 4' DW)	5	24FEB11	02MAR11	12
SUM10100	L1 (DUCTWORK/MECH PIPE MAINS)	10	25FEB11	10MAR11	12
SUM10150	L1 (DUCTWORK/MECH PIPE BRANCHES)	10	28FEB11	11MAR11	17
SUM10200	L1 (PLB MAINS FOR DOM/GAS/AIR/VAC)	8	03MAR11	14MAR11	12



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Early Bar
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HESS CONSTRUCTION + ENGINEERING SERV
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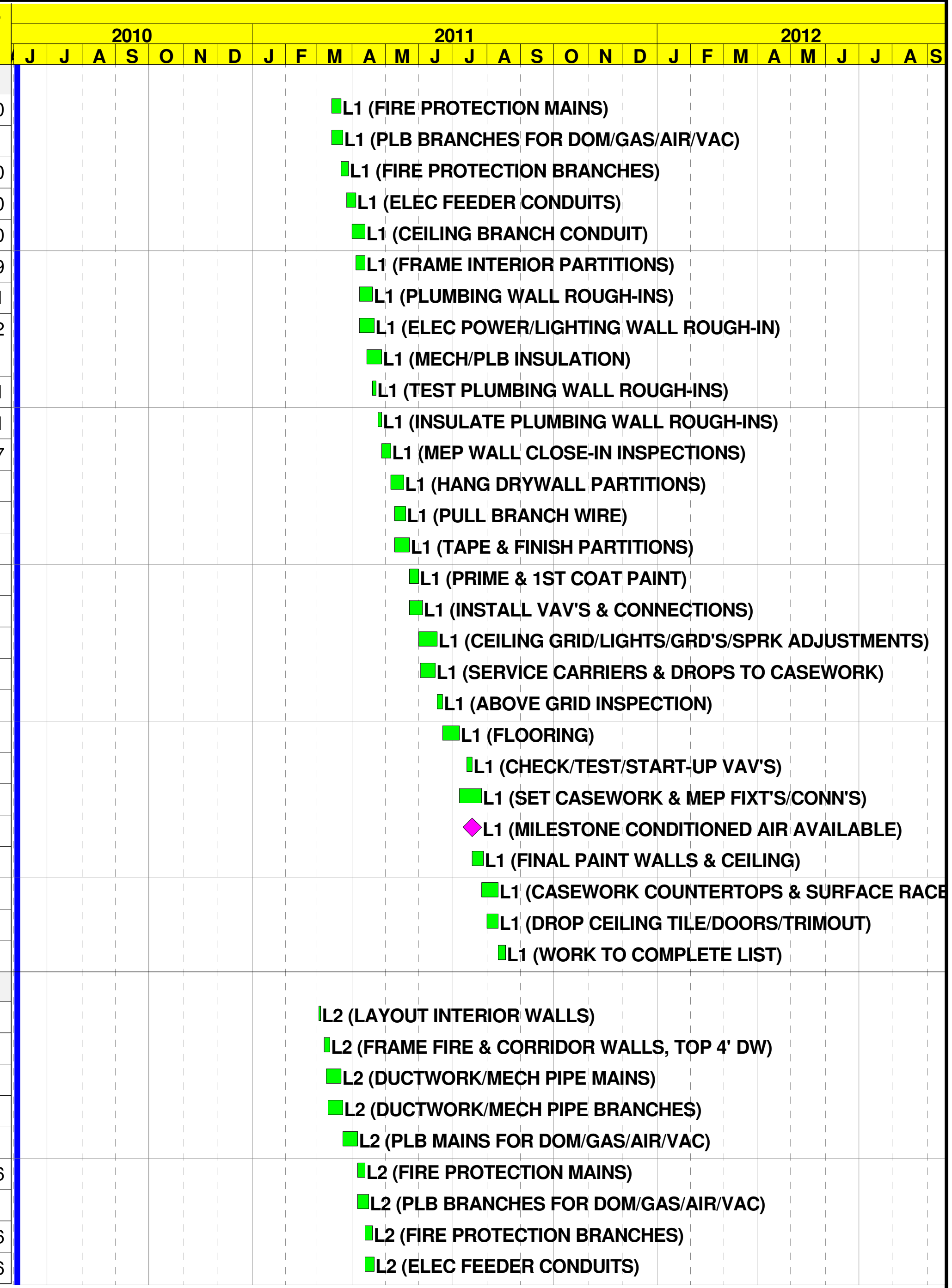
Activity ID	Activity Description	OD	ES	EF	TF
LEVEL 1 ROUGH-INS & FINISHES					
SUM10300	L1 (FIRE PROTECTION MAINS)	5	15MAR11	21MAR11	300
SUM10210	L1 (PLB BRANCHES FOR DOM/GAS/AIR/VAC)	8	15MAR11	24MAR11	12
SUM10320	L1 (FIRE PROTECTION BRANCHES)	5	22MAR11	28MAR11	300
SUM10400	L1 (ELEC FEEDER CONDUITS)	6	28MAR11	04APR11	300
SUM10420	L1 (CEILING BRANCH CONDUIT)	8	01APR11	12APR11	300
SUM10500	L1 (FRAME INTERIOR PARTITIONS)	6	05APR11	12APR11	299
SUM10510	L1 (PLUMBING WALL ROUGH-INS)	8	08APR11	19APR11	311
SUM10540	L1 (ELEC POWER/LIGHTING WALL ROUGH-IN)	10	08APR11	21APR11	312
SUM10220	L1 (MECH/PLB INSULATION)	10	15APR11	28APR11	26
SUM10520	L1 (TEST PLUMBING WALL ROUGH-INS)	3	20APR11	22APR11	331
SUM10530	L1 (INSULATE PLUMBING WALL ROUGH-INS)	4	25APR11	28APR11	331
SUM10550	L1 (MEP WALL CLOSE-IN INSPECTIONS)	5	29APR11	05MAY11	327
SUM10580	L1 (HANG DRYWALL PARTITIONS)	8	06MAY11	17MAY11	2
SUM10730	L1 (PULL BRANCH WIRE)	8	10MAY11	19MAY11	16
SUM10600	L1 (TAPE & FINISH PARTITIONS)	10	10MAY11	23MAY11	2
SUM10700	L1 (PRIME & 1ST COAT PAINT)	5	24MAY11	31MAY11	9
SUM10750	L1 (INSTALL VAV'S & CONNECTIONS)	8	24MAY11	03JUN11	14
SUM10800	L1 (CEILING GRID/LIGHTS/GRD'S/SPRK ADJUSTMENTS)	12	01JUN11	16JUN11	9
SUM10860	L1 (SERVICE CARRIERS & DROPS TO CASEWORK)	8	03JUN11	14JUN11	11
SUM10880	L1 (ABOVE GRID INSPECTION)	3	17JUN11	21JUN11	9
SUM10900	L1 (FLOORING)	10	22JUN11	06JUL11	9
SUM10820	L1 (CHECK/TEST/START-UP VAV'S)	3	14JUL11	18JUL11	6
SUM10910	L1 (SET CASEWORK & MEP FIXT'S/CONN'S)	15	07JUL11	27JUL11	9
SUM10840	L1 (MILESTONE CONDITIONED AIR AVAILABLE)	0		18JUL11	10
SUM10920	L1 (FINAL PAINT WALLS & CEILING)	8	19JUL11	28JUL11	10
SUM10930	L1 (CASEWORK COUNTERTOPS & SURFACE RACEWAYS)	10	28JUL11	10AUG11	9
SUM10940	L1 (DROP CEILING TILE/DOORS/TRIMOUT)	8	01AUG11	10AUG11	9
SUM10990	L1 (WORK TO COMPLETE LIST)	5	11AUG11	17AUG11	43
LEVEL 2 ROUGH-INS & FINISHES					
SUM20000	L2 (LAYOUT INTERIOR WALLS)	2	03MAR11	04MAR11	20
SUM20050	L2 (FRAME FIRE & CORRIDOR WALLS, TOP 4' DW)	5	07MAR11	11MAR11	20
SUM20100	L2 (DUCTWORK/MECH PIPE MAINS)	10	09MAR11	22MAR11	20
SUM20150	L2 (DUCTWORK/MECH PIPE BRANCHES)	10	11MAR11	24MAR11	24
SUM20200	L2 (PLB MAINS FOR DOM/GAS/AIR/VAC)	8	25MAR11	05APR11	12
SUM20300	L2 (FIRE PROTECTION MAINS)	5	06APR11	12APR11	296
SUM20210	L2 (PLB BRANCHES FOR DOM/GAS/AIR/VAC)	8	06APR11	15APR11	12
SUM20320	L2 (FIRE PROTECTION BRANCHES)	5	13APR11	19APR11	296
SUM20400	L2 (ELEC FEEDER CONDUITS)	6	13APR11	20APR11	296



