October 4, 2010

Technical Assignment One

Penn State AE Senior Thesis

UMBC
Performing Arts &
Humanities Facility
Baltimore, MD

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Executive Summary

Technical Assignment One comprisesof an investigation into the existing conditions and parameters that influenced the design and construction of the UMBC Performing Arts & Humanities Facility. This project includes a new state-of-the-art facility for the University of Maryland Baltimore County's Arts and Humanities departments that will enhance its teaching, research and public outreach programs while simultaneously improving the visibility of the arts and humanities as a major component of campus and community life. This report is intended to provide an in-depth analysis of background information relating to the project. Areas of research include milestones within the project schedule, systems incorporated into the design of the building, project costs, existing conditions, the project delivery system and the project staffing plan.

The UMBC Performing Arts & Humanities Facility is a $67 million, 90,000 SF addition to the UMBC campus. The new PAHF will contain a variety of performance spaces, classrooms, labs, seminar rooms and student lounges. PAHF departments struggle to adequately support the collaborative environment needed by UMBC's growing Arts and Humanities departments. The new building will combine these departments and performance venues into one large facility and will encourage shared research and study across the departments, providing a new cultural hub for the campus and community.

The largest challenge associated with this project is the complicated relationship between the site excavations, structural excavation, foundations and structural elements. Certain areas are isolated structurally causing a delay in the progress of adjacent work. Another aspect that makes this project difficult is that the structural system is made up of three different systems; concrete, masonry, and steel. The schedule needs to be carefully planned out and evaluated to ensure the highest quality and most efficient project.

The university and the client user groups paired up with the architects and engineers early in the design process to establish a number of specific design principles and opportunities to incorporate sustainability into the building. The UMBC PAHF project is participating in the United States Green Building Council's Leadership in Energy and Environmental Design (LEED®) program and is striving for a LEED® Silver Certified rating. This project is expected to be the first building on campus to earn LEED® Certification. To accommodate the constraints of the project schedule and project costs, UMBC has brought in the experience of The Whiting-Turner Contracting Company to the project team. Together, the entire project team aims their goals at making the project a success.

Project Schedule Summary

**** SEE APPENDIX – A FOR THE PROJECT SUMMARY**
(NOTE: the schedule described in the appendix is prior to the one year delay due to funding)

The Whiting-Turner Contracting Company was awarded the General Contracting responsibilities for the UMBC Performing Arts & Humanities Facility. The funding was approved in May 2010 followed by the Notice to Proceed in June 2010. The construction for this new building is designed into two phases, each phase providing different types of space for various departments. Phase one consists of a four story, 90,000sf facility providing a variety of performing arts amenities shown on the right hand side of Figure 1 in blue.This phase of the project also includes upgrades to the existing Central Utility Plant and a concrete structure/tunnel connecting the existing Plant Tunnel to the new Performing Arts Facility.Phase two is still in the design process and the projected start date for this portion is not until 2013.This phase will provide space for the Departments of Ancient Studies, Dance, Music and Philosophy as shown on the left hand side of Figure 1 in pink.

Figure 1: Phasing Diagrams for Level 1 (provided by architects)

Mobilization of the field staff on site started directly after the NTP as well as the major construction activities. These activities consist of clearing the existing parking lot, installation of the excavation support system, and major excavation.There is a complicated relationship between the site excavations, structural excavation, foundations and structural elements. There are multiple structural systems being used on this project. The different systems incorporated into this building are concrete structures, masonry bearing structures, structural steel, and some areas have a combination of all three. Certain areas are isolated structurally from adjacent areas and since there are varying depths of excavation and areas of structural foundation, this will cause a hold up in the progression of the adjacent foundation work. Similarly, due to the structural concrete isolation of the theatre, the steel structure of the building in the areas outside of the theatre will also be postponed. One would think the structural steel structure could proceed since it is independent of the concrete theatre, especially since they are designed to be isolated from one another and therefore do not rely on each other for support. Unfortunately, the concrete structure of the theatre (which is the slowest section compared to the installation of steel) has to be installed prior to the steel for constructability reasons. Basically, no one is allowed to work below the concrete installation operation, and therefore that adversely affects the installation of the steel at the humanities portion of the building. A special element that affects the schedule with respect to finishes is the colored, ground, polished concrete in the theatre. It needs to be carefully scheduled to balance the needs for access onto that slab area for the entrance of the construction above, protection for above, and then removal of the protection. The grinding and polishing of the floor in the theatre has to be done at a time when the majority of the work in the theatre is complete. Then the floor needs to be protected again so that the finish work that comes afterwards can be done without harming the finished/polished floor surface. Finally the protection is removed from the theatre floor and the fixed seating is installed. The project completion date is to be achieved in late June 2012 and will allow for UMBC students and faculty to inhabit their new facility.

Building Systems Summary

BUILDING SYSTEMS SUMMARY		
YES	NO	WORK SCOPE
X		Demolition Required
X		Structural Steel Frame
X		Cast in Place Concrete
	X	Precast Concrete
X		Mechanical System
X		Electrical System
X		Masonry
X		Curtain Wall
X		Support of Excavation

Table 1: Building Systems Checklist

Demolition

The site of the UMBC Performing Arts & Humanities Facility was previously utilized by the university as a surface parking lot as shown in Figure 2. Before any of the excavation work can begin, all of the asphalt, concrete curbs, utilities, site lighting, parking control gates, railings, stairs, etc. need to be cleared out. There are no hazardous materials expected to be in the demolition of the site. The materials being demolished are concrete and asphalt and other yard structures on the site. Boring logs provided by Schnabel Engineering Associates for one of the parking lots suggest more concern about citing basements relative to the water table and bedrock. Some unsuitable fills may exist across the site which may require removal and replacement.

Figure 2: Parking Lot Demolition, July 13, 2010

Structural Steel

The complex is composed of a variety of spaces including the three performance spaces, a scene shop, studios, classrooms, offices and support. To respond to the variety of spatial and performance challenges, a composite structural steel frame is recommended. Floor slabs will generally be composed of 2" 20-gage galvanized steel deck plus 3-1/4" of lightweight concrete reinforced with WWF 6x6 x W2.9 X W2.9 creating a 2-hour floor system. The slab will be supported by composite steel beams ranging in depth from 12" at 20' to 18" at 40' spans. In general, column spacings have been planned to allow floor beams and girders not to exceed a total structural envelope of 2'-0". This will expand slightly at some spaces such as the dance studio when a built-up floor with a damping slab and floor vibration criteria may require a slightly deeper structure. There are 6 different roof elevations and many will have roof-top units supported thereon. Roof screen frames are also required. The baseline scheme suggests the use of composite steel construction for all roofs as the concrete is necessary for noise attenuation. Column sizes are generally W10s, although larger columns may be required at tall spaces such as the scene shop and theatre rehearsal spaces.A crane will be used to place the steel and the composite metal deck. I was unable to determine the location and size of the crane at this time however, a crawler cranewould be logical to use because it could move around the building to different locations to reduce the number of movements by the crane.

Cast in Place Concrete

The Performance spaces require concrete walls which are isolated from the adjoining spaces. The concrete walls will support the floor and roof framing within the performance spaces. A combination of cast-in-place concrete and steel framing will support the floors and balconies of these spaces. The concrete walls surrounding the performance spaces will be 18" cast-in-place concrete walls which will serve as the lateral and vertical supports resisting wind and seismic forces and also providing noise and vibration isolation from the surrounding spaces. As these walls are isolated from the surrounding structure for acoustic reasons, the bordering columns of the steel frame will have diagonal braced frames to stabilize the surrounding structure. In general, the stepped and curved seating platforms for the proscenium theatre and concert hall are planned cast-in-place concrete construction. At the rear of the proscenium theatre, two pilasters will be required to supplement lateral support. Steel plates with headed shear connectors will be cast into the walls to support the steel framing. The mechanical room and Concert Hall required basement walls to be 16" thick with reinforcing to support the backfill. The concrete placement methods will be with a concrete truck and pump, but also the use of the crane and bucket will be utilized.

