Emory University Psychology Building

Atlanta, Georgia

Technical Assignment #2

Chris Renshaw
Construction Management
Faculty Consultant: Dr. Riley
Submitted October 24, 2008

Executive Summary

This technical assignment continues to explore the construction aspects of Emory's new Psychology Building in greater detail of cost and time. To determine the construction schedule sequencing, a detailed schedule was made. The schedule demonstrates the work flow through the building during the 16 month construction duration. Major milestones are displayed to show important progress points of the building.

Site layout and logistics are key to any construction project and the Psychology Building is no exception. Since the building has different needs during different phases of construction, three logistical plans are included. The plans show the site during excavation, while the structure is being built, and while the interiors are being fit out and finishes are installed. Each of these phases has separate needs and equipment that are necessary for construction. For this building, there are three major phases and altogether they give are and accurate representation of what the site would look like at any time during construction.

In order to develop an idea of where the costs of the construction come from, a detailed structural estimate was performed. The estimate includes all of the foundations and superstructure of the Psychology Building. Quantities such as cubic yards of concrete, tons of rebar, and square feet of formwork were taken off from the structural drawings and multiplied by RS Means bare costs to find the total estimated cost of the building. Labor, material, and equipment costs were calculated individually. For future research it will be helpful to have these costs separated to see how a change might affect their quantities. The estimate also forced consideration of sequencing and constructability, which helped in creating the schedule. An analysis of the cost is provided as well, to determine its relevance.

Another estimate was performed on the general conditions of the Psychology Building. The general conditions are costs that cannot be related to work that is actually performed in the field. The general conditions of this project can be broken down into four basic categories, staffing, temporary utilities, safety, and miscellaneous costs. The employees' salaries account for the majority of the costs. General conditions are important to the construction manager because these are the costs that pay the project staff, bills, and office expenses. If they are not estimated correctly, the construction manager can end up paying for a lot of costs that should be covered by the owner. The total cost of general conditions in this case accounts for almost four percent of the total project cost, which, when paying out of the construction manager's pocket, is a lot of money.

Attendees of the 17th Annual Partnership for Achieving Construction Excellence (PACE) Roundtable were treated to thought-provoking discussions on current issues of the construction industry. Industry members as well as students were present to voice their opinions and experience of the construction industry and where it is leading. Main topics included Building Information Modeling, LEED certification changes, and energy and the economy, all of which have had an impact on the Psychology Building. Other topics included the implementation of a mentorship program for the Penn State Architectural Engineering program, a panel discussion of how roles within the industry are changing, and how students are dealing with the pressures of today and finding a work/life balance. The conclusion of this report is a summary of those topics.

Table of Contents

2.1 Detailed Project Schedule

This project schedule breaks down the Emory Psychology Building by phase of construction and activity. The major phases for the building are the substructure, superstructure, exterior skin, first through fifth floor interiors, and MEP installation and start up. The schedule can be found in Appendix A.

2.1.1 Structure

Since the building footprint is basically divided into two wings, the schedule is divided into two sequences per floor. There is a north and south sequence starting with the foundation and continuing through to the penthouse steel. The work flow starts with the south sequence, and then moves to the north sequence, then to the south sequence of the floor above. The building tops out on June 12, 2008.

2.1.2 Exterior Skin

The first and second floor masonry are each done as separate sequences. The masonry on the third through penthouse floors starts with the south and moves west, and then north. The stucco finish and windows follow a similar path on those facades. Meanwhile, the curtain wall is installed on the south, then the north of the east façade. The roofing is also installed while the facades are being completed. Since the west façade is so large, it takes the longest to complete and the building is not dried in until it is complete on August 8, 2008.

2.1.3 Interiors

The interior flow of work is pretty standard for the Psychology Building. Each floor is treated as one sequence, unlike the structure. The sequence starts with MEP rough-in, and then moves to framing, distribution, and finishes. Most of the interior work moves up through the building, first floor through the penthouse. The finishes do not. The second floor of this building is the main floor and contains a lot of higher end finishes. The owner, Emory, was making last minute changes on the design of the second floor interior. To prevent any schedule delays, Holder decided to change the schedule of the finishes so that the sequence was first floor, third through fifth floors, and then second floor. This way, Emory has the longest amount of time possible to make their decisions.

2.1.4 Schedule Summary

The total duration for the Psychology building is 352 working days. That equates to 70 weeks of construction, or just over 16 months. The schedule milestones of the Emory Psychology Building are:

- October 19, 2007 – Building Permit Received
- October 23, 2007 – Site Work Begins
- June 12, 2008 – Top Out Structure
- August 1, 2008 – Permanent Power
- August 8, 2008 – Building Dry in
- August 15, 2008 – Conditioned Air
- March 3, 2009 – Substantial Completion

2.2 Site Layout Planning

The site of the Emory Psychology Building is very congested. It is constricted by three roads; Dickey Drive to the north, Dowman Drive to the south, and Eagle Row to the west, and the Atwood Chemistry Building to the east. The building footprint takes up a large portion of that space. Also, since there is a building making up one border, Holder must be careful not to damage or disturb the occupants of the neighboring building.

