University of Maryland, Baltimore
New Administration Building
Baltimore, MD

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Construction Management
Technical Assignment 1
Dr. John Messner

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Executive Summary

This Technical Assignment analyzes the New Administration Building owned by the University of Maryland, Baltimore (referred to as UMB). Areas of focus consist of project schedule, building systems, project cost, site conditions, local conditions, client, project delivery, and staffing.

The UMB is a campus located in Baltimore and this New Administration Building continues their efforts to have the highest quality facilities. This 6 story, above grade, building will contain the University's executive offices and conference rooms.

The building is 80,000 SF and the structure is cast in place concrete with post tension cables running in each direction. Construction started in March of 2007 and is scheduled to be complete by October of 2008. The total project cost is $29,600,000. Barton Malow Company (referred to as BMC) was awarded the Design/Build contract with a Guaranteed Maximum price.

Design/Build is very fast paced and can benefit all those involved if executed correctly. Schedules must be constantly updated to represent the updated design. It is very easy to fall behind early, so some concerns are staying ahead, sticking with schedule and the budget. Much of the difficulties of Design/Build can be remedied with open lines of communication between the owner, architect, CM and subcontractor.

The biggest concern after performing this in depth analysis is the site situation. The building is surrounded by 3 roads that must stay open as well as a day care center. The vehicular and pedestrian traffic must not be obstructed and if unavoidable it cannot be for long. Construction near a day care poses the threat of harming a small child. Extra precaution must be taken within the site which is extremely tight. Aside from the building footprint there is little space for staging and storage. Maneuverability is limited and detailed layouts and schedules are extremely important.

A. Project Schedule Summary

Construction for the UMB Administration Building began March 29th, 2007 and its scheduled completion was September 29th, 2008, with the owner being completely moved in by October 21st.

The building was broken up into two halves during foundation and superstructure construction, North and South. The North foundation began slightly before the South so that the North's superstructure would begin before the South's. Having the concrete erection split into North and South allowed the structure to rise vertically without being completely finished underneath. For example, level 2 North and South would be at different stages in forming/reinforcing. Level 2 North would pour before level 2 South and the next day forming could begin on level 3 North. While level 3 North was forming, level 2 South would be poured and the next day formwork for level 3 South would begin. This staggered construction continued all the way up the building and allowed trades to work continuously.

Building enclosure began on level 1 while erection of the fourth and floors above was still underway. A month after enclosure began rough-in and finishes of level 2 started and would continue up following enclosure. Staggering is also seen with rough-in and finishes, although not broken into North and South.

It is seen in the schedule that the finishes of the sixth floor is completed in much less time than the others. This is because the sixth floor is mostly shell space and for future fit out. This means the amount of finishes is significantly less than anywhere else in the building. The first floor finishes were completed last because it was reserved for contractor storage and gang boxes.

Owner move-in follows the balancing and inspection of the buildings systems which commenced when the majority of the finishes were completed, September 30th 2008.

B. 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

Demolition

The UMB Administration site was occupied by a three story (with a basement), red brick building (with a basement). Aside from the building there was also an eight foot high brick wall surrounding the site. Demolition of this uninhabited shell started in November of 2007 and went until February of 2008.Being on the corner of a city block there were many risks that had to be addressed during demolition. On the South, East, and West sides of the site there are three streets with moderate vehicular traffic. Possibly the biggest concern of demolition and all throughout construction is the day care neighboring the site directly to the North. The property line was right against this day care and because the site was already tight, all available space had to be utilized. Extreme care needed to be used by the operator to ensure all debris stayed within the site. Luckily no hazardous materials were found during demolition.

Cast in Place Concrete

The entire building was constructed of cast in place concrete using a combination of crane and bucket and pump truck. Utilizing post tensioning, a slab thickness of 9 inches was achieved. The tendons, in the North/South direction follow the column lines. The East/West direction is more difficult to see a pattern.

For the super-structure the floors were split in half and constructed in a staggering fashion to allow contractors to work continuously. It meant work did not have to stop while pours were conducted.

The slabs were formed using multi-use plywood and scaffolding the entire floor area. Forming, laying tendons and rebar, and setting pipe penetration inserts took about 4 days and pouring would begin on the 5th. Slabs were poured using a pump truck and could be done and

troweled in one day. The concrete was given 3 days to cure and then the tendons would be stressed. 5 days after the pour, the forms were stripped and reshores were placed underneath, until the concrete reached full strength.

The layout of the columns is pretty uniform throughout the building. Typical bays are thirty feet by thirty feet. Columns followed the same pattern as the slabs. Columns were erected the day after the slab was poured. The column cages that were fabricated on the ground were tied in to bent bars coming up from the slab. Unlimited-use, “Doka”, forms were used for the columns. “Doka” forms are much more expensive initially but can be used forever and are much easier to put into place. In the longer run they end up saving money. Crane and bucket was used to pour the columns and a half of the building could be done in three days.

Mechanical System

The Mechanical rooms are located on the first floor in the Northeast corner of the building. There is an attached room dedicated to the hot water system. On the roof there is a custom made 90,000 CFM Air Handling Unit that services all 6 floors of the building.