Mechanical System

The mechanical rooms are located in the basement level of the new PAHF. A goal of the HVAC systems will be to minimize energy consumption while maintaining space design criteria. Some of the interesting features that contribute to LEED are an automatic shutdown of air handling systems during unoccupied hours subject to building low and high temperature and humidity limits. The controls isolate supply air flow to each floor served from centralized air handling systems based on the floor occupancy schedule. This will be accomplished through DDC system programming, to isolate airflow per floor and per AHU, by closing air terminal unit dampers or floor zone dampers during unoccupied mode. The occupancy sensor controls are reducing the air supply to each space during the day when not in use. There are variable airflow air handling systems with variable frequency controlled fans and variable water flow heating and chilled water distribution systems with variable frequency controls. There is energy recovered from exhaust air and temper outdoor air by the total energy recovery heat wheels.

Cooling and dehumidification control for the building will be provided from the campus chilled water distribution system. A pair of 10" chilled water mains are proposed to serve the building. The chilled water system will utilize variable flow pumping within the building via three base-mounted, bronze fitted, end-suction pumps. The campus high temperature hot water system will be utilized as the energy source for heating and domestic hot water generation within the new facility. Preliminary load estimates of design day heating and domestic water requirements for the new facility indicate a peak hourly load of approximately 9100 MBH. The HTHW mains will extend to three shell and tube heat exchangers for low temperature hot water heating service. Chemical water treatment for the HTHW system will be provided at the central plant by UMBC. Humidity will be controlled year around throughout the facility due to its impact on the short term tuning and the long term preservation of musical instruments, and due to the intermittent high occupancy levels which will require the introduction of large amounts of outdoor air. Steam will be generated to humidify the building by point of used gas fired steam humidifiers generally for each AHU located within the building. The facility will be conditioned by fifteen air-handling units, providing each space with their own capacity. The AHU's airflow quantities will be controlled by VFCs, not inlet vanes or any other control device. Each system

will have a dedicated roof mounted spark resistant exhaust fan, corrosion resistant exhaust ductwork, and automatic isolation dampers.

An 8" combined (fire and domestic) water service will be provided. Once inside the building, the service will split into separate domestic water and fire suppression systems. Because of low water pressure in this portion of the campus distribution system, an electric fire pump will be provided in a dedicated fire pump room on the First Floor. Two fire department Siamese connections will be provided on the exterior of the building. An alarm bell will also be provided on the exterior of the building adjacent to the Siamese connections. Inside, the building will be protected throughout by hydraulically designed automatic wet pipe sprinkler systems.

Electrical System

The electrical rooms are located in the basement level of the new PAHF. The electrical system has 15kv medium voltage feeders that come off of the substations. A unit substation consists of two 15kv, 600 amp switches (incoming); one 15kv, 600 amp switch (outgoing); 2500 KVA transformer; and 3200 Amp, 480Y/277 volt, 3 phase, 4 wire, 60 hertz switchgear. Power will be distributed at 480Y/277 volts and dry type transformers will be provided to supply 208Y/120 volt loads. Emergency power will be provided by a natural gas-fired engine generator with a 600KW, 480Y/277 volt, 3 phase, 4 wire set. The facility program required the switchgear to be a double-ended substation, but in the project team meetings, UMBC has decided that a single line up with one transformer is sufficient for this building and a double ended substation is not required.

Masonry

The masonry on this project consists of 8" CMU block as the exterior load bearing wall covered with a brick veneer façade as shown in Figure 3. The other side of this elevation is also brick veneer façade but there is not 8" CMU used as the backing. The connection is face brick with lipped bricks at lintels and relieving angles attached with masonry anchors. It is assumed that the brick veneer will be relieved at each floor. A relieving angle system is hung from the spandrel beam at the roof, 3rd and 2nd floors using galvanized relieving angles. The scaffolding will be erected for the first portion and then repositioned for the next.

Figure 3: South Elevation Rendering

Curtain Wall

The curtain wall systems found on this project are located on the north and south elevations as shown in Figure 3. They are made up of 8" aluminum framing with 1" insulating glass and custom cap covers. All of the windows throughout the classrooms and offices, including the curtain wall system, have a Low-E coating on the surface. The windows are located in those particular spaces to allow for daylight to penetrate into the space. Aluminum storefront doors are also found where the vestibules and entrances are located.

Support of Excavation

A beam and lagging system is used for the structural excavation support of the basement and tunnel areas as well as for the installation of the underground rain water harvest tank. Other areas of excavation are standard cut/fill operations. The site does not anticipate a dewatering system because it is located at the edge of the groundwater elevations per the soils report and will only need spot watering.

Central Utility Plant Overview

The Central Plant is located to the north of the proposed PAHF building site and provides electrical, high temperature heating water and chilled water services to campus buildings primarily through a system of underground utility tunnels. Construction of the PAHF building requires expansion of the existing UMBC Central Plant, and extension of the existing utility tunnel to provide electrical, high temperature heating water and chilled water to the building. The campus chilled water distribution system will also be upgraded with the installation of new underground piping to hydraulically loop existing chilled water mains to provide chilled water to the hydraulically remote buildings once the PAHF building is brought online. A new utility tunnel will connect the Phase 1 side of the PAHF building with the existing utility tunnel network connected to the Central Plant. This tunnel will be constructed with 10”-16” concrete walls and ceiling and a concrete slab on grade. The most efficient design for the roof of the tunnel will most likely be a cast in place concrete slab, reinforced to produce a box structure. The Central Plant is an existing structure of concrete/masonry bearing walls, with a steel joist roof supported on steel/concrete columns.

LEED Design Aspects

The UMBC Performing Arts & Humanities Facility is striving to achieve a LEED Silver rating which incorporates many sustainability design features. As stated previously, this project is expected to be the first building on campus to earn LEED Certification.Some of the LEED credits associated with this project include Pollution Prevention, Alternative Transportation, Waste Management, and Low-Emitting Materials.

To reduce the pollution, the construction activities control the soil erosion, waterway sedimentation, and airborne dust generation. Also by using alternative transportation such as bicycles, carpools, and fuel efficient vehicles the pollution and land development impacts can be reduced greatly. A sustainable landscape will be achieved by building atop an existing parking lot and planting grass surrounding the building. For waste management, the project requirement is to divert 50% of construction debris from disposal and the project goal is to use materials with recycled content within 500 miles of the project site. For example, the interior wood products are all FSC (Forest Service Conservation) certified.

This project has low water usage by providing low or no flow toilet fixtures. Also installed to this building will be a rainwater harvesting system reusing water for irrigation. Inside the building, low-emitting materials will be used to reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort of the installers and occupants. This is important to have everything controlled in the building by indoor air quality management so that contaminants will not remain in the building. The Low E coating on the glass units reduces radiant heating of the building, thereby

decreasing the use of mechanical and electrical equipment to temper the building. The roofing system is comprised of an energy star thermoplastic membrane having a reflective surface. This will also reduce the radiant heating of the interior spaces of the building.

An extensive commissioning procedure will be followed at the end of the project to ensure proper functioning of all building elements, and that they meet LEED requirements. See attached LEED scorecard for the total points in each section that make up the LEED Silver rating for this project.