Since there was such limited space, Holder set up the field offices west of the site, across Eagle Row. That space occupies field office trailers, some storage, and a limited amount of parking. Each subcontractor is allowed one spot in that area for a worker shuttle van. The van transports the building workers from the site to a remote parking area, about one mile away. Holder's staff and limited subcontractors are allowed to park near the field offices.

2.2.1 Excavation Site Plan

There are three construction gates for the site. The gates off of Emory Row and Dowman Drive are the primary entrances. The gate off of Dickey Drive is mostly used for exiting so trucks do not have to turn around, and so the trucks will not have to make a left across on-coming traffic. If the trucks enter through the Dowman Drive entrance, they have to go in, turn around, and come back out the same way, or cross the site to the Dickey Drive exit. They would must likely turn around since there is not a temporary road going across the site. There is a temporary road from the Emory Row gate to the Dickey Drive gate. The spoils that are shown on site will be hauled off prior to the start of the drilling for the concrete piers. Please refer to the site plan located in Appendix B for more information.

2.2.2 Superstructure Site Plan

While the structure is going up, the site starts to become congested. Concrete trucks need to have constant access to the pump during the pours, but deliveries also have to come in. For that reason it is very beneficial that this site has three entrances. The temporary road on the Northwest corner has been modified to fit around the building footprint, and the other road is extended and widened to allow concrete trucks to turn around. There are wash down areas next to the exits for the concrete trucks to get cleaned off before returning to the roadways. The pump truck is mobile and stations itself outside the temporary roads for easy access. Also, the formwork and shoring for the slabs takes up a lot of room on site. By this time the tower crane with a 240' operating radius has been brought on site and erected. The large radius allows the crane to pick anything on the site. Temporary power is pulled from the Atwood Chemistry Center. Large forklifts help move the rest of the material from delivery areas to lay down areas. Please refer to the site plan located in Appendix B for more information.

2.2.3 Interiors/Finishes Site Plan

The site is also very congested while the interior work is being completed. One reason that it is congested is because the façade is also under construction. The façade on the south and west elevation's has a scaffold around it and takes up a lot of room around the building. Luckily the North and east facades still have openings that large forklifts can use to bring in material. Since the second floor is basically at grade on the east side of the building, the forklifts can reach up to the third floor. The tower crane can drop off material on the fifth floor roof or penthouse roof. There are also areas cantilevered out from the building where part of the curtain wall is left out for the tower crane to drop off large material for each floor. Also, the first elevator will be available on August 26, 2008. Please refer to the site plan located in Appendix B for more information.

2.3 Detailed Structural Systems Estimate

The detailed structural systems estimate analyses the foundations and superstructure of the Psychology Building. To determine a cost for these systems, quantities of formwork, concrete volume, reinforcing, and structural steel were calculated per the structural drawings. Each quantity had a waste factor of 5% added to it except for formwork, which had a 10% waste factor. The waste factor adds in costs that occur in addition to what is actually on the drawings during the construction of the systems. The quantities were multiplied by RS Means Bare Costs to find the price of each item. The total structural system estimate was $4,045,119.93.

In order to keep the estimate organized, an excel spreadsheet was used as much as possible instead of hand-written notes. The quantities were calculated separately for each different aspect of the structure. The table on the following page is a summary of the structural systems estimate. For a detailed estimate of each system, please refer to appendix C.

Item	Labor	Material	Equipment	Total
Drilled Pier Excavation	$ 26,827.20	$ -	$ 38,154.24	$ 64,981.44
Drilled Pier Concrete	$ 37,250.70	$ 357,738.00	$ 1,214.34	$ 396,203.04
Drilled Pier Rebar	$ 31,757.60	$ 92,876.00	$ 1,348.20	$ 125,981.80
Grade Beams Concrete	$ 1,147.98	$ 11,804.70	$ 969.29	$ 13,921.97
Grade Beams Rebar	$ 4,107.20	$ 8,909.00	$ 135.90	$ 13,152.10
Retaining Wall Forms	$ 95,035.15	$ 134,335.40	$ -	$ 229,370.55
Retaining Wall Concrete	$ 144,076.00	$ 867,640.00	$ 52,536.00	$ 1,064,252.00
Retaining Wall Rebar	$ 11,271.15	$ 32,085.00	$ 465.75	$ 43,821.90
SOG Forms	$ 1,900.80	$ 6,388.80	$ -	$ 8,289.60
SOG Concrete	$ 8,266.50	$ 53,955.00	$ 3,019.50	$ 65,241.00
SOG Rebar	$ 7,676.25	$ 10,132.65	$ -	$ 17,808.90
SOG Finish	$ 11,481.00	$ -	$ -	$ 11,481.00
Column Forms	$ 55,527.57	$ 17,631.72	$ -	$ 73,159.29
Column Concrete	$ 10,626.70	$ 57,429.40	$ 3,888.92	$ 71,945.02
Column Rebar	$ 14,973.00	$ 37,432.50	$ -	$ 52,405.50
Elev. Slab Forms	$ 245,540.88	$ 108,391.92	$ -	$ 353,932.80
Elev. Beam Forms	$ 304,963.15	$ 69,795.69	$ -	$ 374,758.84
Elev. Slab Concrete	$ 47,368.00	$ 339,216.00	$ 17,266.40	$ 403,850.40
Elev. Slab Rebar	$ 22,579.20	$ 71,424.00	$ -	$ 94,003.20
Elev. Beam Rebar	$ 18,562.80	$ 46,407.00	$ -	$ 64,969.80
Elev. Slab Finish	$ 51,299.00	$ -	$ -	$ 51,299.00
Structural Steel W	$ 17,236.85	$ 301,498.80	$ 12,328.73	$ 331,064.38
Structural Steel C	$ 13,996.80	$ 4,561.92	$ 1,736.64	$ 20,295.36
Decking	$ 2,485.36	$ 16,181.28	$ 264.40	$ 18,931.04
Post Tensioning Allowance	$ 20,000.00	$ 50,000.00	$ 10,000.00	$ 80,000.00
	$1,205,956.84	**$2,695,834.78**	**$143,328.31**	**$ 4,045,119.93**