Start Date	03MAY10
Finish Date	17AUG12
Data Date	04JUN10
Run Date	04APR11 08:55

Early Bar
Progress Bar
Critical Activity

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HESS CONSTRUCTION + ENGINEERING SERV
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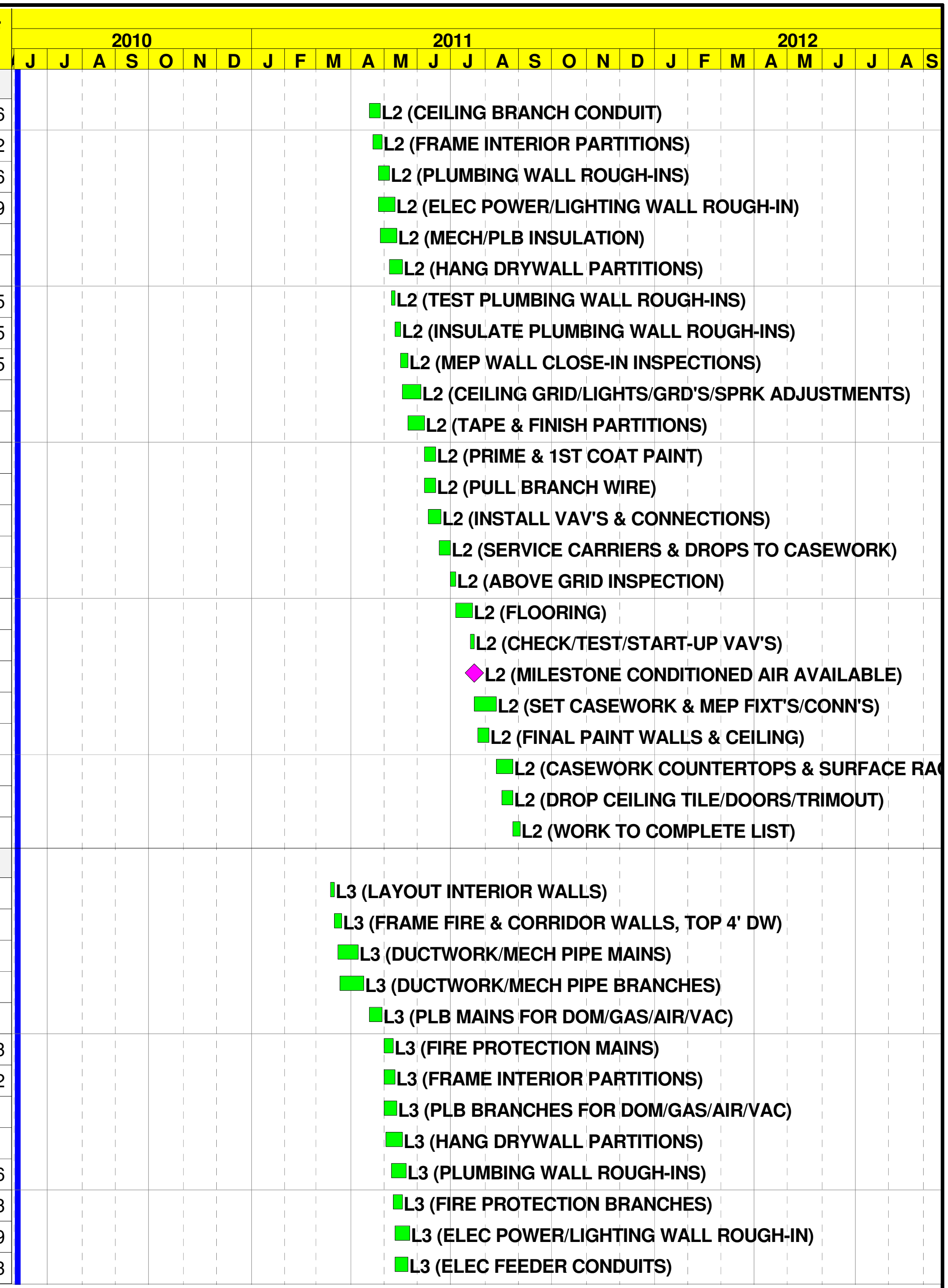
Date	Revision	Checked	Approved

Activity ID	Activity Description	OD	ES	EF	TF
LEVEL 2 ROUGH-INS & FINISHES					
SUM20420	L2 (CEILING BRANCH CONDUIT)	8	19APR11	28APR11	296
SUM20500	L2 (FRAME INTERIOR PARTITIONS)	6	22APR11	29APR11	292
SUM20510	L2 (PLUMBING WALL ROUGH-INS)	8	27APR11	06MAY11	306
SUM20540	L2 (ELEC POWER/LIGHTING WALL ROUGH-IN)	10	27APR11	10MAY11	309
SUM20220	L2 (MECH/PLB INSULATION)	10	29APR11	12MAY11	26
SUM20580	L2 (HANG DRYWALL PARTITIONS)	8	06MAY11	17MAY11	12
SUM20520	L2 (TEST PLUMBING WALL ROUGH-INS)	2	09MAY11	10MAY11	315
SUM20530	L2 (INSULATE PLUMBING WALL ROUGH-INS)	4	11MAY11	16MAY11	315
SUM20550	L2 (MEP WALL CLOSE-IN INSPECTIONS)	5	17MAY11	23MAY11	315
SUM20800	L2 (CEILING GRID/LIGHTS/GRD'S/SPRK ADJUSTMENTS)	12	18MAY11	03JUN11	26
SUM20600	L2 (TAPE & FINISH PARTITIONS)	10	24MAY11	07JUN11	2
SUM20700	L2 (PRIME & 1ST COAT PAINT)	8	08JUN11	17JUN11	8
SUM20730	L2 (PULL BRANCH WIRE)	8	08JUN11	17JUN11	10
SUM20750	L2 (INSTALL VAV'S & CONNECTIONS)	8	10JUN11	21JUN11	10
SUM20860	L2 (SERVICE CARRIERS & DROPS TO CASEWORK)	8	20JUN11	29JUN11	8
SUM20880	L2 (ABOVE GRID INSPECTION)	3	30JUN11	05JUL11	8
SUM20900	L2 (FLOORING)	10	06JUL11	19JUL11	8
SUM20820	L2 (CHECK/TEST/START-UP VAV'S)	3	19JUL11	21JUL11	6
SUM20840	L2 (MILESTONE CONDITIONED AIR AVAILABLE)	0		21JUL11	6
SUM20910	L2 (SET CASEWORK & MEP FIXT'S/CONN'S)	15	22JUL11	11AUG11	6
SUM20920	L2 (FINAL PAINT WALLS & CEILING)	8	26JUL11	04AUG11	13
SUM20930	L2 (CASEWORK COUNTERTOPS & SURFACE RACEWAYS)	10	12AUG11	25AUG11	6
SUM20940	L2 (DROP CEILING TILE/DOORS/TRIMOUT)	8	16AUG11	25AUG11	6
SUM20990	L2 (WORK TO COMPLETE LIST)	5	26AUG11	01SEP11	32
LEVEL 3 ROUGH-INS & FINISHES					
SUM30000	L3 (LAYOUT INTERIOR WALLS)	3	14MAR11	16MAR11	24
SUM30050	L3 (FRAME FIRE & CORRIDOR WALLS, TOP 4' DW)	6	17MAR11	24MAR11	24
SUM30100	L3 (DUCTWORK/MECH PIPE MAINS)	15	21MAR11	08APR11	24
SUM30150	L3 (DUCTWORK/MECH PIPE BRANCHES)	15	23MAR11	12APR11	31
SUM30200	L3 (PLB MAINS FOR DOM/GAS/AIR/VAC)	10	18APR11	29APR11	12
SUM30300	L3 (FIRE PROTECTION MAINS)	6	02MAY11	09MAY11	283
SUM30500	L3 (FRAME INTERIOR PARTITIONS)	8	02MAY11	11MAY11	292
SUM30210	L3 (PLB BRANCHES FOR DOM/GAS/AIR/VAC)	10	02MAY11	13MAY11	12
SUM30580	L3 (HANG DRYWALL PARTITIONS)	10	04MAY11	17MAY11	24
SUM30510	L3 (PLUMBING WALL ROUGH-INS)	10	09MAY11	20MAY11	306
SUM30320	L3 (FIRE PROTECTION BRANCHES)	6	10MAY11	17MAY11	283
SUM30540	L3 (ELEC POWER/LIGHTING WALL ROUGH-IN)	10	11MAY11	24MAY11	309
SUM30400	L3 (ELEC FEEDER CONDUITS)	8	12MAY11	23MAY11	283