The UMB New Administration Building utilizes Forced-Circulation Air-Cooling and Air Heating-Coils. There are 8 glycol air conditioning units throughout the building. There are various heating and cooling terminal units including, finned tube radiation, convectors, electric unit heaters, cabinet heaters, and coils. To control air volume in different zones, this system uses Single Duct Variable Air Volume. The entire system is automated with sensors to monitor and control the environment within a space.

The entire building is equipped with a wet sprinkler system that has broken up each floor into zones and ensures that 100psi is available at the most remote fire hose connection in the system.

Electrical System

The electrical system is fed by a 200KW generator set rated 208/120V, 3 phase, 4 wire. This generator feeds dual 15kV switches and steps down to a 750kVA transformer. Areas are lit by various sized fluorescent lights.

Masonry

Brick veneer is used to encase the building everywhere except for where curtain wall is present. The facade is accented with soldiers and header courses around the roof, second and fifth floors. Tiebacks connect the brick to the metal wall framing. Tiebacks were required to be spaced no more than 16 inches vertically and no more than 24 inches horizontally.

Mast climbing scaffolds were set up on each side of the building for the masons and moved up the exterior walls as the courses were laid. Every floor the scaffold was tied into the building structure much like a hoist. Due to the length of the building sides, 4 masts were necessary for support.

Curtain Wall

Wrapping around the Southwest corner is an 878 SF curtain wall. This is the main architectural feature and also the main entrance to the building. It starts just after the first floor and extends 27.5 feet high. The main panes are 8 feet 7inces tall and 6 feet wide.

The curtain wall is comprised of glazed aluminum. Accenting the main entrance curtain wall are metal wall panels and more glazed aluminum instead of the brick veneer found on all other sides. Telescoping lifts were used to set the curtain wall after it was framed in during enclosure. Being on the corner with the highest volume of vehicular traffic, there was not much room to maneuver. This emphasizes the need for detailed scheduling.

Support of Excavation

Going from the North to South of the building the site slopes down. This meant that there was much more excavation needed at the North end. For foundations and SOG, excavation had to go down about 15 feet at its deepest. To keep the perimeter earth and existing structures, sidewalks, light poles, etc., in place the concrete contractor used soldier beam and lag. Beams were set into predrilled holes and lagging boards were placed between the flanges of the beams. This system was designed to be permanent. When the space between the building and the supports was filled, the tops of the beams were cut off and the rest was left to be buried. Dewatering was not needed because the excavation did not go below the water table.

C. Project Cost Evaluations

The construction cost for the University of Maryland, Baltimore New Administration Building was $21,227,460. This excludes site work, permits, and fees. The usable space in this building is nearly 80,000 sq. feet. However in pricing documents I have reviewed the cost/sq.ft. estimates are derived using the gross square footage, 107,730 sq ft. The resulting construction cost per sq. foot is $184.49.

Aside from the actual cost breakdown of the project, below is a D4Cost estimate and a R.S. Means estimate. D4Cost takes data from previous buildings and combines them to predict your building cost. R.S. Means has collected data from many similar jobs and has come up with a range of square foot costs for your particular project (office, school, lab, etc.). It uses your

building's square footage and develops an estimate based on those ranges. Adjustments can be made to fit your building design more accurately.

Actual Cost Information			
Building System	**SF Cost**		**Cost**
Foundations	**$5.47**		**$589,283**
Substructure	**$2.92**		**$314,572**
Superstructure	**$21.05**		**$2,267,717**
Exterior Closure	**$29.62**		**$3,190,963**
Roofing	**$2.86**		**$308,108**
Interior Construction	**$32.12**		**$3,460,288**
Conveying Systems	**$3.95**		**$425,534**
Mechanical	**$46.40**		**$4,998,672**
Electrical	**$19.15**		**$2,063,030**
Trade General Conditions	**$4.96**		**$534,341**
Scope Holds	**$4.35**		**$468,626**

RSmeans SF Estimate				
		Base Building	**Admin Building**	**C/SF**
Exterior Wall	**SF Area**	**80,000**	**80,000**	**$138.05**
	LF Perimeter	**420**	**560**	
Perimeter Adj.	**Per 100 LF**	**$6.55**	**140**	**$9.17**
Floor Height Adj.	**Per 1 LF**	**$2.25**	**2.7**	**$6.08**
Location Factor			**Baltimore, MD**	**$0.92**
			Adjusted C/SF	**$154.22**
			Estimate w/o Systems Adj.	**$12,337,600.00**

Systems Adjustments				
	Quantity	U of M	Unit Price	Cost
Post Tension Tendons	138,983	LBS	$2.00	$277,966
Augercast Piles	6,345	LF	$34.00	$215,730
6"SOG	18,955	SF	$7.00	$132,685
Pile Caps/Grade Beams	269	CUYD	$571.00	$153,599
Elevator Pit Pile Cap	254	CUYD	$287.57	$73,043
Perimeter Retaining Wall	6,227	SF	$33.00	$205,491
Sand Filter	125	SF	$720.00	$90,000
Brick Veneer	35,399	SF	$30.50	$1,079,670
Elevator 1 (6 stops-5000lb)				$147,675
Elevator 2 (6 stops-3500lb)				$142,175
Sprinkler (1-5 Floors)	92,250	SF	$2.50	$230,625
Sprinkler (6th Floor)	15,480	SF	$1.51	$23,375
Curtain Wall	878	SF	$75.00	$65,850
Windows	13,949	SF	$48.00	$669,552
			Adjustment Total:	$3,507,435
			Total:	$15,845,035