Table 1 Detailed Structural System Estimate.

2.3.1 Foundation Calculation

There are 6 different kinds of drilled piers supporting this building. Each one was counted separately along with the total depth for each pier type. The average depth is about 40.5 feet. Once the depth was known, the volume of cubic yards was calculated. That volume was totaled and multiplied by the RS Means bare costs for direct chute poured, deep foundations, since that was the closest item to match to foundation system. The concrete strength is 4,000 psi.

The pounds per foot depth of rebar was taken off the drawings and multiplied by the total depths to get the total pounds of vertical reinforcing. The bands holding the reinforcing together were calculated considering spacing and 2 additional bands near the top of the. Those numbers were added by pier type and totaled to find the total weight in tons of rebar in the piers.

The grade beams were earth formed, so there was no need to find the square feet of contact area. The rebar was averaged as having 13 #6 bars continuously throughout the beam for the entire length. The bands were also calculated and added to the other reinforcing to find the total tonnage. The cubic yards of concrete (4,000 psi) were then taken off and multiplied by RS Mean's factors for direct chute poured grade beams.

2.3.2 Retaining Wall Calculation

The retaining wall along the east façade is made up of 4,000 psi concrete. It is 14" thick and 14' tall. The forms are made of plywood and supported by 2x4 bracings while the concrete is pumped. RS Means does not seem to factor in the shoring necessary to hold the forms during the pour. The reinforcing is mostly #5 rebar, with some #7 bars.

2.3.3 Slab-on-Grade Calculation

The slab on grade took into account elevator pits, pits for incoming utilities, equipment pads, and the turndown area of the slab for the cubic yard calculation of 4,000 psi concrete. The concrete for this slab and the rest of the building was pumped. The reinforcing is welded wire fabric. Forms for this slab were made of plywood. The slab finish was assumed to be screed, with bull and manual float.

2.3.4 Column Calculation

The columns were taken off per the column schedule on the structural drawings. There are four types of columns, 16", 24," and 30" square columns, and 24" round columns. Each one was calculated for square feet of formwork contact area, tonnage of rebar, and cubic yards. The columns vary between 5,000 psi and 7,000 psi concrete, but most are 7,000 psi. The material cost is based on 7,000 psi rates. The second floor was quantified separately because it has a 16' height instead of a 13' height like floors one, and third through fifth.

2.3.5 Elevated Slab Calculation

The third floor was used as a model for all elevated slabs. All of the quantifications were taken from the third floor and extrapolated to the other floors and roof slab. The plywood forms were assumed to be covering 75% of the slab area, with the other 25% covered by beams and girders. Therefore, the forms were multiplied by 0.75 of the total area and added to the edge slab formwork to get the total square footage. The cubic yardage was based on a 5" pumped slab and 21,900 square feet of area. Rebar from a typical bay was quantified and extrapolated to find a total tonnage for one floor. The finish, like the slab-on-grade finish, is assumed to be screed, with bull and manual float.

2.3.6 Elevated Beam and Girder Calculation

Similar to the slabs, the third floor is used as a model for the rest of the floors. All 89 types of beams and post-tensioned beams for the third floor were taken off by length from the structural drawings. From there, the areas of each were taken from the beam schedules and multiplied by the length to find the cubic yardage. The plywood formwork was also taken off using the beam schedules, as well as the reinforcing. Since RS means did not have a value for post-tensioning tendons (only pre-stressed tendons), an allowance of $80,000 was included.

2.3.7 Structural Steel Calculation

The structural steel supporting the roof mostly consists of W14x22 members, but has some members as large as W18x55. For this estimate, all the steel was taken off as a sum of linear feet of the members. The RS Means factors used were for W14x26 members to correct for some beams that may be slightly larger than the average W14x22. The outside of the roof consists of channels that are mostly C6x12. Since there were no C6x12 members in RS Means, a C7x9.2 member was used since it was the closest match to the actual member. The steel decking was taken off by square feet of coverage.