Start Date	03MAY10
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Early Bar
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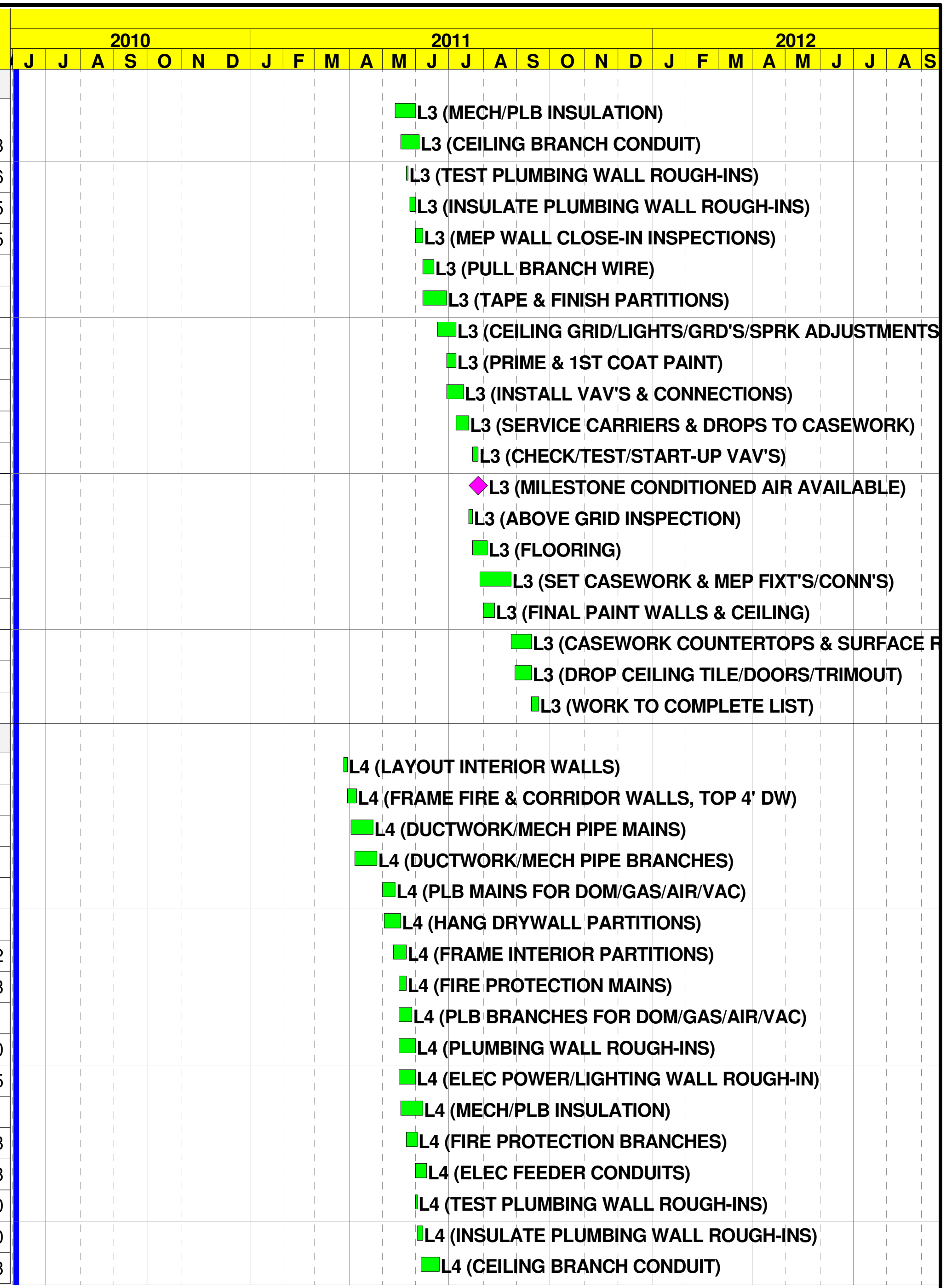
Activity ID	Activity Description	OD	ES	EF	TF
LEVEL 3 ROUGH-INS & FINISHES					
SUM30220	L3 (MECH/PLB INSULATION)	12	13MAY11	31MAY11	26
SUM30420	L3 (CEILING BRANCH CONDUIT)	12	18MAY11	03JUN11	283
SUM30520	L3 (TEST PLUMBING WALL ROUGH-INS)	2	23MAY11	24MAY11	306
SUM30530	L3 (INSULATE PLUMBING WALL ROUGH-INS)	3	26MAY11	31MAY11	305
SUM30550	L3 (MEP WALL CLOSE-IN INSPECTIONS)	5	01JUN11	07JUN11	305
SUM30730	L3 (PULL BRANCH WIRE)	8	08JUN11	17JUN11	12
SUM30600	L3 (TAPE & FINISH PARTITIONS)	15	08JUN11	28JUN11	2
SUM30800	L3 (CEILING GRID/LIGHTS/GRD'S/SPRK ADJUSTMENTS)	12	20JUN11	06JUL11	12
SUM30700	L3 (PRIME & 1ST COAT PAINT)	5	29JUN11	06JUL11	4
SUM30750	L3 (INSTALL VAV'S & CONNECTIONS)	10	29JUN11	13JUL11	5
SUM30860	L3 (SERVICE CARRIERS & DROPS TO CASEWORK)	8	07JUL11	18JUL11	4
SUM30820	L3 (CHECK/TEST/START-UP VAV'S)	3	22JUL11	26JUL11	6
SUM30840	L3 (MILESTONE CONDITIONED AIR AVAILABLE)	0		26JUL11	6
SUM30880	L3 (ABOVE GRID INSPECTION)	3	19JUL11	21JUL11	4
SUM30900	L3 (FLOORING)	10	22JUL11	04AUG11	4
SUM30910	L3 (SET CASEWORK & MEP FIXT'S/CONN'S)	20	29JUL11	25AUG11	4
SUM30920	L3 (FINAL PAINT WALLS & CEILING)	8	02AUG11	11AUG11	16
SUM30930	L3 (CASEWORK COUNTERTOPS & SURFACE RACEWAYS)	12	26AUG11	13SEP11	4
SUM30940	L3 (DROP CEILING TILE/DOORS/TRIMOUT)	10	30AUG11	13SEP11	4
SUM30990	L3 (WORK TO COMPLETE LIST)	5	14SEP11	20SEP11	20
LEVEL 4 ROUGH-INS & FINISHES					
SUM40000	L4 (LAYOUT INTERIOR WALLS)	3	28MAR11	30MAR11	25
SUM40050	L4 (FRAME FIRE & CORRIDOR WALLS, TOP 4' DW)	6	31MAR11	07APR11	25
SUM40100	L4 (DUCTWORK/MECH PIPE MAINS)	15	04APR11	22APR11	25
SUM40150	L4 (DUCTWORK/MECH PIPE BRANCHES)	15	06APR11	26APR11	31
SUM40200	L4 (PLB MAINS FOR DOM/GAS/AIR/VAC)	10	02MAY11	13MAY11	12
SUM40580	L4 (HANG DRYWALL PARTITIONS)	10	04MAY11	17MAY11	34
SUM40500	L4 (FRAME INTERIOR PARTITIONS)	8	12MAY11	23MAY11	292
SUM40300	L4 (FIRE PROTECTION MAINS)	6	16MAY11	23MAY11	283
SUM40210	L4 (PLB BRANCHES FOR DOM/GAS/AIR/VAC)	10	16MAY11	27MAY11	12
SUM40510	L4 (PLUMBING WALL ROUGH-INS)	10	17MAY11	31MAY11	300
SUM40540	L4 (ELEC POWER/LIGHTING WALL ROUGH-IN)	10	17MAY11	31MAY11	305
SUM40220	L4 (MECH/PLB INSULATION)	12	19MAY11	06JUN11	22
SUM40320	L4 (FIRE PROTECTION BRANCHES)	6	24MAY11	01JUN11	283
SUM40400	L4 (ELEC FEEDER CONDUITS)	8	31MAY11	09JUN11	283
SUM40520	L4 (TEST PLUMBING WALL ROUGH-INS)	2	01JUN11	02JUN11	300
SUM40530	L4 (INSULATE PLUMBING WALL ROUGH-INS)	3	03JUN11	07JUN11	300
SUM40420	L4 (CEILING BRANCH CONDUIT)	12	06JUN11	21JUN11	283