LEED® for New Construction

Credit Scorecard

LEED-NC Green Building Rating System, version 2.2, final version

UMBC Performing Arts and Humanities Facility

Grimm & Parker

June 4, 2010

Sustainable Design Consulting

Y	?	N			
44	2	23	**Total Project Score**		Possible Points **69**

Certified 26 to 32 points **Silver** 33 to 38 points **Gold** 39 to 51 points **Platinum** 52 or more points

Sustainable Sites — Possible Points 14

Y	?	N			
Y			Prereq 1	**Construction Activity Pollution Prevention**	
1			Credit 1	**Site Selection**	1
1			Credit 2	**Development Density & Community Connectivity**	1
		1	Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation:** Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation:** Bicycle Storage & Changing Rooms	1
1			Credit 4.3	**Alternative Transportation:** Low Emitting & Fuel Efficient Vehicles	1
1			Credit 4.4	**Alternative Transportation:** Parking Capacity	1
		1	Credit 5.1	**Site Development:** Protect or Restore Habitat	1
1			Credit 5.2	**Site Development:** Maximize Open Space	1
1			Credit 6.1	**Stormwater Design:** Quantity Control	1
1			Credit 6.2	**Stormwater Design:** Quality Control	1
1			Credit 7.1	**Heat Island Effect:** Non-Roof	1
1			Credit 7.2	**Heat Island Effect:** Roof	1
	1		Credit 8	**Light Pollution Reduction**	1

Water Efficiency — Possible Points 5

Y	?	N			
1			Credit 1.1	**Water Efficient Landscaping:** Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping:** No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction:** 20% Reduction	1
1			Credit 3.2	**Water Use Reduction:** 30% Reduction	1

Energy & Atmosphere — Possible Points 17

Y	?	N			
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	
Y			Prereq 2	**Minimum Energy Performance**	
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	
2			Credit 1.1	**Optimize Energy Performance:** 14% New / 7% Existing	2
		2	Credit 1.2	**Optimize Energy Performance:** 21% New / 14% Existing	2
		2	Credit 1.3	**Optimize Energy Performance:** 28% New / 21% Existing	2
		2	Credit 1.4	**Optimize Energy Performance:** 35% New / 28% Existing	2
		2	Credit 1.5	**Optimize Energy Performance:** 42% New / 35% Existing	2
		1	Credit 2.1	**On-Site Renewable Energy:** 2.5%	1
		1	Credit 2.2	**On-Site Renewable Energy:** 7.5%	1
		1	Credit 2.3	**On-Site Renewable Energy:** 12.5%	1
1			Credit 3	**Enhanced Commissioning**	1
1			Credit 4	**Enhanced Refrigerant Management**	1
1			Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

Materials & Resources — Possible Points 13

Y	?	N			
Y			Prereq 1	**Storage & Collection of Recyclables**	
		1	Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors & Roof	1
		1	Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors & Roof	1
		1	Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management:** Divert 50% from Disposal	1
	1		Credit 2.2	**Construction Waste Management:** Divert 75% from Disposal	1
		1	Credit 3.1	**Materials Reuse:** 5%	1
		1	Credit 3.2	**Materials Reuse:** 10%	1
1			Credit 4.1	**Recycled Content:** 10% (post-consumer + 1/2 pre-consumer)	1
1			Credit 4.2	**Recycled Content:** 20% (post-consumer + 1/2 pre-consumer)	1
1			Credit 5.1	**Regional Materials:** 10% Extracted, Processed & Manufactured Regiona	1
1			Credit 5.2	**Regional Materials:** 20% Extracted, Processed & Manufactured Regiona	1
		1	Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1

Indoor Environmental Quality — Possible Points 15

Y	?	N			
Y			Prereq 1	**Minimum IAQ Performance**	
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	
1			Credit 1	**Outdoor Air Delivery Monitoring**	1
		1	Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan:** Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials:** Paints	1
1			Credit 4.3	**Low-Emitting Materials:** Carpet	1
1			Credit 4.4	**Low-Emitting Materials:** Composite Wood & Agrifiber Products	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems:** Lighting	1
1			Credit 6.2	**Controllability of Systems:** Thermal Comfort	1
1			Credit 7.1	**Thermal Comfort:** Design	1
1			Credit 7.2	**Thermal Comfort:** Verification	1
		1	Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views:** Views for 90% of Spaces	1

Innovation & Design Process — Possible Points 5

Y	?	N				
1			Credit 1.1	**Innovation in Design:**	Green Educational Program	1
1			Credit 1.2	**Innovation in Design:**	Green Housekeeping Program	1
1			Credit 1.3	**Innovation in Design:**	40% Water Efficiency	1
1			Credit 1.4	**Innovation in Design:**	Maximize Open Space	1
1			Credit 2	**LEED Accredited Professional**		1

Design credit accepted

Credit clarification uploaded

Project Cost Evaluation

The actual construction costs are based on the GMP tabulation provided by The Whiting-Turner Contracting Company. The amounts are slightly altered and rounded for comparison purposes. All costs shown do not represent actual bid costs for the project.

Project Parameters

Total Square Footage:	90,000 SF
Total Building Perimeter:	768 LF

Construction Cost

Actual:	$63,034,950
Per SF:	$700.39

Total Project Cost

Actual:	$67,735,293
Per SF:	$752.61

Major Building Systems Cost

Major Building Systems		
System	Actual	Per SF
Concrete	$5,484,200	$60.94
Masonry	$1,730,188	$19.22
Steel/Metals	$4,515,340	$50.17
Mechanical	$11,774,000	$130.82
Electrical	$8,285,510	$92.06

Table 2: Major Building Systems Cost Estimate

D4 Cost Estimate

****See APPENDIX B for D4 Cost Estimate**

Actual:	$11,278,262
Per SF:	$125.31

R.S. Means Square Foot Estimate

****See APPENDIX C for RS Means Estimate**

Classroom/Offices

Actual:	$5,413,500
Per SF:	$206.18

Auditorium

Actual:	$1,734,000
Per SF:	$163.41

Total Construction (Classroom/Offices + Auditorium)

Actual:	$7,147,500
Per SF:	$184.80

Cost Comparison

When comparing the estimates, it can be seen that both D4 Cost Estimating and RS Means produce considerably lower results than the actual costs of construction. The actual costs of construction were used as a basis for comparison rather than the total project costs due to the fact that the estimating software does not account for site work, contingencies, insurance, fees, etc.

The D4 Cost estimate is approximately $52 million below the actual construction cost, or $575.08/SF less. After analyzing the estimate, it was determined that a major source of error occurred when selecting the case study that was used as a basis for comparison. Due to the limited educational performing arts facilities within the database, the one chosen for comparison was a performing arts center that was not as large and not as costly and UMBC's PAHF. Also the one chosen did not account for classrooms and offices, only the performing arts amenities. It is felt that since the estimate selected was not completely comparable in price or size, so that is why the costs are extremely low. This is a direct result of the software not being able to account for all of the information in their provided case studies.

The estimate from RS Means was generated from their CostWorks software and was also significantly low in cost. Since RS Means does not have a performing arts facility option with classrooms and offices for the square foot estimator, two estimates were run to account for the different facilities. The first estimate was a 2-3 story college classroom with face brick and steel framing. However, the actual structure pertaining to the classrooms and offices consisted of 4 stories. The second estimate was an auditorium with concrete block and steel framing. The actual exterior façade surrounding the PAHF auditorium is made up of metal panels not concrete. Also the actual total height exceeded the limits on the chosen auditorium from RS Means. The result of combining these two issues and having slight discrepancies within the two chosen, reflected in significantly lower costs of construction.