D4 Parametric Estimate			
Division	**Percent**	**SF Cost**	**Projected**
Bidding Requirements	**1.67**	**$3.60**	**$288,000**
General Requirements	**4.55**	**$9.82**	**$785,600**
Site Work	**13.96**	**$30.20**	**$2,416,000**
Concrete	**10.48**	**$22.62**	**$1,809,600**
Masonry	**9.17**	**$19.79**	**$1,583,200**
Metals	**4.05**	**$8.74**	**$699,200**
Wood & Plastics	**0.95**	**$2.04**	**$163,200**
Thermal & Moisture Protection	**4.82**	**$10.41**	**$832,800**
Doors & Windows	**3.45**	**$7.44**	**$595,200**
Finishes	**6.99**	**$15.09**	**$1,207,200**
Specialties	**0.51**	**$1.10**	**$88,000**
Equipment	**0.2**	**$0.42**	**$33,600**
Furnishings	**0.66**	**$1.43**	**$114,400**
Conveying Systems	**1.91**	**$4.11**	**$328,800**
Mechanical	**27.46**	**$51.22**	**$4,097,600**
Electrical	**9.17**	**$19.79**	**$1,583,200**
Totals:	**100**	**$207.82**	**$16,625,600**

Before getting to the cost I will explain some of the reasoning for my adjustments in R.S. Means. First, I accounted for the deep piles and large foundations, especially the elevator pit. R.S. Means also used a 4 inch slab instead of 6, so I corrected that. Last, I added in specialties like a storm water sand filter, curtain wall, and larger amounts of brick and windows than called out in R.S. Means. Even after this, the estimate is still very low.

As you can see in both the D4Cost and the R.S. Means the resulting price is much lower than the actual cost. There are a few reasons for this. First these methods of estimation are

"ballpark" estimates. They are very good for initial calculations before too many details of the building are known but once design is in progress there will to be many differences. A general building estimate will not do.

Also in reviewing the Request for Proposal from the owner I noticed that the initial construction budget developed by UMB was around $19 million. Considering that, the D4Cost and R.S. Means estimates faired wells as preliminary estimates.

Possible the biggest reason for the large differences in cost is square footage. As mentioned before the cost per square foot was determined using the gross square footage (107,730 SF). For my R.S. Means and D4Cost estimates I used the usable space square footage of 80,000 SF. R.S. Means asks for floor area as does D4Cost. Although I used the 80,000, I did make estimates with the GSF for reference. The R.S. Means estimate using the GSF came out to $18,380,000 and the D4Cost was $19,580,000. As you can see these estimates are much closer to the actual cost.

D. Site Plan of Existing Conditions

The UMB New Administration building is set in the city of Baltimore. This obviously leads to site logistic problems. Aside from the site itself Barton Malow was given half of Pearl Street (East) and the other half was to stay open for public use (both directions). They were also given the sidewalk of Lexington Street (South). Arch Street (West) is one way flowing south and had to stay open because it leads to the UMB Administration current parking lot. The sidewalk adjacent to the site also could not be obstructed.

A small one story brick building had to be leveled to make room for trailers opposite the site. To the West of the site is a recovery center for cancer patients and to the North of the site is a day care center. These have inherent risks that need to be addressed (noise, sediment control, etc.).

Most utility plans, they are old and hard to read. This site has even more difficulty because the previous building had been vacant for some time, so points of connection are very vague. There are two proposed electrical entries into the building.

E. Local Conditions

Augercast piles, which were used for the foundations, are very common in the Baltimore area. A high water table results in the need for deep piles. This method also offers benefits. Augercast piles combine drilling the hole for the pile and setting the pile. Grout is pumped through the tip of the auger as it comes out of the ground and then the reinforcing is set within.

This saves money and time because it is doing two tasks at once. The site contractor at UMB averaged about sixteen piles a day.

Another common practice is post tension (PT). The UMB Administration Building is 6 stories of PT slabs. Post-tension slabs offer advantages over traditional reinforcing. Using PT allows the floor slab to be thinner and thus uses significantly less concrete. Not only is there less concrete but there is also less reinforcing. Because of the opposing forces between the concrete and the tendons in PT slabs, they are able to achieve the same strength with much less material.

There is no on-site parking for Subcontractors and their Subordinate Parties' employees. Each Subcontractor is responsible for providing transportation to and from the site, if required. This is simply because the site is so tight in the middle of the city.

The soil is fair, but there were deep brick wells that at times caused minor inconvenience. Dumpsters were shared and there was no recycling on-site.

F. Client Information

Founded in 1807, the University of Maryland at Baltimore (The University) is the oldest of the eleven (11) collegiate institutions, which, along with two (2) research institutes, comprise the statewide University System of Maryland (UMS).

The campus is comprised of the seven (7) University of Maryland Schools, which include Dentistry, Medicine, Pharmacy, Law, Social Work, Nursing, and the Baltimore Graduate School; the Thurgood Marshall Law Library; and the Health Sciences Library. The University of Maryland, Baltimore strives for excellence in all these fields and one way they achieve this is by providing world class facilities.