Start Date	03MAY10
Finish Date	17AUG12
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Early Bar
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Critical Activity

STEM

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HESS CONSTRUCTION + ENGINEERING SERV
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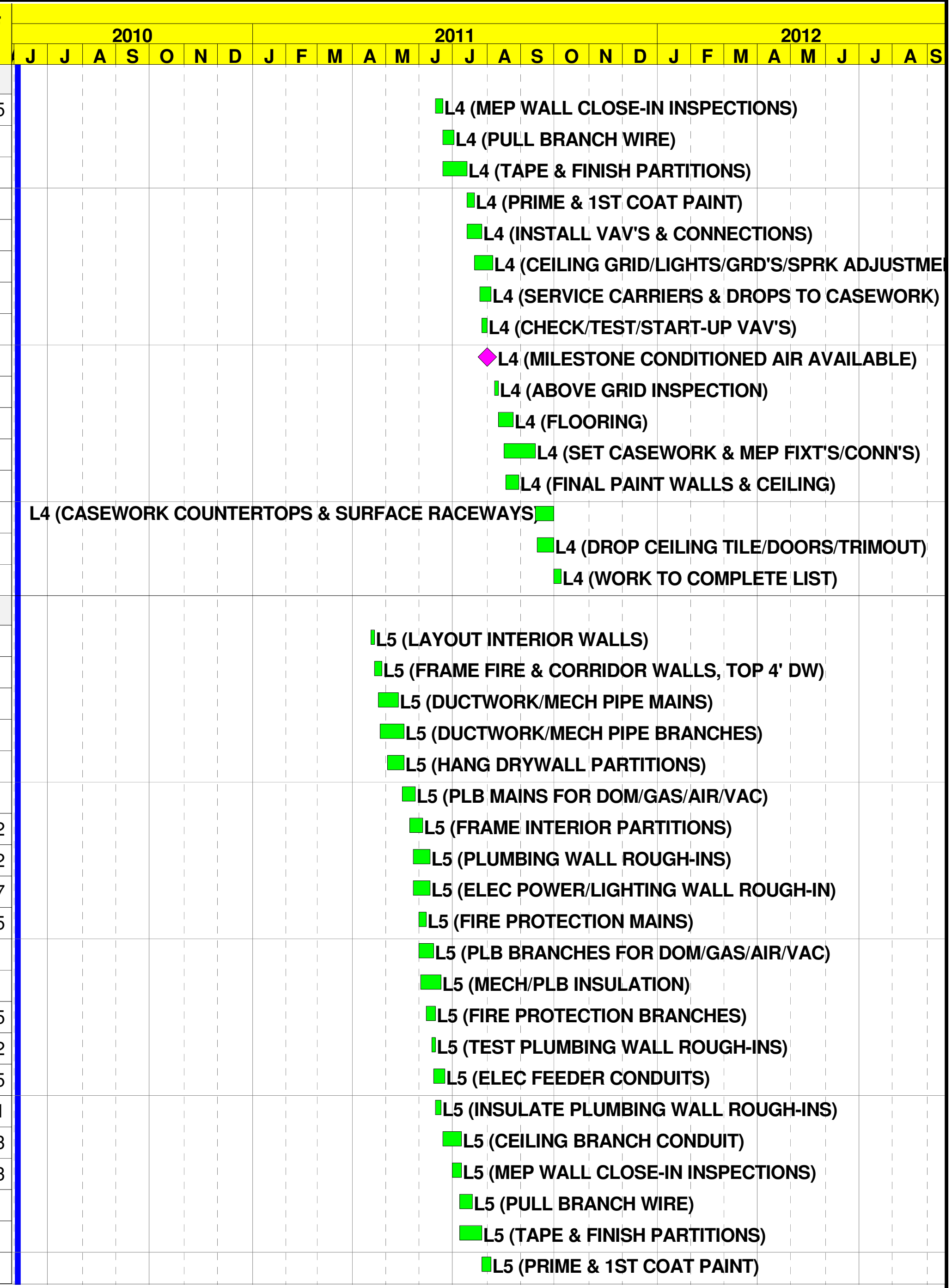
Date	Revision	Checked	Approved

Activity ID	Activity Description	OD	ES	EF	TF
LEVEL 4 ROUGH-INS & FINISHES					
SUM40550	L4 (MEP WALL CLOSE-IN INSPECTIONS)	5	15JUN11	21JUN11	295
SUM40730	L4 (PULL BRANCH WIRE)	8	22JUN11	01JUL11	14
SUM40600	L4 (TAPE & FINISH PARTITIONS)	15	22JUN11	13JUL11	2
SUM40700	L4 (PRIME & 1ST COAT PAINT)	5	14JUL11	20JUL11	2
SUM40750	L4 (INSTALL VAV'S & CONNECTIONS)	10	14JUL11	27JUL11	5
SUM40800	L4 (CEILING GRID/LIGHTS/GRD'S/SPRK ADJUSTMENTS)	12	21JUL11	05AUG11	2
SUM40860	L4 (SERVICE CARRIERS & DROPS TO CASEWORK)	8	25JUL11	03AUG11	4
SUM40820	L4 (CHECK/TEST/START-UP VAV'S)	3	28JUL11	01AUG11	12
SUM40840	L4 (MILESTONE CONDITIONED AIR AVAILABLE)	0		01AUG11	12
SUM40880	L4 (ABOVE GRID INSPECTION)	3	08AUG11	10AUG11	2
SUM40900	L4 (FLOORING)	10	11AUG11	24AUG11	2
SUM40910	L4 (SET CASEWORK & MEP FIXT'S/CONN'S)	20	16AUG11	13SEP11	2
SUM40920	L4 (FINAL PAINT WALLS & CEILING)	8	18AUG11	29AUG11	14
SUM40930	L4 (CASEWORK COUNTERTOPS & SURFACE RACEWAYS)	12	14SEP11	29SEP11	2
SUM40940	L4 (DROP CEILING TILE/DOORS/TRIMOUT)	10	16SEP11	29SEP11	2
SUM40990	L4 (WORK TO COMPLETE LIST)	5	30SEP11	06OCT11	8
LEVEL 5 ROUGH-INS & FINISHES					
SUM50000	L5 (LAYOUT INTERIOR WALLS)	3	18APR11	20APR11	17
SUM50050	L5 (FRAME FIRE & CORRIDOR WALLS, TOP 4' DW)	6	21APR11	28APR11	17
SUM50100	L5 (DUCTWORK/MECH PIPE MAINS)	15	25APR11	13MAY11	17
SUM50150	L5 (DUCTWORK/MECH PIPE BRANCHES)	15	27APR11	17MAY11	23
SUM50580	L5 (HANG DRYWALL PARTITIONS)	10	04MAY11	17MAY11	44
SUM50200	L5 (PLB MAINS FOR DOM/GAS/AIR/VAC)	10	16MAY11	27MAY11	12
SUM50500	L5 (FRAME INTERIOR PARTITIONS)	8	24MAY11	03JUN11	292
SUM50510	L5 (PLUMBING WALL ROUGH-INS)	10	27MAY11	10JUN11	292
SUM50540	L5 (ELEC POWER/LIGHTING WALL ROUGH-IN)	10	27MAY11	10JUN11	297
SUM50300	L5 (FIRE PROTECTION MAINS)	6	31MAY11	07JUN11	285
SUM50210	L5 (PLB BRANCHES FOR DOM/GAS/AIR/VAC)	10	31MAY11	13JUN11	12
SUM50220	L5 (MECH/PLB INSULATION)	12	03JUN11	20JUN11	12
SUM50320	L5 (FIRE PROTECTION BRANCHES)	6	08JUN11	15JUN11	285
SUM50520	L5 (TEST PLUMBING WALL ROUGH-INS)	2	13JUN11	14JUN11	292
SUM50400	L5 (ELEC FEEDER CONDUITS)	8	14JUN11	23JUN11	285
SUM50530	L5 (INSULATE PLUMBING WALL ROUGH-INS)	3	16JUN11	20JUN11	291
SUM50420	L5 (CEILING BRANCH CONDUIT)	12	22JUN11	08JUL11	283
SUM50550	L5 (MEP WALL CLOSE-IN INSPECTIONS)	5	01JUL11	08JUL11	283
SUM50730	L5 (PULL BRANCH WIRE)	8	07JUL11	18JUL11	14
SUM50600	L5 (TAPE & FINISH PARTITIONS)	15	07JUL11	27JUL11	2
SUM50700	L5 (PRIME & 1ST COAT PAINT)	5	28JUL11	03AUG11	2