2.3.8 Analyses of Estimate

Although these specific items were quantified accurately, the final sum is less than would be expected. Referring back to the first technical assignment on the Emory Psychology Building, the structural cost was about $5.2 million. This number may not be perfectly accurate either, but it is about 15% of the total project cost, which is a good indicator that it is close. This detailed estimate came out to be about 11.5% of the total building cost, which is a little low.

2.3.9 Factors Affecting Detailed Estimate

There are several factors that need to be looked at when analyzing this estimate. The following is a list of factors that may have caused the estimate to be low:

- Inaccurate take-offs
- Unclear structural drawings
- Oversimplification of systems
- Inaccurate RS Means rates
- Costly items not included as part of estimate
- Difficulty of construction is not factored

Also, it is important to break the estimate down by labor, material, and equipment because it can give an idea where some of the costs are low. According to the RS Means data, the equipment total for this building is only $148,323.31. That cost is somewhat low for approximately seven months of work of this magnitude, especially since there was a crane on site for ten months. RS Means does not be include all of the specific equipment needed for the duration of Psychology Building structure. That is most likely the case because the labor costs seem to be close, but may be a little low, and the material costs appear to be accurate. Some other items that must be considered but were not included in the estimate are:

- Tower crane rental, erection, and dismantle
- Mobile crane to assist with steel erection
- Tools to perform work
- Layout and control labor costs
- Slab-on-grade water stops, vapor barrier, and backfill
- Steel estimate does not include base plate, bolts, or connections
- Dowels are not included in rebar costs

Since there are many items not included using RS means, the take-off quantities are probably fairly accurate. If there was pricing information for the missing items, the total estimate would probably be more realistic for structural system.

2.4 General Conditions Estimate

General conditions costs are costs that are not actually caused by work done on the project. The main portion of the general conditions is staffing costs for the construction management or general contractor team. The team members bill how much time they work on the project to the owner. Most people are on site full time but some upper management people divide their time between a number of projects and do not bill their full salary. Items like telephone bills, internet service, and temporary utilities also need to be planned for and paid for during construction. In order to estimate the general conditions costs of the Emory Psychology Building, time and local rates were considered. Then each item was given a dollar amount based on previous knowledge and general estimates from Holder Construction.

2.4.1 Cost Evaluation

The general conditions cost of this building is estimated to be $1,374,100.00, which accounts for approximately 3.93% of the total building cost. The percentage shows that it is a pretty accurate estimate of typical general conditions on a project like this. Of the total general conditions, about 77% of the costs are from staffing, which is also pretty standard in terms of percentage. As a way to manage the general conditions, they were broken down into 4 categories, staffing, temporary utilities, safety, and any other items that fall under general conditions.

2.4.2 Staffing Costs

Almost everyone included in the staffing costs are on-site at all times at Emory. The only two people who are not always on site are the project executive and the project director. In the following table, they are identified with asterisks. It was determined that the project director will most likely be splitting his time between Emory and another similarly sized project. Therefore, his total price per unit cost is halved to represent half of his time spent at Emory for the duration of the project. The project executive has his time split between two other similarly sized projects and his price per unit is represented in the general conditions similar to the project director's. The rest of the people bill their full weekly amount to Emory for their time on site, which varies. Some people do not join the project until the structure goes up, and others leave during the close out phase. The number of weeks next to their title represents their time on site in the table on the following page.

Staffing	Qty.	Unit	Price/Unit	Price
Project Executive*	72	Wks	$ 1,200.00	$ 86,400.00
Project Director*	72	Wks	$ 1,550.00	$ 111,600.00
Sr. Project Manager	70	Wks	$ 2,800.00	$ 196,000.00
General Superintendent	68	Wks	$ 2,800.00	$ 190,400.00
Sr. Project Engineer	65	Wks	$ 1,700.00	$ 110,500.00
Sr. Project Engineer	72	Wks	$ 1,700.00	$ 122,400.00
Project Engineer	64	Wks	$ 1,200.00	$ 76,800.00
Sr. Field Engineer	70	Wks	$ 1,500.00	$ 105,000.00
Field Office Processor	72	Wks	$ 800.00	$ 57,600.00
			Total	**$1,056,700.00**

Table 2 Staffing costs.

2.4.3 Temporary Utilities Costs

During construction, different utilities are necessary for various tasks. It is Holder Construction's responsibility to pay for these utilities while under construction. All of the utility bills come on a monthly basis, but Holder will not have to pay for all the utilities for the duration of the project. The internet and trailer temporary power are the only two items that need to be paid for during the entire construction process of November, 2007 to March, 2009. The cost per month is averaged over the entire 17 months. Most of the rest of the items can start into December, 2007 and can be billed for one less month. The temporary power duration is 12 months since the building will have access to permanent power in August, 2008, but there will be some overlap in the use of temporary and permanent power. The table below details the temporary utility costs.