The New Administration Building promotes growth of the University. A new and better accommodating building advances organization, technology, and the ability to recruit the best faculty and students. Providing up-to-date facilities shows people the commitment of the UMB to stay at the top. Another example of this commitment is the beautiful and cutting edge Dental School that was finished just prior to the construction of the Administration Building.

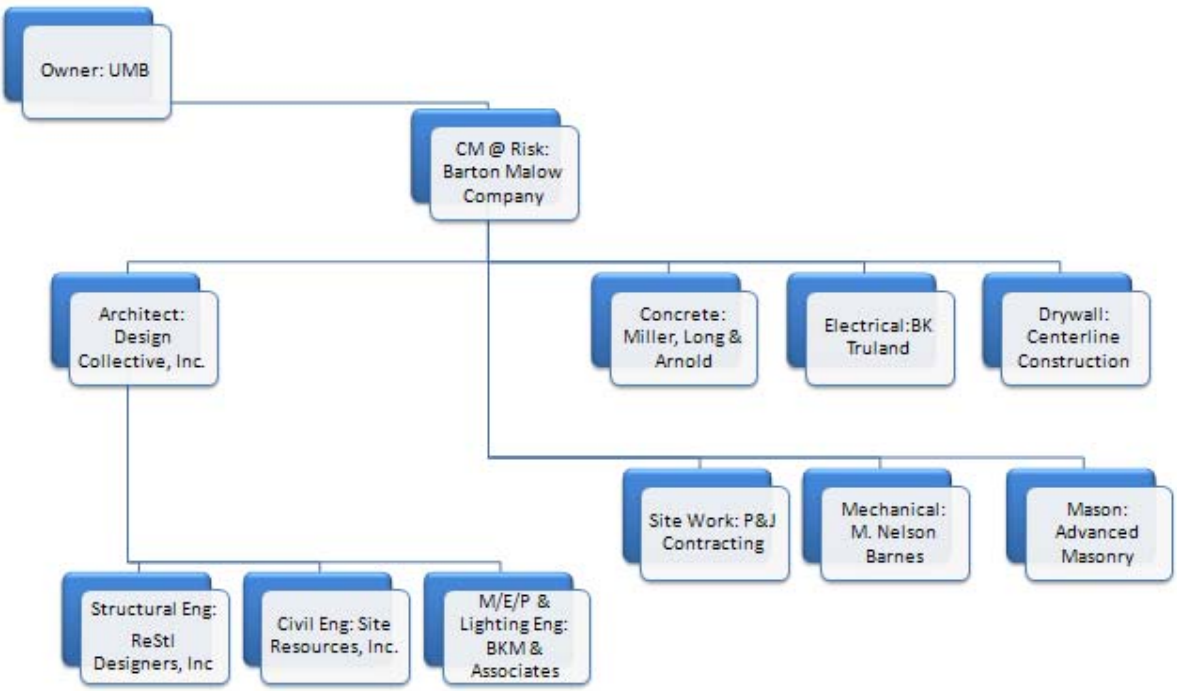
With those considerations in mind the expectations for cost and quality are very high. This can be seen with the Design/Build approach, because it allows the Owner to be an important influence on what goes into the building. Having a guaranteed maximum price also shows that the Owner has a budget developed and will make sure that the project stays within this budget. This high level of involvement from the Owner is just another example of their commitment to excellence.

The key to meeting these expectations of UMB is to have their interests in mind at all times. Design options and alternatives should be tailored to meet these expectations wherever possible.

The biggest sequencing issue of interest to the Owner is the curtain wall. It is the main architectural feature of the building and will need to be carefully planned so it looks the way it is intended to look.

G. Project Delivery System

Design/Build was chosen for this project because the owner wanted it fast tracked. Not all the designs were complete but there was enough work to be done while designs and considerations were made. Barton Malow was awarded the Construction Management position with a Guaranteed Maximum Price Contract. They have worked with UMB in the past. In fact BMC was finishing the UMB Dental School, less than a block away from the site, just before construction. Also, Barton Malow has done Design/Build work which made them a suitable candidate. Below is the job organizational chart.