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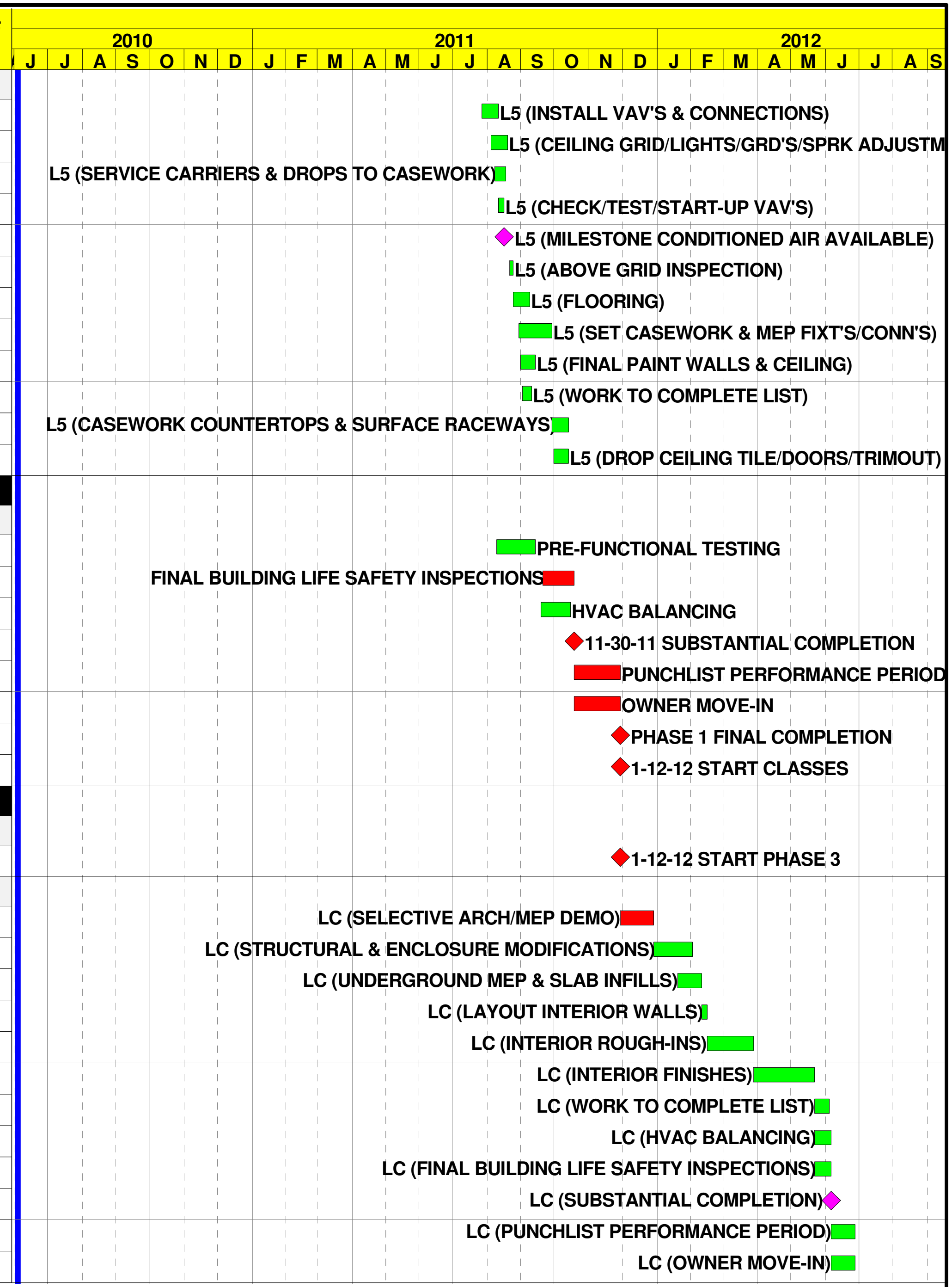
Activity ID	Activity Description	OD	ES	EF	TF
LEVEL 5 ROUGH-INS & FINISHES					
SUM50750	L5 (INSTALL VAV'S & CONNECTIONS)	10	28JUL11	10AUG11	5
SUM50800	L5 (CEILING GRID/LIGHTS/GRD'S/SPRK ADJUSTMENTS)	12	04AUG11	19AUG11	2
SUM50860	L5 (SERVICE CARRIERS & DROPS TO CASEWORK)	8	08AUG11	17AUG11	4
SUM50820	L5 (CHECK/TEST/START-UP VAV'S)	3	11AUG11	15AUG11	5
SUM50840	L5 (MILESTONE CONDITIONED AIR AVAILABLE)	0		15AUG11	12
SUM50880	L5 (ABOVE GRID INSPECTION)	3	22AUG11	24AUG11	2
SUM50900	L5 (FLOORING)	10	25AUG11	08SEP11	2
SUM50910	L5 (SET CASEWORK & MEP FIXT'S/CONN'S)	20	30AUG11	27SEP11	2
SUM50920	L5 (FINAL PAINT WALLS & CEILING)	8	01SEP11	13SEP11	11
SUM50990	L5 (WORK TO COMPLETE LIST)	5	02SEP11	09SEP11	11
SUM50930	L5 (CASEWORK COUNTERTOPS & SURFACE RACEWAYS)	12	28SEP11	13OCT11	2
SUM50940	L5 (DROP CEILING TILE/DOORS/TRIMOUT)	10	30SEP11	13OCT11	2
PHASE 1 FINAL CLOSE-OUT					
PHASE 1 FINAL CLOSE-OUT					
SUM60000	PRE-FUNCTIONAL TESTING	25	09AUG11	13SEP11	5
SUM60100	FINAL BUILDING LIFE SAFETY INSPECTIONS	20	21SEP11	18OCT11	0
SUM60050	HVAC BALANCING	20	19SEP11	14OCT11	2
SUM60200	11-30-11 SUBSTANTIAL COMPLETION	0		18OCT11	0
SUM60300	PUNCHLIST PERFORMANCE PERIOD	28	19OCT11	29NOV11	0
SUM60400	OWNER MOVE-IN	28	19OCT11	29NOV11	0
SUM60500	PHASE 1 FINAL COMPLETION	0		29NOV11	0
SUM60510	1-12-12 START CLASSES	0	30NOV11		0
PHASE 3 RENOVATIONS					
PHASE 3 START RENOVATIONS					
SUM70000	1-12-12 START PHASE 3	0	30NOV11		0
PHASE 3 LEARNING CENTER RENOVATIONS					
SUM71000	LC (SELECTIVE ARCH/MEP DEMO)	20	30NOV11	28DEC11	0
SUM71010	LC (STRUCTURAL & ENCLOSURE MODIFICATIONS)	25	29DEC11	02FEB12	5
SUM71020	LC (UNDERGROUND MEP & SLAB INFILLS)	15	20JAN12	09FEB12	31
SUM72000	LC (LAYOUT INTERIOR WALLS)	3	10FEB12	14FEB12	31
SUM72020	LC (INTERIOR ROUGH-INS)	30	15FEB12	27MAR12	31
SUM72030	LC (INTERIOR FINISHES)	40	28MAR12	22MAY12	31
SUM72640	LC (WORK TO COMPLETE LIST)	8	23MAY12	04JUN12	33
SUM72700	LC (HVAC BALANCING)	10	23MAY12	06JUN12	31
SUM72750	LC (FINAL BUILDING LIFE SAFETY INSPECTIONS)	10	23MAY12	06JUN12	31
SUM72800	LC (SUBSTANTIAL COMPLETION)	0		06JUN12	31
SUM72850	LC (PUNCHLIST PERFORMANCE PERIOD)	15	07JUN12	27JUN12	31
SUM72900	LC (OWNER MOVE-IN)	15	07JUN12	27JUN12	31