Site Plan of Existing Conditions

****See APPENDIX D for the Existing Conditions Site Logistics Plan**

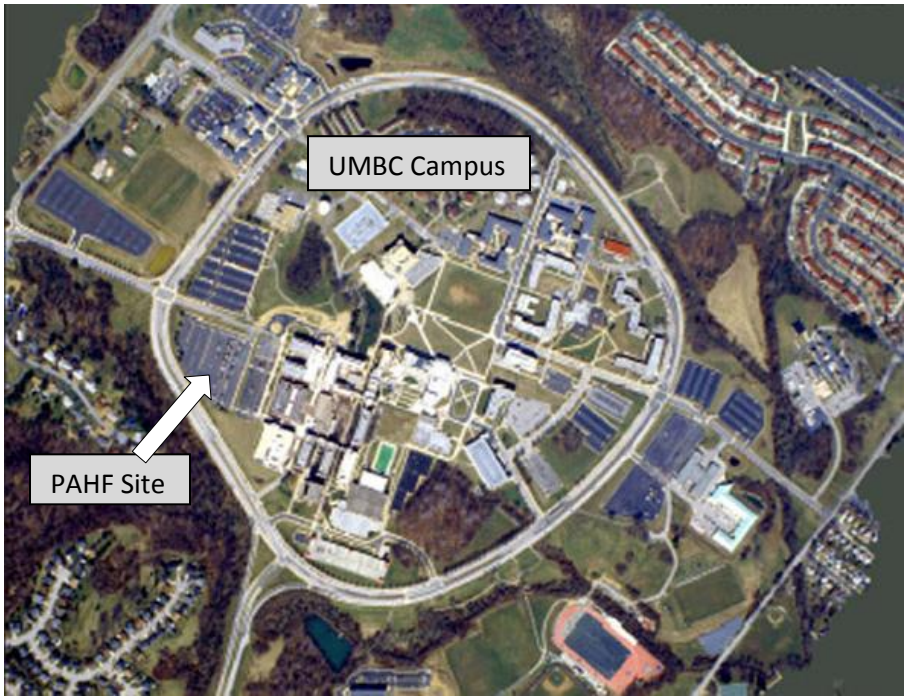


Figure 4: Aerial View of UMBC Campus and Surrounding Area

The site for the new Performing Arts & Humanities Facility is located adjacent to the existing Fine Arts, Engineering and ITE Buildings. The Fine Arts Building, located northeast of the proposed site, has served as the university's principal exhibition space – a forum for students, professors, and staff, as well as the general public to experience contemporary visual culture and to dialogue about important cultural and aesthetic issues. The existing Engineering Building, located directly east of the site, houses the Center for Photonics Technology, which conducts research in fiber optics. The ITE Building located southeast of the site, new in 2003, houses the Department of Computer Science and Electrical Engineering, the Department of Information Systems, the offices of the College of Engineering, the Center for Women and Information Technology and the Imaging Research Center, which is the state-of-the-art computer - based research and production facility specializing in high end computer animation and visualization. While public vehicular and pedestrian traffic is not a concern since the site is located on a private campus, the site is currently comprised of two parking lots providing 690 parking spaces for the campus and will need to be addressed during construction. Since the site consists of two parking lots, it will not be necessary to remove existing forested area. If improvements are necessary due to repair of the existing storm drain, clearing of forested area will be required to access the storm drain repair. Connections for water and sanitary sewer will need to be serviced from surrounding locations during construction. See APPENDIX D for the existing conditions site plan.

Local Conditions

UMBC Performing Arts & Humanities Facility is located at 1000 Hilltop Circle in Baltimore, MD. The PAHF will be situated on 4.8 acres on the west side of Hilltop Road adjacent to the existing Fine Arts, Engineering and ITE Buildings shown in Figure 5. The blue outline represents where the site will be and the red outline shows the adjacent buildings. The picture off to the right (Figure 6) is a view of the existing site from which the black arrow is facing in Figure 5.This campus is located 15 minutes from Baltimore's Inner Harbor, 45 minutes from Washington, D.C. and four miles from BWI Airport. In this region of the mid-Atlantic, concrete structures are competitive with steel; that is not the case in most regions. PAHF uses both types of structures on this project, which does not adversely affect the costs to any great extent. The market conditions at the time, made the market very favorable from a cost perspective for the owner. Being that the construction is taking place on existing parking lots, campus parking was reduced and is extremely tight. This allows there to be no available construction parking on campus, making workers park at a neighboring Rt. 95 Park & Ride and be shuttled into the site.

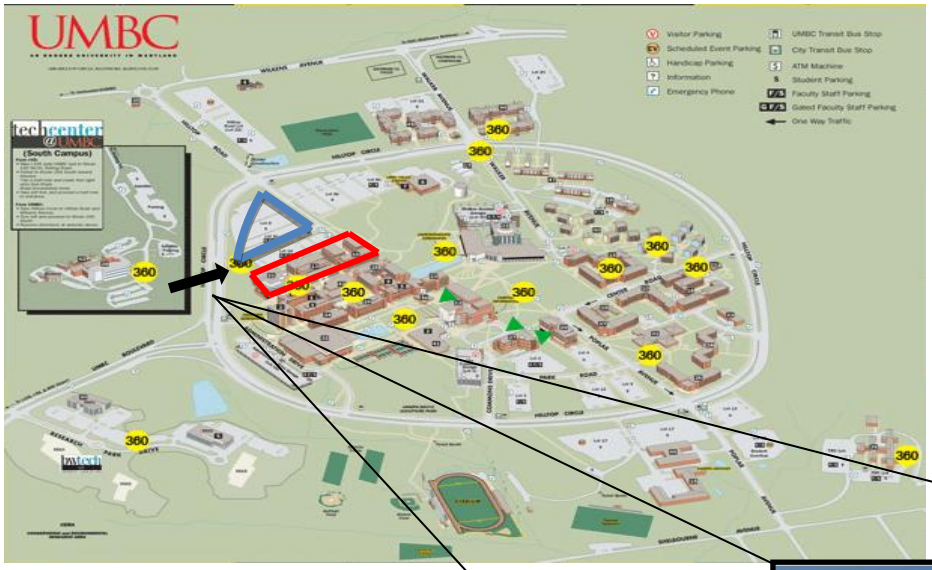


Figure 5: UMBC Campus Map

Figure 6: Camera View of the Existing Parking Lot and Adjacent Buildings

Along with the LEED certification, recycling is available and is being used on this project. The recycling/waste management requirement is to divert 50% of construction debris from disposal and the tipping fees are $400 per 5 ton cans plus $65/ton over the original 5 tons. The types of soils on this site in Baltimore, MD are suitable per the soils report (n/a). Significant rock was encountered during excavation which was not evident on the soils report. Also the subsurface water conditions are not a concern on this construction site.

Client Information

The owner of this project is the University of Maryland, Baltimore, an Honors University in Maryland who is overseeing the construction of the facility for the campus of University of Maryland Baltimore County. Both fall under the global "University of Maryland System". UMBC combines the emphasis on teaching found at the best liberal arts colleges with the innovation of a research university. This university offers 39 undergraduate majors leading to the B.A., B.S., and B.F.A. degrees, 39 minors, 13 post-baccalaureates, 28 master's degree programs, and 22 doctoral programs through its five major academic units.

The facility is being built because the existing theatre and music facilities on campus are old and horribly inadequate. They are also building the PAHF because the programs are growing on campus and they need more space. UMB is also making a philosophical statement by combining the arts and the humanities into one facility; every student on campus must take humanities classes in this building requiring them to come face to face with the arts components of the building and the campus.

This project has many expectations that must be met in order to satisfy the owner's requirements. Costs are very tight on this project and the owner expects that the project comes in on budget without any additional costs. Numerous budget phases during preconstruction, including value engineering, were used to ensure the cost does not exceed the limit. Independent third party estimates were also done at every stage to double check the Construction Managers Budgets. Quality is expected to be very high and the schedule is considered aggressive but not expedited. Several mockups are planned for, to set the level of quality expectations on the job. The specifications are clear, outlining quality expectations and independent inspectors are required on critical items of work. All contracts are written with specific schedule information and there are liquidated damages assessed to all parties involved in the project if the schedule is not met. Safety is always a number one priority for everyone involved. There is a project specific safety plan with incentives for maintaining a safe workplace. Subcontractor EMR's (Experience Modification Ratings) were taken into consideration before awarding any contracts.

The main sequencing issues that are of interest to the owner are the utility tie-ins in the campus loop road and all of the work associated with the central utility plant. This project does not anticipate any joint, dual, or phased occupancy requirements. The major keys to completing the project to the owners' satisfaction are completing the project on time and on budget and producing a very high quality building. This project is expected to be the first building on campus to earn LEED® Certification.