Utilities	Qty.	Unit	Price/Unit	Price
Temporary Water	15	MO	$ 350.00	$ 5,250.00
Temporary Power	12	MO	$ 1,000.00	$ 12,000.00
Phone Service	16	MO	$ 1,200.00	$ 19,200.00
Trailer Sewer Service	16	MO	$ 300.00	$ 4,800.00
Temporary Toilets	15	MO	$ 1,250.00	$ 18,750.00
Trailer Internet Service	17	MO	$ 350.00	$ 5,950.00
Trailer Temporary Power	17	MO	$ 250.00	$ 4,250.00
			Total	**$ 70,200.00**

Table 3 Temporary utility costs.

2.4.4 Safety Costs

Safety is paramount to any contractor and Holder is no exception. Holder's safety program, or Zero Accident Culture (ZAC), is incorporated on every project, no matter how large or small. Holder employs a full time safety coordinator to make sure all employees are safe on-site and follow all of the site safety rules. The coordinator is billed in this section since he is an hourly worker and not included with the salaried Holder employees. His time is averaged as 50 hours per week and includes any overtime pay. General safety measures include meetings, safety equipment for Holder employees and visitors, and some visits and meetings with Holder's corporate safety director. Incentives are prizes given to employees or companies who are doing an exceptional job staying accident free and working safe. The following table summarizes the safety general conditions.

Safety	***Qty.***	***Unit***	***Price/Unit***	***Price***
General	15	MO	$ 500.00	$ 7,500.00
Coordinator	70	Wks	$ 1,200.00	$ 84,000.00
Incentives	16	MO	$ 150.00	$ 2,400.00
			Total	**$ 93,900.00**

Table 4 Safety costs.

2.4.5 Other General Conditions Costs

The rest of the general conditions costs make up anything else that Holder will have to pay for during construction. All Holder project managers and superintendents are given trucks and Holder pays for gas, insurance, and maintenance. Traditionally, construction sites will have parties for groundbreaking, topping out, and other major milestones. Holder plans to have these and also has barbeques and other functions for major holidays as a thank you to the workers. Office supplies and maintenance is another large cost. The table below summarizes the rest of the general conditions costs.

Other	***Qty.***	***Unit***	***Price/Unit***	***Price***
Superintendent Truck	16	MO	$ 1,000.00	$ 16,000.00
Project Manager Car	17	MO	$ 1,000.00	$ 17,000.00
Tools/Other	17	MO	$ 300.00	$ 5,100.00
Job Parties/Meetings	6	LS	$ 1,000.00	$ 6,000.00
Signage	1	LS	$ 2,500.00	$ 2,500.00
Moving/Travel Expenses	17	MO	$ 800.00	$ 13,600.00
Computers/Tech.	16	MO	$ 2,100.00	$ 33,600.00
Office Costs	17	MO	$ 3,500.00	$ 59,500.00
			Total	**$ 153,300.00**

Table 5 Other general conditions costs.

2.4.6 General Conditions Conclusions

The final general conditions estimate came out to $1,374,100.00. A summary of the costs can be found in the table below.

General Conditions	***Price***
Staffing	$1,056,700.00
Temporary Utilities	$ 70,200.00
Safety	$ 93,900.00
Other	$ 153,300.00
Total	**$1,374,100.00**

Table 6 General conditions estimate.

Obviously, the staff's salaries make up most of the general conditions. This is fairly typical on a construction project. The rest of the general conditions are also typical for a project of this size and scope.

2.5 PACE Roundtable

During the Partners for Achieving Construction Excellence (PACE) Roundtable there were several sessions that allowed interaction between students and members of the construction industry. These sessions had varying topics including adopting a Penn State AE Student/Industry member mentorship program, Building Information Modeling, the modifications to the LEED certification points, energy prices and the economy, and two panel discussions about changing roles in the construction industry and how students balance workload and their personal life.

2.5.1 Mentor/Protégé Benefits

Based on the discussion about the mentorship program it was evident that industry members and students believed that a mentor/protégé relationship could be valuable for both parties. While listing benefits for both parties, each side included future employment as a potential upside of the program. However, industry members were adamant in saying that protégés should not be subject to recruiting. Many expressed concern that the relationships would be "walking a dangerous line" and could possibly be detrimental for students if mentors abused the relationship for recruiting. Other than that, potential benefits for students would be help on selecting an option, knowledge of life in a chosen career path, and advice from someone who has been through AE program before. Industry members would benefit by getting to learn cutting edge technology and innovation that generally starts at the university level.

2.5.2 Mentor Selection

Having a mentor would be great, but how are the students and mentors matched? There was some debate whether the mentor would be selected randomly or if the student could have some way of picking their mentor. Again, industry members stressed that "mentorship does not equal or lead to internship." Although there was a lot of debate on the topic, no real conclusion was ever met.

2.5.3 Interaction Facilitation and Proof of Success

In order for the relationship to be successful, strong communication would be necessary between the mentor and student. In order to do that, the student must establish contact regularly, at least on a bi-weekly basis. To alleviate student's worries that they are a bother to the mentor, the mentor should establish when and how they are to be contacted. Also, the student should have a checklist or list of goals that the mentor can help them complete. At the end of the year or whatever the time-frame may be for the mentorship, the student can refer back to the checklist and determine if the relationship helped them develop as a person and student.