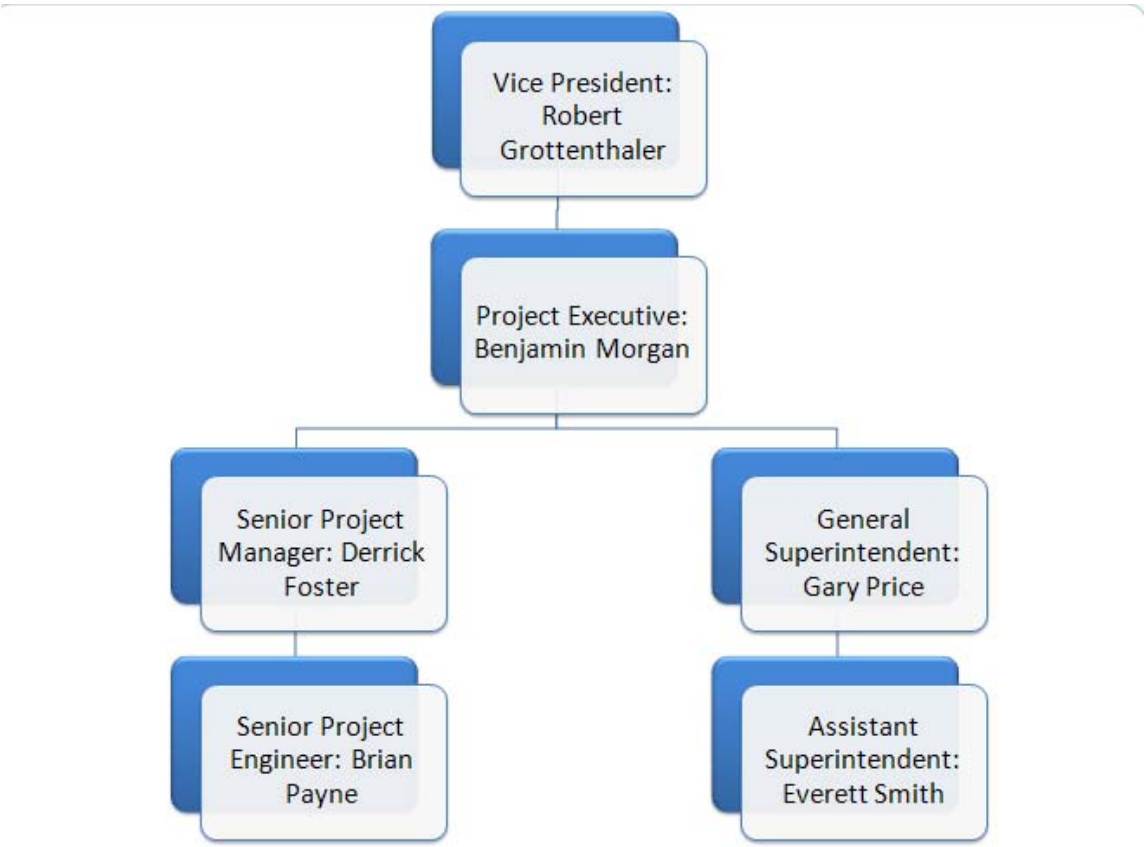


Barton Malow held all contracts with subcontractors and the architect. This made BMC @ Risk because they would be held liable for work that was not completed. All contracts were GMP. This offers some maneuverability, because if the design is a work in progress (Design/Build) then changes can be made to keep the cost under the budget with less of an overall impact.

Like most jobs, bids were accepted up until a due date and time. After that, no more bids were accepted for a specific bid package. The contractor who won the award was the one who met all the requirements and whose estimate was comparable to BMC's. This is public work and many times the lowest bidder is taken, but that is within reason. Extremely low or high bids can be thrown out. One requirement that Barton Malow had to meet is 25% MBE/WBE (Minority Business Enterprise/Women Business Enterprise) participation of total construction. This means subcontractors must either be or employ MBE/WBE businesses. For instance if the mechanical contractor is not minority or woman owned but their sheet metal supplier is, then that counts towards to project. Another requirement is that any contractor with over $100,000 in their budget had to furnish a bid bond, issued by a surety company licensed to issue bonds in the State of Maryland.

I agree with the contract type and delivery method of the UMB Administration Building. Design/Build is a contract you want to enter with companies you work well with. BMC and UMB have proven they work well together. Also, having all the contracts in Barton Malow's hands presents a lot of risks but also clearly defines a chain of correspondence (point of contact) so there is less confusion among different parties.