Project Delivery System

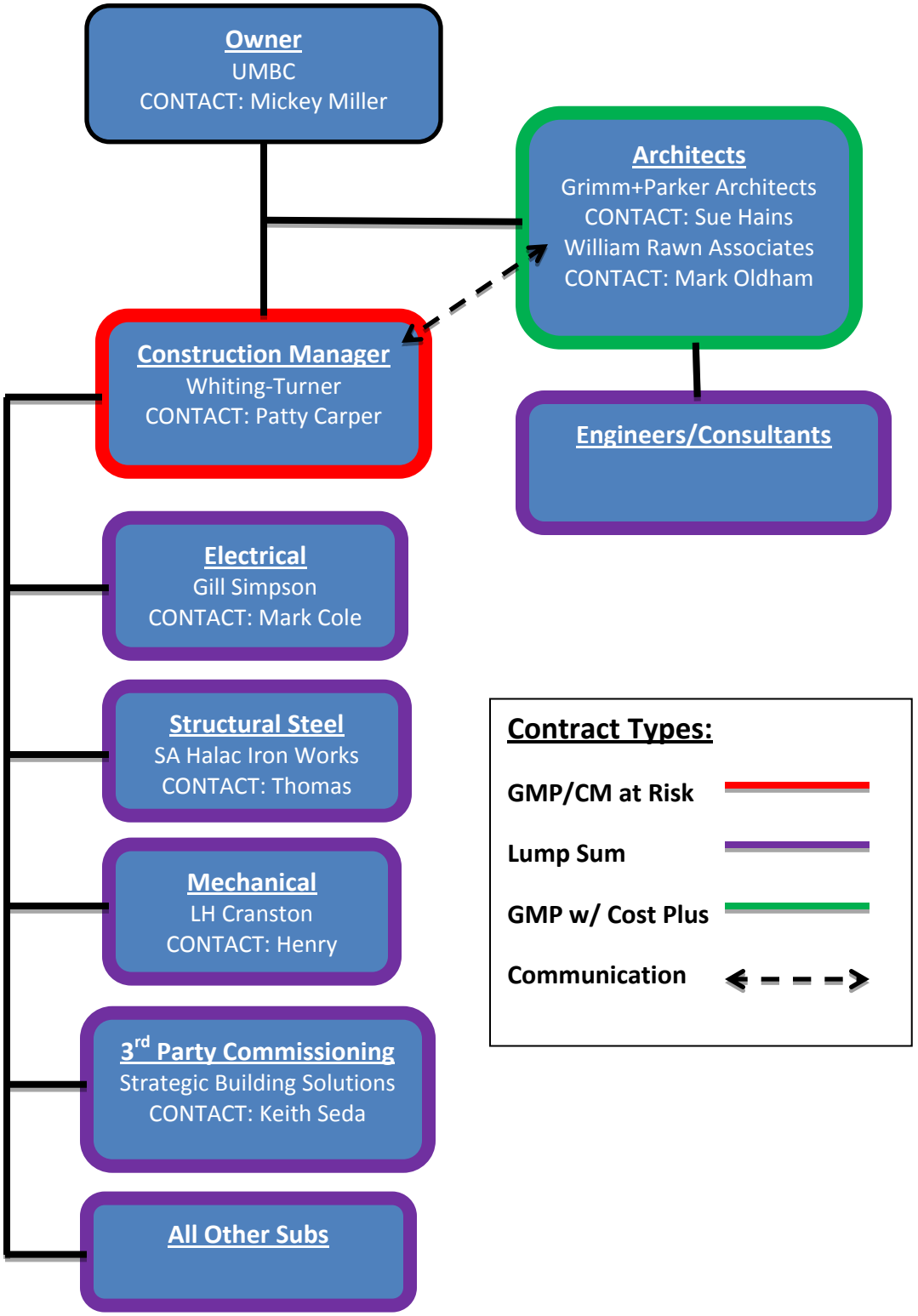


Figure 7: Project Organizational Chart

The project delivery system for the UMBC Performing Arts & Humanities Facility is a CM at Risk. This type of delivery method was chosen because it has the least risk to the funding amount. The state has a guaranteed amount that is required in order to make sure that the project will not exceed that amount before they will move forward with funding on any project.

The Whiting-Turner Contracting Company's contract for general contractor services is a guaranteed maximum price. This contractor was selected under a "best value" procurement process. First there was a submission of qualifications from all bidders on which they were all scored on based on their qualifications. Then there was a submission of general conditions and fees which they were also scored on based on those elements. Afterwards, interviews were held with the key personnel and the bidders were scored based on their interview. The three scores were added together and the construction manager with the best value was selected. For this type of contract with Whiting-Turner, there are 100% Performance and Payment Bonds required and the type of insurance required is Liability Insurance. University of Baltimore County will be carrying the required Builders Risk Insurance.

The contractual agreement between parties is shown above in Figure 7. The contract type between UMBC and Whiting-Turner is a GMP/CM at Risk. All of the subcontracts held by Whiting-Turner are lump sum contracts awarded to the lowest, prequalified bidder. The type of contract held between UMBC and the architect is a GMP with a Cost plus a Fee in case there are project delays and extra costs.