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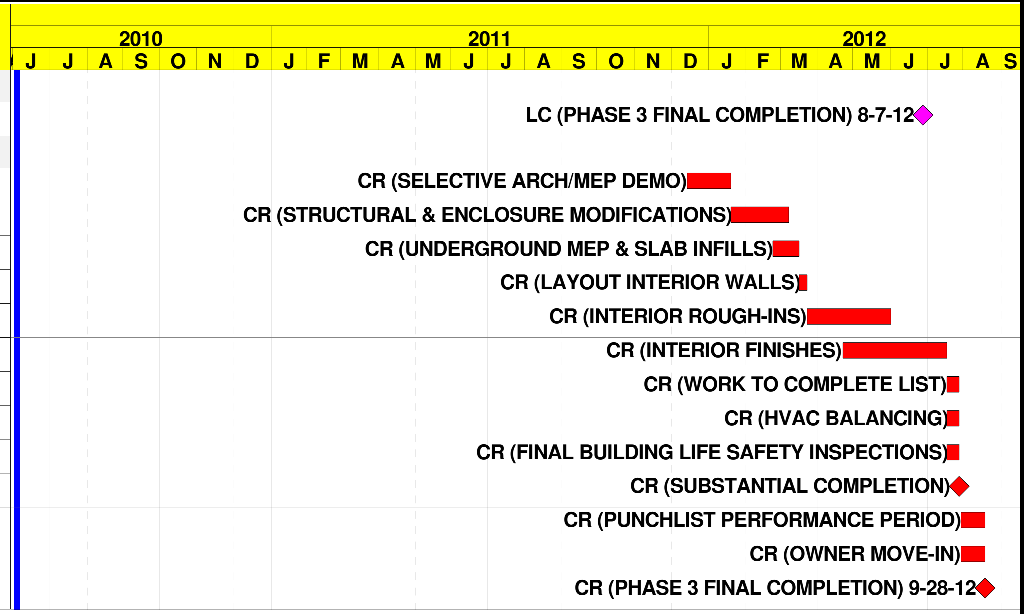
PHASE 3 LEARNING CENTER RENOVATIONS					
SUM72950	LC (PHASE 3 FINAL COMPLETION) 8-7-12	0		27JUN12	31
PHASE 3 CLASSROOM BUILDING					
SUM81000	CR (SELECTIVE ARCH/MEP DEMO)	25	14DEC11	19JAN12	0
SUM81010	CR (STRUCTURAL & ENCLOSURE MODIFICATIONS)	35	20JAN12	08MAR12	0
SUM81020	CR (UNDERGROUND MEP & SLAB INFILLS)	15	24FEB12	15MAR12	0
SUM82000	CR (LAYOUT INTERIOR WALLS)	5	16MAR12	22MAR12	0
SUM82020	CR (INTERIOR ROUGH-INS)	50	23MAR12	01JUN12	0
SUM82030	CR (INTERIOR FINISHES)	60	23APR12	17JUL12	0
SUM82640	CR (WORK TO COMPLETE LIST)	8	18JUL12	27JUL12	0
SUM82700	CR (HVAC BALANCING)	8	18JUL12	27JUL12	0
SUM82750	CR (FINAL BUILDING LIFE SAFETY INSPECTIONS)	8	18JUL12	27JUL12	0
SUM82800	CR (SUBSTANTIAL COMPLETION)	0		27JUL12	0
SUM82850	CR (PUNCHLIST PERFORMANCE PERIOD)	15	30JUL12	17AUG12	0
SUM82900	CR (OWNER MOVE-IN)	15	30JUL12	17AUG12	0
SUM82950	CR (PHASE 3 FINAL COMPLETION) 9-28-12	0		17AUG12	0



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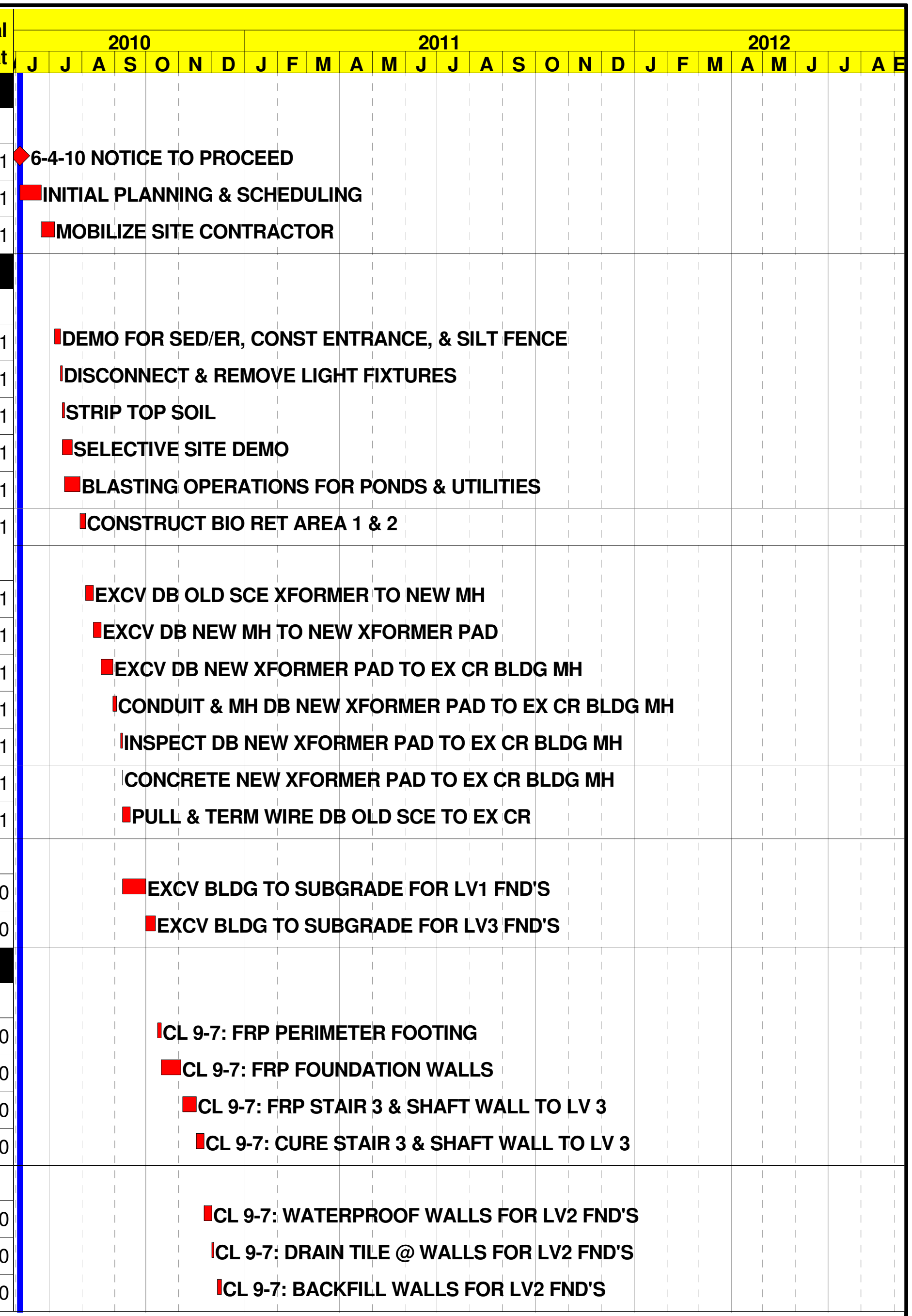
Appendix I