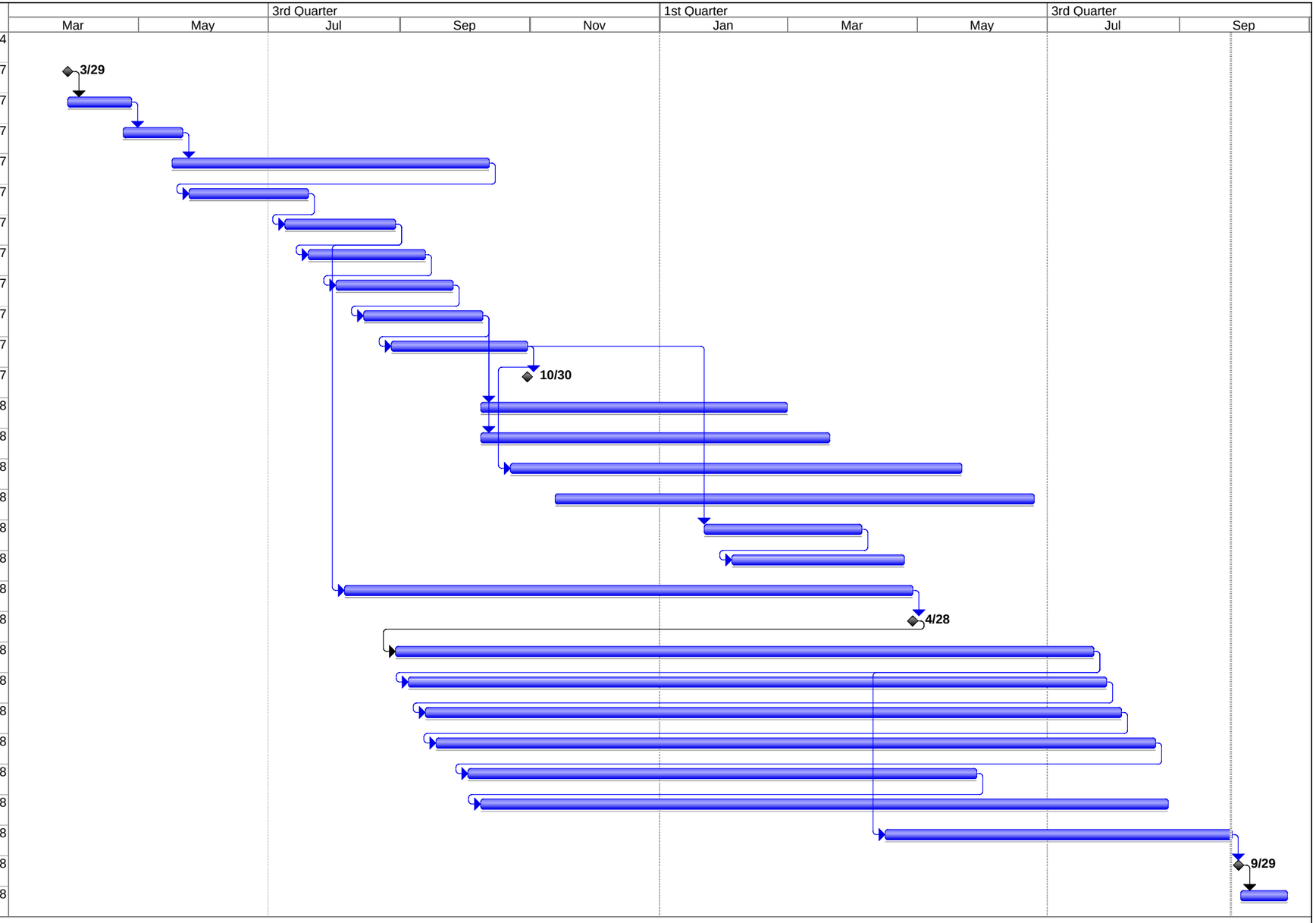
H. Staffing Plan



The Project Manager is involved on a continual basis from commencement of the design until construction completion. This person will be responsible for the overall management of the design/build team and the completion of the project. The Project Engineer is delegated work by the PM. Much of the work entails retrieving submittals, request for information (RFI), keeping drawings up-to-date, etc.

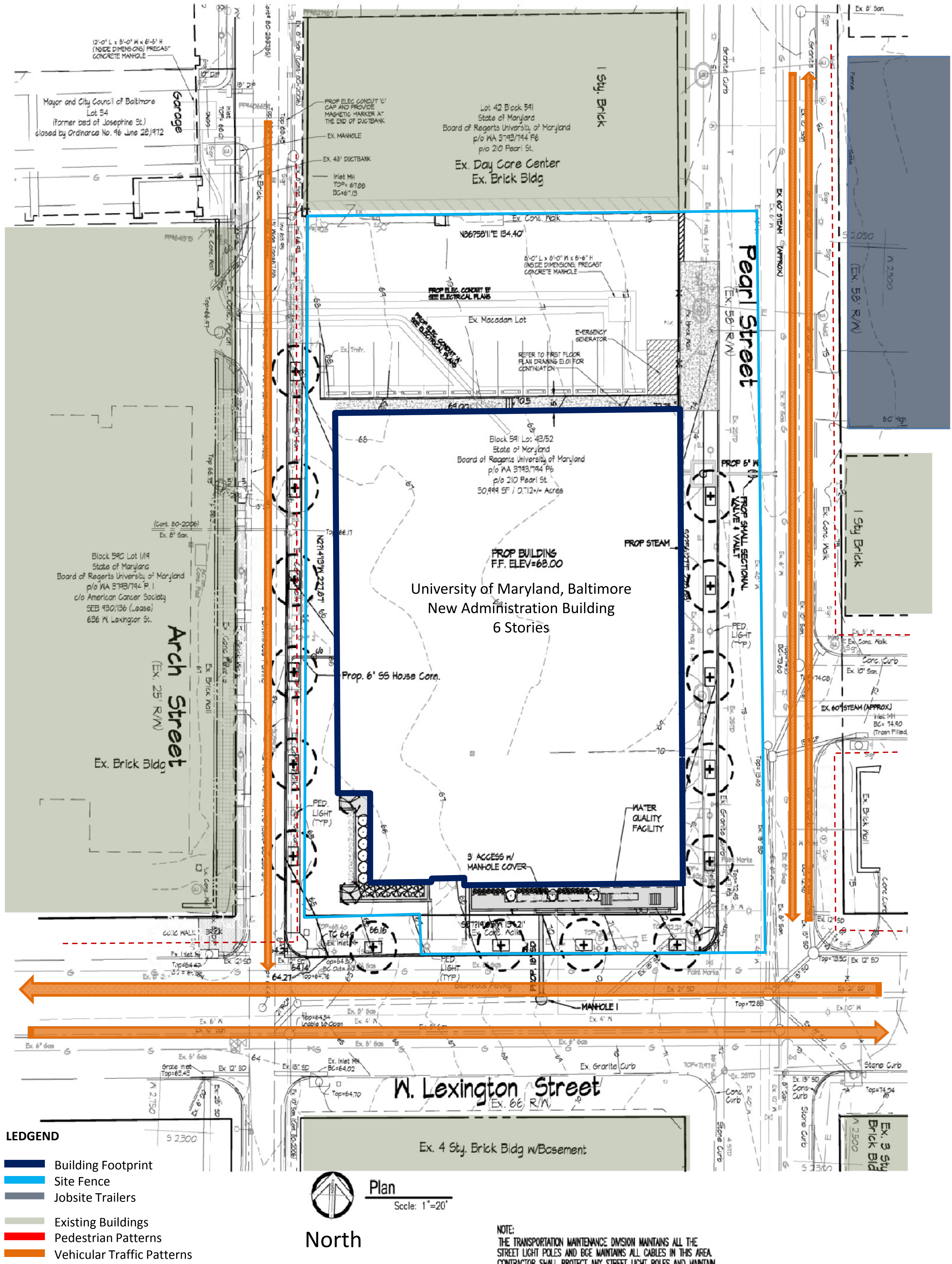
The Superintendent is on site 100% once construction commences and will be responsible for the direct supervision of the trade contractors, daily coordination of the work on-site to maintain the schedule, on-site management such as material deliveries, outages, etc. The Assistant Superintendent is delegated work by the General Superintendent.