Staffing Plan

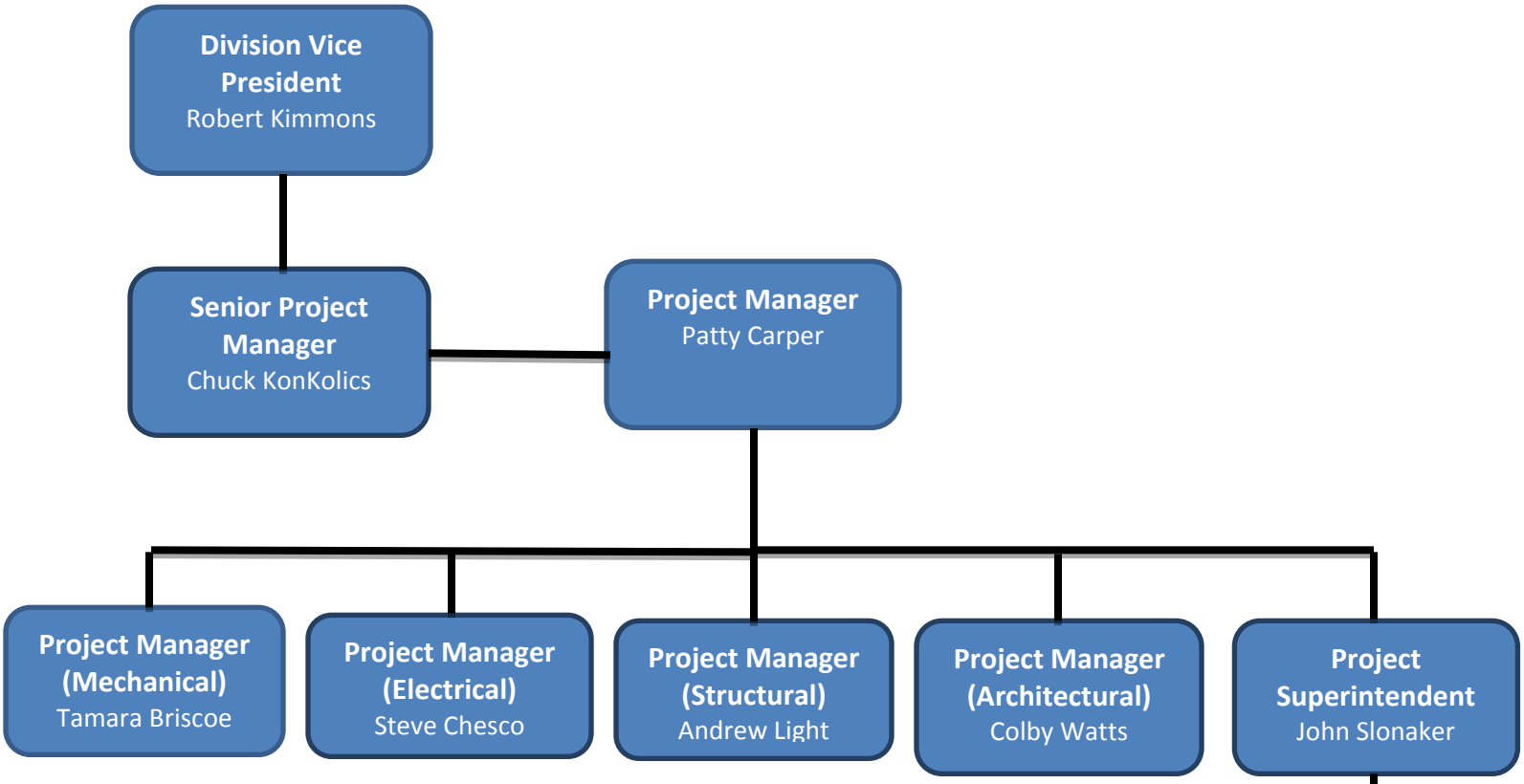


Figure 8: GC Staffing Plan

Whiting-Turner staffs their projects based on project size. As shown in Figure 8, the on-site field staff is managed by Project Manager, Patty Carper. She is in charge of handling the overall project control such as schedules, LEED oversight and owner invoicing. The other project managers are broken up into subdivisions. Each PM is responsible for their major building systems; mechanical, electrical, structural, and architectural. The entirety of this staff is overseen by a senior project manager and vice president. The senior PM's role consists of the site work, surveying, testing & inspection and the BIM Modeling. The vice president provides executive authority necessary to overcome the project team's obstacles and barriers, which are faced on the job. He is also ultimately responsible for this projects success.

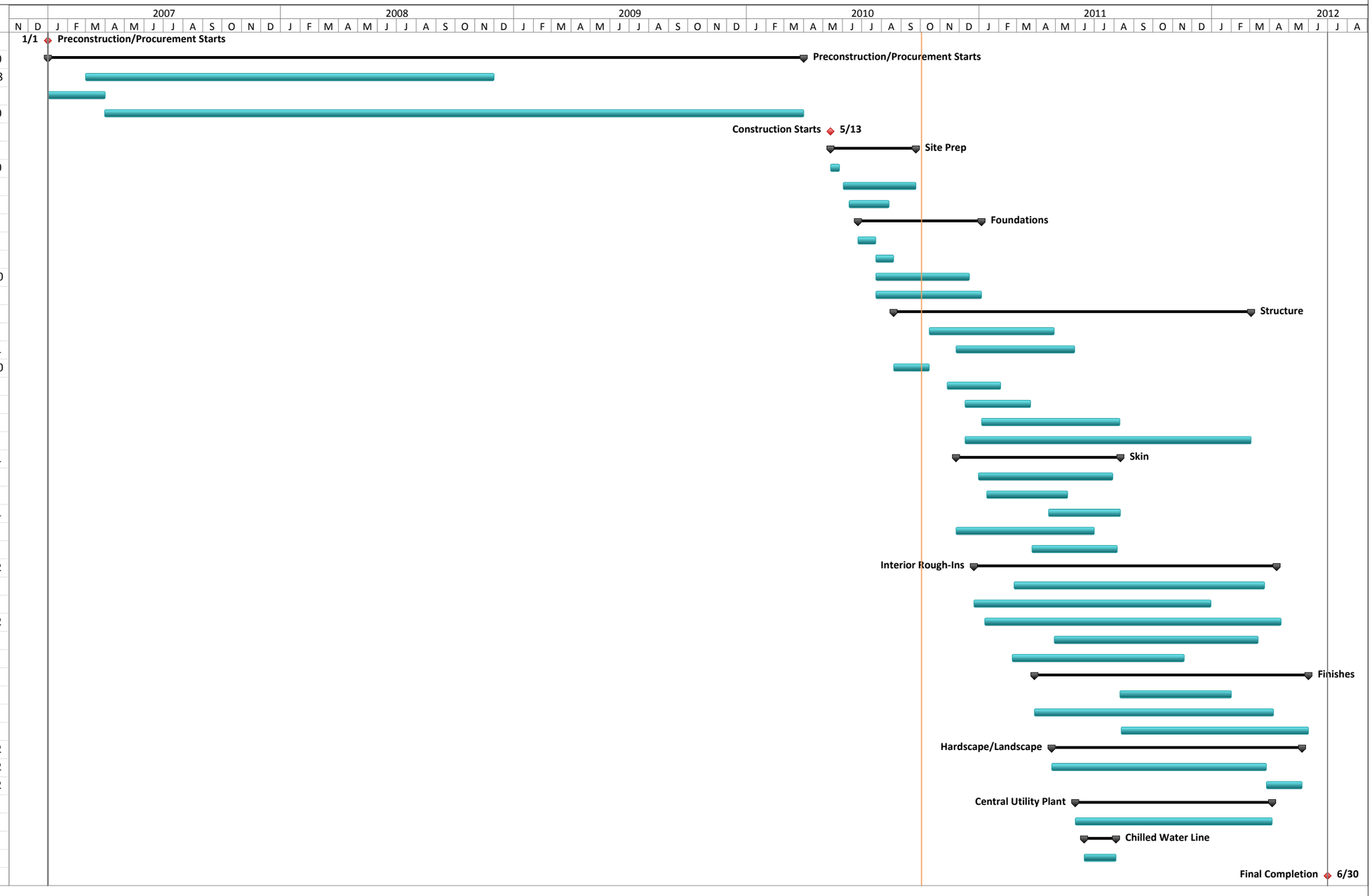
On this project, the management staff and field staff are stationed at the jobsite in a field trailer. Typically, the architect visits the site weekly for Construction Administration and bi-weekly for certain meetings. As for safety, all of Whiting-Turner's project team is responsible to bring the attention to any hazardous construction activities that are seen on site. In addition, the superintendent is also the safety officer for the job.