Accelerated Schedule Critical Path

Activity ID	Cal ID	Activity Description	OD	Start	Finish	Total Float
INITIAL SITE MTGS/PERMITS/CRITICAL PROCUREMENT						
NTP/INITIAL SITE MEETINGS/PERMITS						
1	1	6-4-10 NOTICE TO PROCEED	0	04JUN10*		1
10	1	INITIAL PLANNING & SCHEDULING	15	04JUN10	24JUN10	1
20	1	MOBILIZE SITE CONTRACTOR	7	25JUN10	06JUL10	1
INITIAL SITEWORK						
INIITAL SITE DEMO & SED/ER CONTROL						
4000	1	DEMO FOR SED/ER, CONST ENTRANCE, & SILT FENCE	4	07JUL10	12JUL10	1
4010	1	DISCONNECT & REMOVE LIGHT FIXTURES	2	13JUL10	14JUL10	1
4030	1	STRIP TOP SOIL	1	15JUL10	15JUL10	1
4020	1	SELECTIVE SITE DEMO	6	15JUL10	22JUL10	1
4035	1	BLASTING OPERATIONS FOR PONDS & UTILITIES	10	16JUL10	29JUL10	1
4040	1	CONSTRUCT BIO RET AREA 1 & 2	4	30JUL10	04AUG10	1
POWER RELOCATION @ NEW BUILDING PAD						
4200	3	EXCV DB OLD SCE XFORMER TO NEW MH	5	05AUG10	12AUG10	1
4250	3	EXCV DB NEW MH TO NEW XFORMER PAD	4	13AUG10	18AUG10	1
4300	3	EXCV DB NEW XFORMER PAD TO EX CR BLDG MH	7	19AUG10	30AUG10	1
4310	3	CONDUIT & MH DB NEW XFORMER PAD TO EX CR BLDG MH	4	31AUG10	03SEP10	1
4320	3	INSPECT DB NEW XFORMER PAD TO EX CR BLDG MH	1	07SEP10	07SEP10	1
4330	3	CONCRETE NEW XFORMER PAD TO EX CR BLDG MH	1	08SEP10	08SEP10	1
4350	1	PULL & TERM WIRE DB OLD SCE TO EX CR	5	09SEP10	15SEP10	1
BUILDING PAD EXCAVATION						
5100	3	EXCV BLDG TO SUBGRADE FOR LV1 FND'S	15	08SEP10	30SEP10	0
5120	3	EXCV BLDG TO SUBGRADE FOR LV3 FND'S	5	01OCT10	08OCT10	0
SUBSTRUCTURE						
CL 9-7 LV1 SUBSTRUCTURE						
6010	3	CL 9-7: FRP PERIMETER FOOTING	3	11OCT10	14OCT10	0
6020	3	CL 9-7: FRP FOUNDATION WALLS	12	15OCT10	02NOV10	0
6040	3	CL 9-7: FRP STAIR 3 & SHAFT WALL TO LV 3	8	04NOV10	16NOV10	0
6050	2	CL 9-7: CURE STAIR 3 & SHAFT WALL TO LV 3	7	17NOV10	23NOV10	0
9-7 WALL BRACING/WP/BACKFILL FOUNDATION WALLS						
6620	3	CL 9-7: WATERPROOF WALLS FOR LV2 FND'S	3	24NOV10	30NOV10	0
6630	3	CL 9-7: DRAIN TILE @ WALLS FOR LV2 FND'S	2	02DEC10	03DEC10	0
6640	3	CL 9-7: BACKFILL WALLS FOR LV2 FND'S	4	06DEC10	10DEC10	0



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Activity ID	Cal ID	Activity Description	OD	Start	Finish	Total Float
CL 9.2-11.5: LV3 SUBSTRUCTURE						
6700	3	CL 9.2-11.5: DRILL/INSTALL ROCK ANCHORS	3	13DEC10	16DEC10	0
6710	3	CL 9.2-11.5: TEST & INSPECT ROCK ANCHORS	3	17DEC10	21DEC10	0
6720	3	CL 9.2-11.5: FRP PERIMETER FOOTING	4	23DEC10	30DEC10	0
6730	3	CL 9.2-11.5: FRP FOUNDATION WALL	8	03JAN11	14JAN11	0
6740	3	CL 9.2-11.5: FRP STAIR #2 SHAFT WALL TO ROOF	12	10JAN11	28JAN11	0
7-9 LV2 SLAB ON GRADE						
6800	3	CL 9-7: INTERIOR BACKFILL TO GRADE FOR LV2	2	17JAN11	18JAN11	0
6820	3	CL 9-7: UNDERGROUND PLB ROUGH IN FOR LV2 SOG	3	20JAN11	24JAN11	0
6840	3	CL 9-7: UNDERGROUND ELEC ROUGH IN FOR LV2 SOG	1	25JAN11	25JAN11	0
6850	3	CL 9-7: STONE FILL/SLAB PREP FOR LV2 SOG	2	27JAN11	28JAN11	0
6860	3	CL 9-7: IN-STONE ELECTRICAL ROUGH IN FOR LV2 SOG	2	31JAN11	01FEB11	0
6880	3	CL 9-7: LV2 POUR SLAB ON GRADE	1	03FEB11	03FEB11	0
CL 9.2-11.5: LV3 SLAB ON GRADE						
6910	3	CL 9.2-11.5: INTERIOR BACKFILL TO GRADE FOR LV3	3	31JAN11	03FEB11	0
6920	3	CL 9.2-11.5 UNDERGROUND PLB ROUGH IN FOR LV3 SOG	3	04FEB11	09FEB11	0
6940	3	CL 9.2-11: UNDERGROUND ELEC ROUGH IN FOR LV3 SOG	1	11FEB11	11FEB11	0
6950	3	CL 9.2-11.5: STONE FILL/SLAB PREP FOR LV3 SOG	2	14FEB11	15FEB11	0
6960	3	CL 9.2-11.5: IN-STONE ELEC ROUGH IN FOR LV3 SOG	2	17FEB11	18FEB11	0
6980	3	CL 9.2-11.5: LV3 POUR SLAB ON GRADE	1	21FEB11	21FEB11	0
SUPERSTRUCTURE STEEL						
STEEL WEST SIDE LV3 TO ROOF						
7100	3	CL 1-7: ERECT COL & BEAMS 3RD TO ROOF	5	04FEB11	14FEB11	0
7110	3	CL 1-7: METAL DECK 4TH, 5TH & ROOF	4	15FEB11	21FEB11	0
7120	3	CL 1-7: DETAIL STEEL 4TH FLOOR	3	22FEB11	25FEB11	0
7130	3	CL 1-7: DETAIL STEEL 5TH FLOOR	3	28FEB11	03MAR11	0
7140	3	CL 1-7: DETAIL STEEL ROOF	3	04MAR11	08MAR11	0
STEEL EAST SIDE LV 3 TO ROOF						
7200	3	CL 7-11.1: ERECT COL & BEAMS 3RD TO ROOF	5	22FEB11	01MAR11	0
7210	3	CL 7-11.1: METAL DECK 4TH, 5TH & ROOF	4	03MAR11	08MAR11	0
7220	3	CL 7-11.1: DETAIL STEEL 4TH FLOOR	3	10MAR11	14MAR11	0
7230	3	CL 7-11.1: DETAIL STEEL 5TH FLOOR	3	15MAR11	18MAR11	0
7240	3	CL 7-11.1: DETAIL STEEL ROOF	3	21MAR11	24MAR11	0