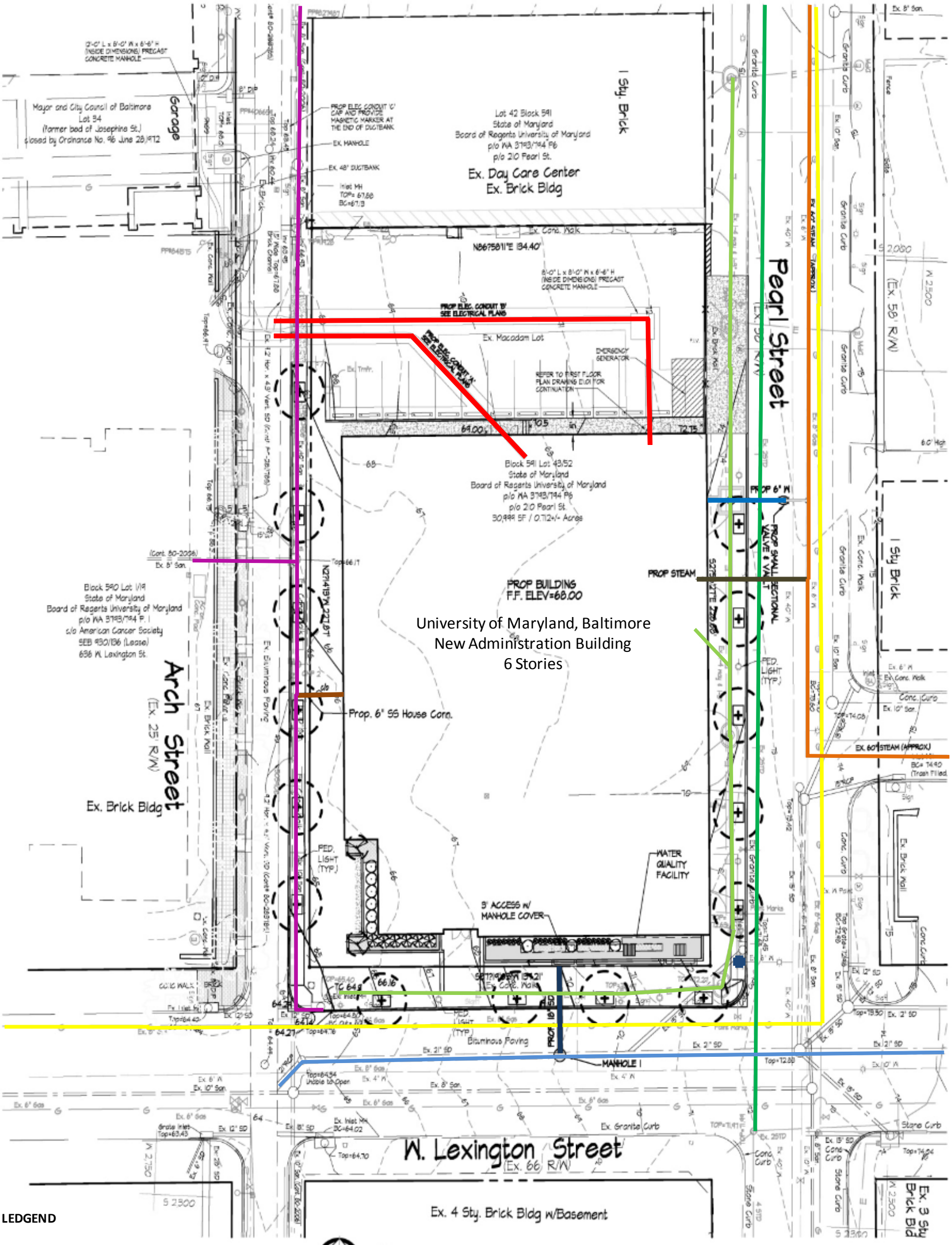
ID	Task Name	Duration	Start	Finish
1	Design Start	0 days	Wed 12/15/04	Wed 12/15/04
2	Start of Construction	0 days	Thu 3/29/07	Thu 3/29/07
3	Excavation/Sheeting/Shoring	22 days	Thu 3/29/07	Fri 4/27/07
4	Augercast Piles	20 days	Tue 4/24/07	Mon 5/21/07
5	Pile Caps/Grade Beams/SOG	103 days	Thu 5/17/07	Fri 10/12/07
6	FRP Level 2 North/South	38 days	Fri 5/25/07	Thu 7/19/07
7	FRP Level 3 North/South	38 days	Mon 7/9/07	Wed 8/29/07
8	FRP Level 4 North/South	38 days	Fri 7/20/07	Wed 9/12/07
9	FRP Level 5 North/South	38 days	Thu 8/2/07	Tue 9/25/07
10	FRP Level 6 North/South	38 days	Wed 8/15/07	Tue 10/9/07
11	FRP Roof North/South	44 days	Tue 8/28/07	Tue 10/30/07
12	Building Top Out	0 days	Tue 10/30/07	Tue 10/30/07
13	Electrical Room	97 days	Tue 10/9/07	Fri 2/29/08
14	Mechanical Room	111 days	Tue 10/9/07	Thu 3/20/08
15	Rooftop Mechanical	145 days	Tue 10/23/07	Wed 5/21/08
16	Sitework	154 days	Tue 11/13/07	Tue 6/24/08
17	Elevator 2	53 days	Tue 1/22/08	Fri 4/4/08
18	Elevator 1	58 days	Mon 2/4/08	Thu 4/24/08
19	Enclosure	182 days	Mon 8/6/07	Mon 4/28/08
20	Building Enclosed	0 days	Mon 4/28/08	Mon 4/28/08
21	Rough In & Finishes Level 2	223 days	Thu 8/30/07	Tue 7/22/08
22	Rough In & Finishes Level 3	224 days	Wed 9/5/07	Mon 7/28/08
23	Rough In & Finishes Level 4	223 days	Thu 9/13/07	Mon 8/4/08
24	Rough In & Finishes Level 5	232 days	Tue 9/18/07	Wed 8/20/08
25	Rough In & Finishes Level 6	162 days	Wed 10/3/07	Wed 5/28/08
26	Rough In & Finishes Level 1	222 days	Tue 10/9/07	Tue 8/26/08
27	Balancing/Commisioning/Inspect	114 days	Wed 4/16/08	Thu 9/25/08
28	Substantial Completion	0 days	Mon 9/29/08	Mon 9/29/08
29	Owner Move-In	15 days	Tue 9/30/08	Tue 10/21/08