APPENDIX A – Project Summary Schedule

Courtney Glaub
Construction Management

Project Schedule Summary - Tech 1
October 4, 2010

Task Name	Duration	Start	Finish
Preconstruction/Procurement	0 days	Mon 1/1/07	Mon 1/1/07
Preconstruction/Procurement	848 days	Mon 1/1/07	Wed 3/31/10
Design Phase Schedule	458 days	Thu 3/1/07	Sun 11/30/08
Procurement of Construction Services	66 days	Mon 1/1/07	Sat 3/31/07
Preconstruction Services	784 days	Sat 3/31/07	Wed 3/31/10
Construction	0 days	Thu 5/13/10	Thu 5/13/10
Site Prep	96 days	Thu 5/13/10	Thu 9/23/10
Site Fence	10 days	Thu 5/13/10	Wed 5/26/10
Site Earthwork	82 days	Wed 6/2/10	Thu 9/23/10
Site Utilities	45 days	Fri 6/11/10	Thu 8/12/10
Foundations	138 days	Fri 6/25/10	Tue 1/4/11
Basement Excavation	20 days	Fri 6/25/10	Thu 7/22/10
Tunnel Excavation	20 days	Fri 7/23/10	Thu 8/19/10
Foundations	105 days	Fri 7/23/10	Thu 12/16/10
Underground Plumbing/Electrical	118 days	Fri 7/23/10	Tue 1/4/11
Structure	401 days	Fri 8/20/10	Fri 3/2/12
Concrete SOG/Elevated Slabs	140 days	Fri 10/15/10	Thu 4/28/11
Theater Concrete	132 days	Fri 11/26/10	Mon 5/30/11
Tunnel Concrete	40 days	Fri 8/20/10	Thu 10/14/10
Structural Masonry	60 days	Fri 11/12/10	Thu 2/3/11
Structural Steel	73 days	Fri 12/10/10	Tue 3/22/11
Fireproofing	155 days	Wed 1/5/11	Tue 8/9/11
Misc Metals	321 days	Fri 12/10/10	Fri 3/2/12
Skin	184 days	Fri 11/26/10	Wed 8/10/11
Roofing	151 days	Fri 12/31/10	Fri 7/29/11
Structural Studs & Sheathing	91 days	Thu 1/13/11	Thu 5/19/11
Stainless Steel Shingles	81 days	Wed 4/20/11	Wed 8/10/11
Skin Masonry	155 days	Fri 11/26/10	Thu 6/30/11
Glazing	96 days	Fri 3/25/11	Fri 8/5/11
Interior Rough-Ins	339 days	Fri 12/24/10	Wed 4/11/12
Interior Metals Studs/GWB/Ceilings	281 days	Fri 2/25/11	Fri 3/23/12
Sheet Metal/Mech/Plumb Rough-Ins	266 days	Fri 12/24/10	Fri 12/30/11
Elec/Low Voltage/Lighting Rough-Ins	333 days	Mon 1/10/11	Wed 4/18/12
15E - Fire Sprinkler Rough-Ins	228 days	Fri 4/29/11	Tue 3/13/12
Elevators	194 days	Tue 2/22/11	Fri 11/18/11
Finishes	308 days	Tue 3/29/11	Thu 5/31/12
Flooring	125 days	Wed 8/10/11	Tue 1/31/12
Paint/Wall Covering	269 days	Tue 3/29/11	Fri 4/6/12
Finishes	210 days	Fri 8/12/11	Thu 5/31/12
Hardscape/Landscape	281 days	Mon 4/25/11	Mon 5/21/12
Site Concrete/Hardscape	241 days	Mon 4/25/11	Mon 3/26/12
Landscaping	40 days	Tue 3/27/12	Mon 5/21/12
Central Utility Plant	221 days	Wed 6/1/11	Wed 4/4/12
Renovations	221 days	Wed 6/1/11	Wed 4/4/12
Chilled Water Line	36 days	Wed 6/15/11	Wed 8/3/11
Chilled Water Line	36 days	Wed 6/15/11	Wed 8/3/11
Final Completion	0 days	Sat 6/30/12	Sat 6/30/12



Project: schedule.mpp

Milestone ◆ Summary ——— Rolled Up Manual Task ▬

APPENDIX B – D4 Cost Report

Case Study for UMBC PAHF

UMBC Performing Arts & Humanities Facility	
Case Number	1
Project Name	UMBC PAHF
Project Cost	11278262
Site Size	239580
Building Use	Educational
Bid Date	3/1/2010
Num Floors	4
Historic	FALSE
Base Location	MD - Baltimore
Projected Month	Jul
Projected Year	2010
Projected Location	MD - Baltimore
Building Size	90000
Auto Calc	TRUE
Num Buildings	1
Project Height	73
1st Floor Height	15
1st Floor Size	36041
Foundation	CON
Exterior Wall	MAS
Interior Wall	GYP
Roof Type	EPD
Floor Type	WOD
Project Type	NEW

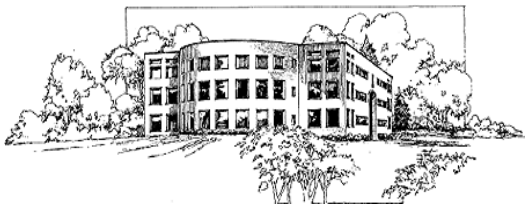
Code	Division Name	%	Sq. Cost	Projected
01	General Requirements	4.42	5.54	498,420
	Contract Closeout	4.42	5.54	498419.56
03	Concrete	8.34	10.45	940,895
	Concrete	8.34	10.45	940895.15
04	Masonry	9.66	12.10	1,089,268
	Masonry	9.66	12.10	1089268.30
05	Metals	15.02	18.82	1,693,759
	Metals	15.02	18.82	1693759.33
06	Wood & Plastics	1.75	2.19	197,337
	Wood & Plastics	1.75	2.19	197337.34
07	Thermal & Moisture Protection	6.30	7.90	710,880
	Thermal & Moisture Protection	6.30	7.90	710879.76
08	Doors & Windows	3.40	4.26	383,570
	Doors & Windows	3.40	4.26	383570.50
09	Finishes	14.03	17.58	1,582,294
	Finishes	14.03	17.58	1582294.40
10	Specialties	0.79	0.99	88,939
	Specialties	0.79	0.99	88939.29
11	Equipment	9.84	12.33	1,109,890
	Equipment	9.84	12.33	1109890.37
12	Furnishings	2.20	2.76	248,417
	Furnishings	2.20	2.76	248416.62
14	Conveying Systems	0.71	0.89	80,056
	Elevators	0.71	0.89	80055.93
15	Mechanical	14.94	18.73	1,685,509
	Fire Protection	1.68	2.10	189119.18
	HVAC	10.92	13.69	1232015.32
	Plumbing	2.34	2.94	264374.93
16	Electrical	8.59	10.77	969,026
	Electrical	8.59	10.77	969025.77
	Total Building Costs	100.00	125.31	11,278,262

APPENDIX C – R.S. Means

Estimate for UMBC PAHF

Classrooms/Offices Estimate:

	Square Foot Cost Estimate Report
Estimate Name:	**Classrooms - Offices**
Building Type:	**College, Classroom, 2-3 Story with Face Brick with Concrete Block Back-up / Steel Frame**
Location:	**BALTIMORE, MD**
Story Count:	**4**
Story Height (L.F.):	**15**
Floor Area (S.F.):	**26256**
Labor Type:	**Union**
Basement Included:	**No**
Data Release:	**Year 2010 Quarter 3**
Cost Per Square Foot:	**$206.18**
Building Cost:	**$5,413,500**

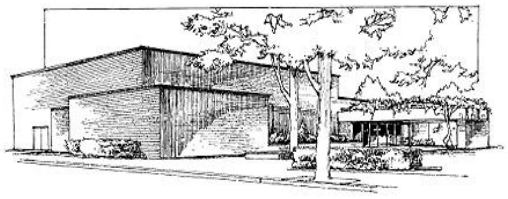


		% of Total	Cost Per S.F.	Cost
A Substructure		**2.30%**	**$3.52**	**$92,500**
A1010	Standard Foundations		$0.40	$10,500
A1030	Slab on Grade		$1.12	$29,500
A2010	Basement Excavation		$0.06	$1,500
A2020	Basement Walls		$1.94	$51,000
B Shell		**33.50%**	**$51.59**	**$1,354,500**
B1010	Floor Construction		$16.82	$441,500
B1020	Roof Construction		$2.09	$55,000
B2010	Exterior Walls		$18.07	$474,500
B2020	Exterior Windows		$12.42	$326,000
B2030	Exterior Doors		$0.57	$15,000
B3010	Roof Coverings		$1.62	$42,500
C Interiors		**19.50%**	**$29.99**	**$787,500**
C1010	Partitions		$3.69	$97,000
C1020	Interior Doors		$4.67	$122,500
C1030	Fittings		$4.51	$118,500
C2010	Stair Construction		$2.76	$72,500
C3010	Wall Finishes		$4.30	$113,000
C3020	Floor Finishes		$4.38	$115,000
C3030	Ceiling Finishes		$5.67	$149,000
D Services		**44.80%**	**$69.05**	**$1,813,000**
D1010	Elevators and Lifts		$3.31	$87,000