Some industry members that were helpful during this session were:

- Steve Lee – Benchmark Construction
- Chris Smith – Benchmark Construction

- Andrew Kerr – Turner Construction
- Michael Barnhart – Forrester Construction

2.5.4 BIM Roundtable Discussion

This roundtable discussion began with everyone introducing themselves and their knowledge of BIM. The majority of the attendees classified themselves as BIM beginners with some people claiming intermediate knowledge. Next some company representatives discussed their uses and difficulties with BIM. It became clear that building modeling is now almost standard practice, yet the information associated with it is severely lacking.

2.5.5 BIM Pitfalls

Unfortunately, many people in the construction industry still do not see the benefits of BIM. Designers are reluctant to change their design practices and do not want to spend more money for something that does not help them. It is hard for them to spend a large sum of money to create a smart model, and then hand it over to the construction manager so the construction manager can save money. It is often difficult to determine who the owner of the BIM is since the construction manager needs to use it, but the designer created it.

Another problem is that architects, engineers, steel fabricators, manufacturers and all other parties use different software to create their models. They save all of their information to their own file type, which may not be readable by programs that the construction manager uses. Some construction managers have programs that can read multiple file types, but others lose the information in the conversion process and can only read the model.

2.5.6 Current BIM Uses

The most common use of BIM is with clash detection. About half of the companies that have implemented BIM use it for clash detection, but they are struggling to find more uses. One company has found another effective use for BIM. They are using the BIM to track their steel submittals. If a submittal is late or missing, they can go to the model and see exactly where it is and what it will affect if there is a delay. The same company made that system work because they incorporated BIM into the RFP sent to subcontractors. All of the subcontractors were aware early that they had to use BIM on the project. The construction manager on the project uses a program named TEKLA to combine all of their files into one model. The TEKLA program imports IFC files for its use, which are fairly easily made from most design programs.

2.5.7 BIM Best Practices

Like many aspects of the construction industry, BIM has to be set up for success early in the process, hopefully in the design or preconstruction phase. For that reason, Design-Build projects are currently having the most success with BIM. Since everyone is on the team, there is less worry about ownership of the model and who to fault if something is wrong. The project team can work with the architect rather than trying to settle disputes while the project is under construction.

Having language in the contract documents relating to BIM is also very important. Every subcontractor should know what is expected of them. That includes what information needs to be in the model, the file type, and how to update the model if changes need to be made.

2.5.8 Facility Management

Another thing that was discussed in relation to BIM was facilities management. The BIM can be used after the building is built as a way for the owner to monitor the building. A facility model has to have information linked to it for it to be successful. Some of the industry members discussed the need for manufacturers to create smart models of their products. If they do, it will be much easier to insert those into the BIM and have a very useful tool. Manufacturers could link things like warranties, maintenance, user manuals, and other information about their products to the model. Then the owner could use the model to make sure their facility is well maintained.

2.5.9 BIM Discussion Conclusions

One good thing about the discussion was that everyone in the room saw the need for BIM and that it is part of the future. Even the contractors who were not using BIM were trying to find out how and where they could use it. The contractors that already are using BIM were looking for more ways to use the models to help streamline the construction process.

Some contacts that were met or could help with research on the Emory Psychology Building are:

- John Bechtel – Penn State Office of the Physical Plant
- Corinne Ambler – Barton Malow Company
- Mark Konchar – Balfour Beatty Construction

2.5.10 LEED Evolution

Another topic up for discussion at the roundtable was how LEED credits are changing and how to adapt to those changes. The primary points of focus of that discussion were:

- Early team integration leads to greater success
- Knowing how the points change and awareness
- Regional impacts of the point system changes
- Owner education of point changes and cost implications
- How to prove how much a LEED design will save in operating costs

2.5.11 Energy and the Economy

The discussion on energy and the economy focused on how companies were responding to the current economic downturn. Surprisingly, students seemed more concerned about the economy than the industry members. It seems that although not many new projects are starting, most of the companies are in the middle of several long term projects that will not be over for at least a year. The owners of those buildings are not going to stop a project in the middle, so the construction managers are still doing fine. Also, many of the companies represented are from the Washington DC area and work on a lot of federally funded projects. Those types of projects continue to be steady even in a slow economy. However, there are less recreational and condominium projects to build right now since people are not spending money like they were before. The companies all seemed to have the attitude that if they just continue to work hard, they will come out of the downturn strong.

2.5.12 Industry Panel

The industry member panel was well represented by a large variety of companies. Each company was unique in size, location, and scope of work. They fielded questions on how roles of construction managers and anyone in the construction industry are changing today. BIM seemed to be the largest area where companies saw change. New technology and innovations have caused younger employees to be much more valuable to a company than they have been in the past. The younger employees are more comfortable with new technology and can navigate some of the programs better. Their knowledge has caused them to have a much larger role in the construction industry.
Owners are also causing the industry to change. Owners are becoming much more knowledgeable and want to know more about their buildings. Many owners want to have a larger part in the projects. Construction managers have to accommodate them and make sure that they communicate information well to the owners.