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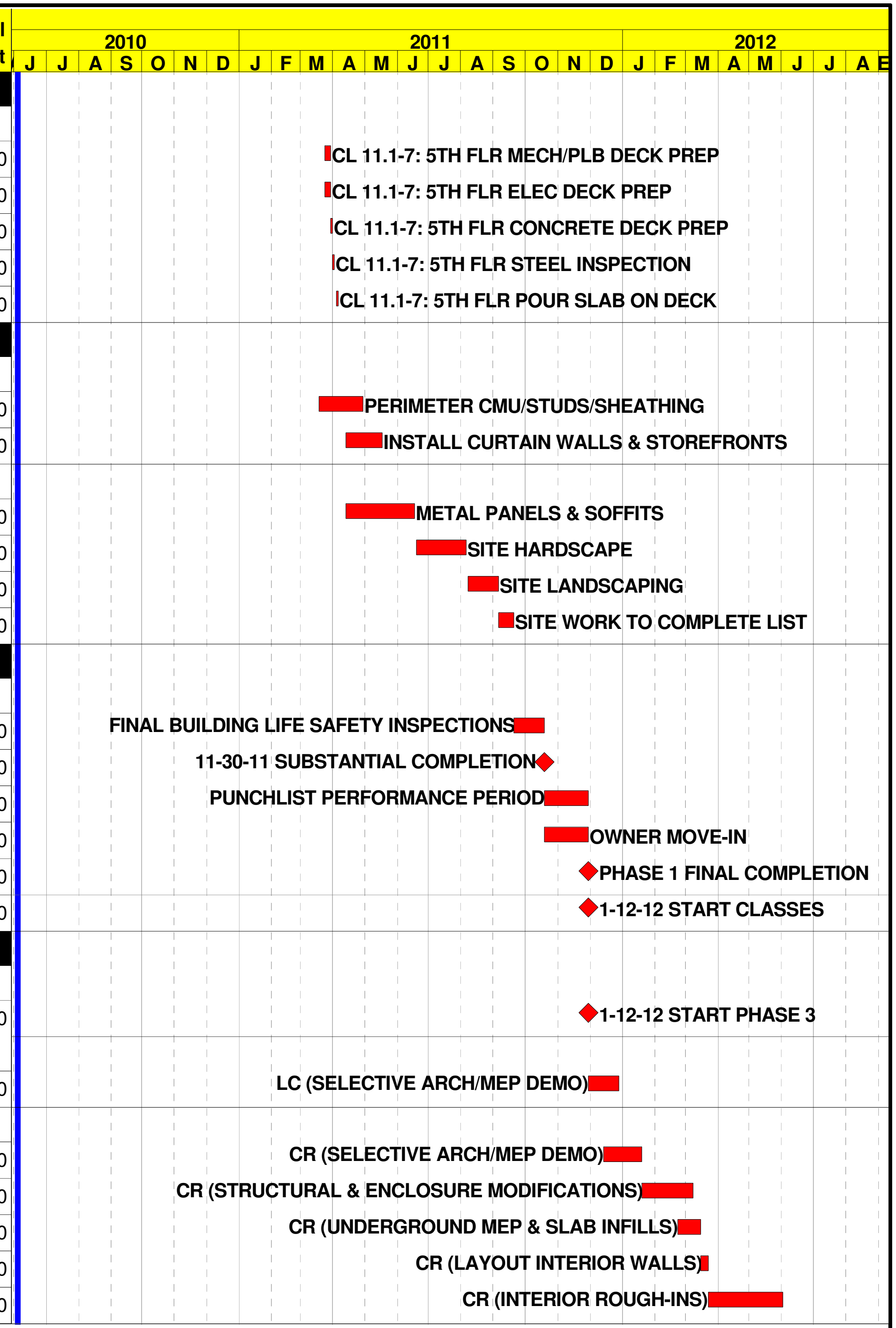
SLAB ON DECK PLACEMENTS						
EAST LEVEL 4 & LEVEL 5 SLAB ON DECK PLACEMENTS						
8500	3	CL 11.1-7: 5TH FLR MECH/PLB DECK PREP	2	25MAR11	28MAR11	0
8510	3	CL 11.1-7: 5TH FLR ELEC DECK PREP	2	25MAR11	28MAR11	0
8520	3	CL 11.1-7: 5TH FLR CONCRETE DECK PREP	2	29MAR11	31MAR11	0
8530	3	CL 11.1-7: 5TH FLR STEEL INSPECTION	1	01APR11	01APR11	0
8550	3	CL 11.1-7: 5TH FLR POUR SLAB ON DECK	1	04APR11	04APR11	0
ENCLOSURE & SITE FINISHES						
SUMMARY ENCLOSURE						
SUM90100	3	PERIMETER CMU/STUDS/SHEATHING	25	18MAR11	29APR11	0
SUM90500	3	INSTALL CURTAIN WALLS & STOREFRONTS	20	14APR11	17MAY11	0
SITE FINISHES						
SUM91000	3	METAL PANELS & SOFFITS	40	14APR11	17JUN11	0
SUM91100	3	SITE HARDSCAPE	30	20JUN11	05AUG11	0
SUM91200	3	SITE LANDSCAPING	20	08AUG11	05SEP11	0
SUM91300	3	SITE WORK TO COMPLETE LIST	10	06SEP11	20SEP11	0
PHASE 1 FINAL CLOSE-OUT						
PHASE 1 FINAL CLOSE-OUT						
SUM60100	1	FINAL BUILDING LIFE SAFETY INSPECTIONS	20	21SEP11	18OCT11	0
SUM60200	1	11-30-11 SUBSTANTIAL COMPLETION	0		18OCT11	0
SUM60300	1	PUNCHLIST PERFORMANCE PERIOD	28	19OCT11	29NOV11	0
SUM60400	1	OWNER MOVE-IN	28	19OCT11	29NOV11	0
SUM60500	1	PHASE 1 FINAL COMPLETION	0		29NOV11	0
SUM60510	1	1-12-12 START CLASSES	0	30NOV11		0
PHASE 3 RENOVATIONS						
PHASE 3 START RENOVATIONS						
SUM70000	1	1-12-12 START PHASE 3	0	30NOV11		0
PHASE 3 LEARNING CENTER RENOVATIONS						
SUM71000	1	LC (SELECTIVE ARCH/MEP DEMO)	20	30NOV11	28DEC11	0
PHASE 3 CLASSROOM BUILDING						
SUM81000	1	CR (SELECTIVE ARCH/MEP DEMO)	25	14DEC11	19JAN12	0
SUM81010	1	CR (STRUCTURAL & ENCLOSURE MODIFICATIONS)	35	20JAN12	08MAR12	0
SUM81020	1	CR (UNDERGROUND MEP & SLAB INFILLS)	15	24FEB12	15MAR12	0
SUM82000	1	CR (LAYOUT INTERIOR WALLS)	5	16MAR12	22MAR12	0
SUM82020	1	CR (INTERIOR ROUGH-INS)	50	23MAR12	01JUN12	0



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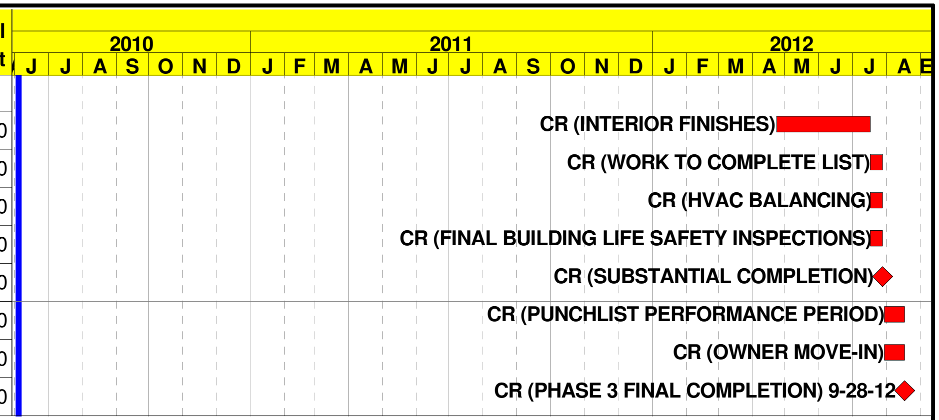
PHASE 3 CLASSROOM BUILDING						
SUM82030	1	CR (INTERIOR FINISHES)	60	23APR12	17JUL12	0
SUM82640	1	CR (WORK TO COMPLETE LIST)	8	18JUL12	27JUL12	0
SUM82700	1	CR (HVAC BALANCING)	8	18JUL12	27JUL12	0
SUM82750	1	CR (FINAL BUILDING LIFE SAFETY INSPECTIONS)	8	18JUL12	27JUL12	0
SUM82800	1	CR (SUBSTANTIAL COMPLETION)	0		27JUL12	0
SUM82850	1	CR (PUNCHLIST PERFORMANCE PERIOD)	15	30JUL12	17AUG12	0
SUM82900	1	CR (OWNER MOVE-IN)	15	30JUL12	17AUG12	0
SUM82950	1	CR (PHASE 3 FINAL COMPLETION) 9-28-12	0		17AUG12	0



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