D2010	Plumbing Fixtures		$14.30	$375,500
D2020	Domestic Water Distribution		$2.17	$57,000
D2040	Rain Water Drainage		$0.51	$13,500
D3050	Terminal & Package Units		$17.48	$459,000
D4010	Sprinklers		$2.67	$70,000
D4020	Standpipes		$0.27	$7,000
D5010	Electrical Service/Distribution		$8.53	$224,000
D5020	Lighting and Branch Wiring		$12.30	$323,000
D5030	Communications and Security		$6.84	$179,500
D5090	Other Electrical Systems		$0.67	$17,500
E Equipment & Furnishings		0.00%	$0.00	$0
E1090	Other Equipment		$0.00	$0
F Special Construction		0.00%	$0.00	$0
G Building Sitework		0.00%	$0.00	$0
SubTotal		100%	$154.16	$4,047,500
Contractor Fees (General Conditions,Overhead,Profit)		25.00%	$38.54	$1,012,000
Architectural Fees		7.00%	$13.48	$354,000
User Fees		0.00%	$0.00	$0
Total Building Cost			$206.18	$5,413,500

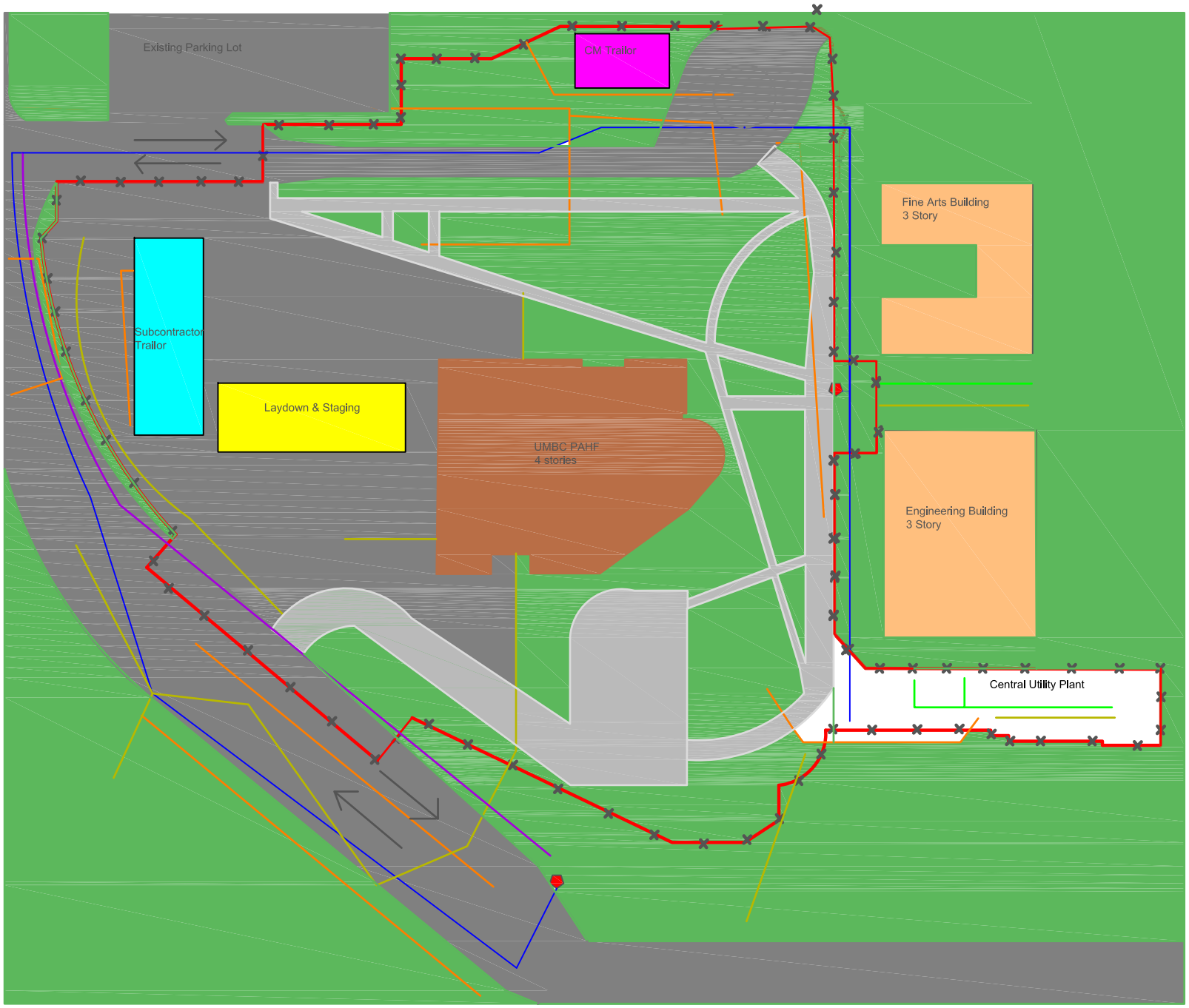
Auditorium Estimate:

	Square Foot Cost Estimate Report
Estimate Name:	Auditorium
Building Type:	Auditorium with Concrete Block / Steel Frame
Location:	BALTIMORE, MD
Story Count:	1
Story Height (L.F.):	44
Floor Area (S.F.):	10611
Labor Type:	Union
Basement Included:	No
Data Release:	Year 2010 Quarter 3
Cost Per Square Foot:	$163.41
Building Cost:	$1,734,000



		% of Total	Cost Per S.F.	Cost
A Substructure		**8.90%**	**$10.84**	**$115,000**
A1010	Standard Foundations		$1.84	$19,500
A1030	Slab on Grade		$5.61	$59,500
A2010	Basement Excavation		$0.14	$1,500
A2020	Basement Walls		$3.25	$34,500
B Shell		**35.00%**	**$42.79**	**$454,000**
B1010	Floor Construction		$2.03	$21,500
B1020	Roof Construction		$14.80	$157,000
B2010	Exterior Walls		$11.36	$120,500
B2020	Exterior Windows		$7.30	$77,500
B2030	Exterior Doors		$1.74	$18,500
B3010	Roof Coverings		$5.37	$57,000
B3020	Roof Openings		$0.19	$2,000
C Interiors		**20.90%**	**$25.59**	**$271,500**
C1010	Partitions		$2.97	$31,500
C1020	Interior Doors		$2.36	$25,000
C2010	Stair Construction		$1.74	$18,500
C3010	Wall Finishes		$5.65	$60,000
C3020	Floor Finishes		$8.95	$95,000
C3030	Ceiling Finishes		$3.91	$41,500
D Services		**35.20%**	**$42.97**	**$456,000**
D1010	Elevators and Lifts		$3.72	$39,500
D2010	Plumbing Fixtures		$4.52	$48,000
D2020	Domestic Water Distribution		$0.75	$8,000
D2040	Rain Water Drainage		$1.88	$20,000
D3050	Terminal & Package Units		$11.40	$121,000
D4010	Sprinklers		$2.97	$31,500
D5010	Electrical Service/Distribution		$2.31	$24,500
D5020	Lighting and Branch Wiring		$11.03	$117,000
D5030	Communications and Security		$3.16	$33,500
D5090	Other Electrical Systems		$1.23	$13,000
E Equipment & Furnishings		**0.00%**	**$0.00**	**$0**
E1090	Other Equipment		$0.00	$0
F Special Construction		**0.00%**	**$0.00**	**$0**
G Building Sitework		**0.00%**	**$0.00**	**$0**
SubTotal		**100%**	**$122.18**	**$1,296,500**
Contractor Fees (General Conditions,Overhead,Profit)		**25.00%**	**$30.53**	**$324,000**
Architectural Fees		**7.00%**	**$10.70**	**$113,500**
User Fees		**0.00%**	**$0.00**	**$0**
Total Building Cost			**$163.41**	**$1,734,000**

APPENDIX D – Existing Conditions Site Logistics Plan



LEGEND:

Existing Utilities

- Water
- Gas
- Storm Drain
- Sanitary
- Electric

Symbols

- Fire Hydrant
- Vehicular Traffic
- Construction Fence

UMBC
Performing Arts & Humanities
Facility

Existing Conditions Site Plan

October 4, 2010

Courtney Glaub - CM