Another big change that is making a difference in the industry is a rise in the amount of collaborative contracts. Many owners and construction managers are finding that a large team approach, where everyone gets on board early is much more effective than the standard design-bid-build contracts. Construction managers are working on planning much early and finding that later on, the projects are much less stressful.

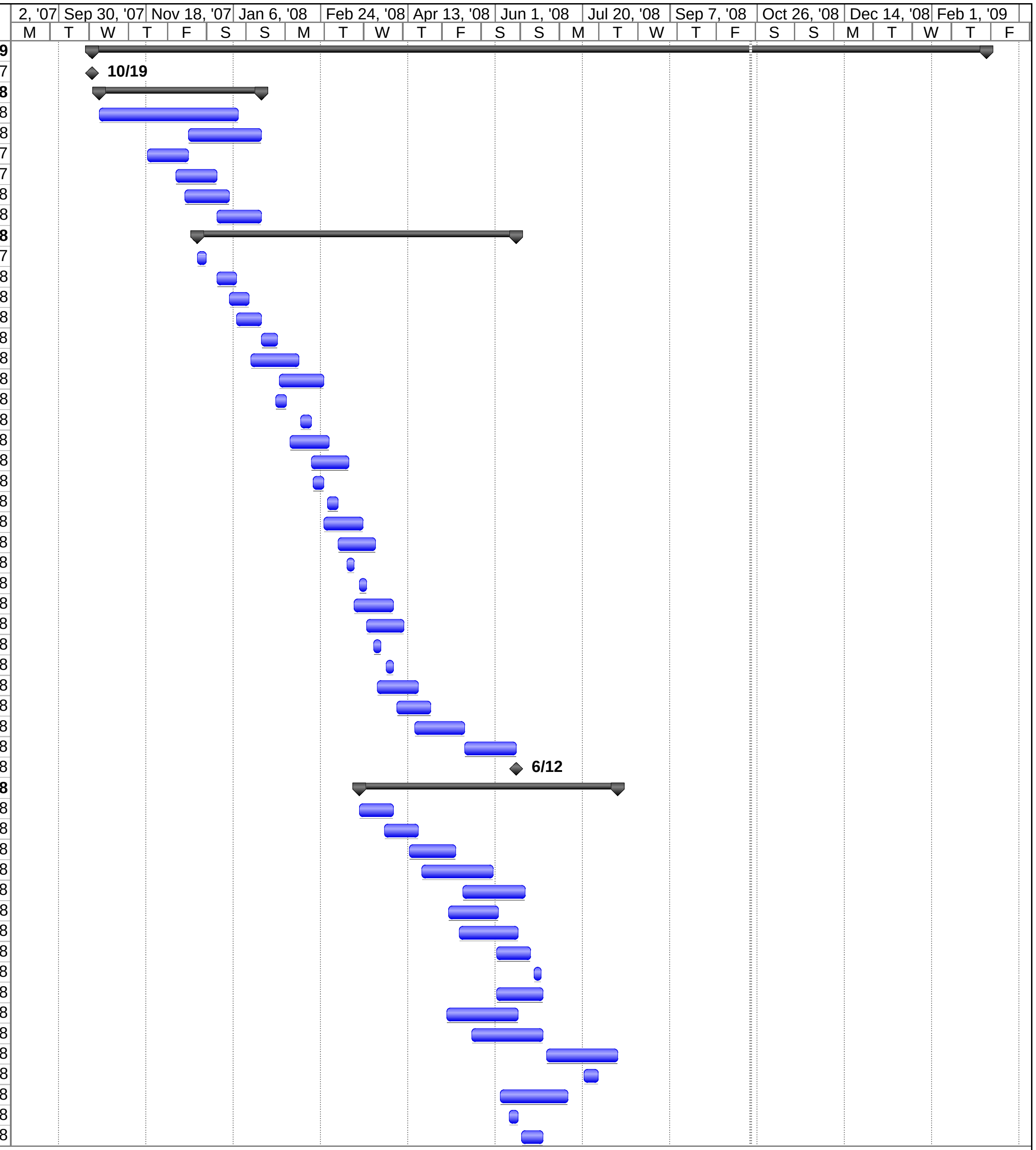
2.5.13 Student Panel

The last session of the roundtable was a student panel fielding questions on how they keep a balance between school work and other activities. Industry members questioned the students on how they felt their workload would change after graduation. Most of the students seemed to understand that there would be a lot of work in their first job, but were eager to take on the challenge.