Project: Tech 1 Sched.
Date: Thu 9/25/08

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline


University of Maryland, Baltimore
New Administration Building
6 Stories
PROP BUILDING
F.F. ELEV=68.00
Block 591 Lot 43/52
State of Maryland
Board of Regents University of Maryland
p/o WA 3793/194 P6
p/o 210 Pearl St.
30,999 SF / 0.712+/- Acres
Lot 42 Block 591
State of Maryland
Board of Regents University of Maryland
p/o WA 3793/194 F6
p/o 210 Pearl St.
Ex. Day Care Center
Ex. Brick Bldg
1 Sty. Brick
Pearl Street
(Ex. 58' R/W)
Arch Street
(Ex. 25' R/W)
Ex. Brick Bldg
Block 590 Lot 1/19
State of Maryland
Board of Regents University of Maryland
p/o WA 3793/194 P. 1
c/o American Cancer Society
SEB 930/136 (Lease)
636 W. Lexington St.
Mayor and City Council of Baltimore
Lot 34
(former bed of Josephine St.)
closed by Ordinance No. 96 June 28, 1972
Garage
Ex. Macadam Lot
EMERGENCY GENERATOR
PROP STEAM
Prop. 6" SS House Conn.
WATER QUALITY FACILITY
3' ACCESS w/ MANHOLE COVER
PED. LIGHT (TYP.)
MANHOLE 1
W. Lexington Street
(Ex. 66' R/W)
Ex. 4 Sty. Brick Bldg w/Basement
1 Sty Brick
Ex. 3 Sty Brick Bldg
LEDGEND
Building Footprint
Site Fence
Jobsite Trailers
Existing Buildings
Pedestrian Patterns
Vehicular Traffic Patterns
North
Plan
Scale: 1"=20'
NOTE:
THE TRANSPORTATION MAINTENANCE DIVISION MAINTAINS ALL THE
STREET LIGHT POLES AND BGE MAINTAINS ALL CABLES IN THIS AREA
CONTRACTOR SHALL PROTECT ANY STREET LIGHT POLES AND MAINTAIN



LEDGEND

- Exist. Gas
- Prop. Electric
- Exist. Sanitary
- Exist. Steam
- Prop. Steam
- Fire Hydrant
- Exist. Electric
- Prop. Sanitary
- Prop. Storm Drain
- Exist. Electric (Telephone)
- Exist. Storm Drain

Plan
Scale: 1"=20'

NOTE:
THE TRANSPORTATION MAINTENANCE DIVISION MAINTAINS ALL THE STREET LIGHT POLES AND BGE MAINTAINS ALL CABLES IN THIS AREA. CONTRACTOR SHALL PROTECT ANY STREET LIGHT POLES AND MAINTAIN UNINTERUPTED SERVICE IN THIS AREA DURING THE CONSTRUCTION PERIOD.

University of Maryland, Baltimore
New Administration Building
Utility Plan

Keith Meacham
9/29/2008