Appendix A

Detailed Project Schedule

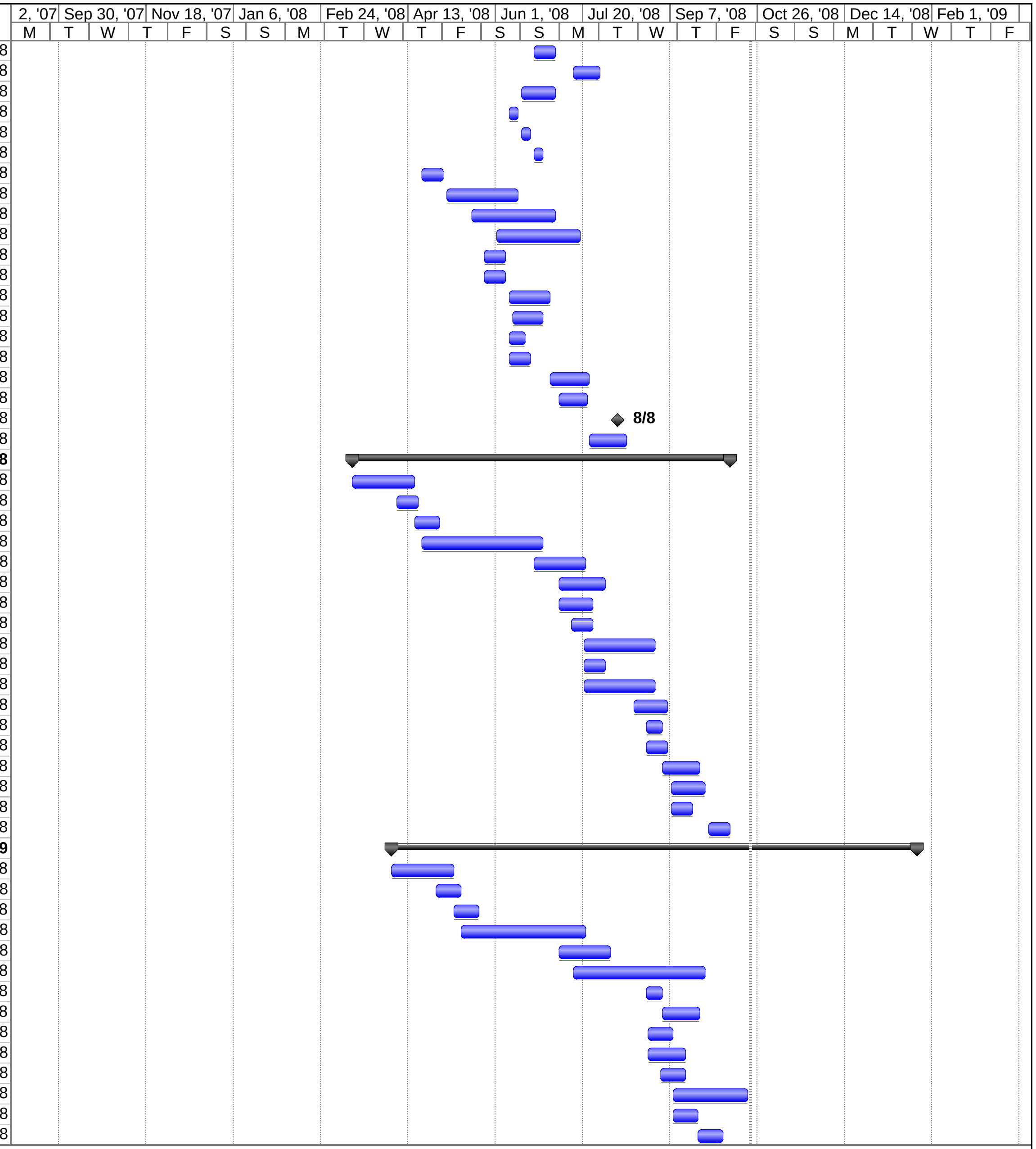
ID	Task Name	Duration	Start	Finish
1	**Emory Psychology Building**	**352 days**	**Fri 10/19/07**	**Tue 3/3/09**
2	Building Permit Obtained	0 days	Fri 10/19/07	Fri 10/19/07
3	**Substructure**	**59 days**	**Tue 10/23/07**	**Mon 1/21/08**
4	Earthwork/Site Utility Relocation	50 days	Tue 10/23/07	Tue 1/8/08
5	MEP Underground	25 days	Wed 12/12/07	Mon 1/21/08
6	Deep Foundations South	15 days	Mon 11/19/07	Tue 12/11/07
7	Deep Foundations North	15 days	Wed 12/5/07	Thu 12/27/07
8	Shallow Foundations South	15 days	Mon 12/10/07	Thu 1/3/08
9	Shallow Foundations North	15 days	Fri 12/28/07	Mon 1/21/08
10	**Superstructure**	**125 days**	**Mon 12/17/07**	**Thu 6/12/08**
11	1st Level Columns South	5 days	Mon 12/17/07	Fri 12/21/07
12	1st Level Columns North	5 days	Fri 12/28/07	Mon 1/7/08
13	SOG South	7 days	Fri 1/4/08	Mon 1/14/08
14	Electrical Underground	10 days	Tue 1/8/08	Mon 1/21/08
15	SOG North	7 days	Tue 1/22/08	Wed 1/30/08
16	2nd Level Slab South	19 days	Wed 1/16/08	Mon 2/11/08
17	2nd Level Slab North	17 days	Fri 2/1/08	Mon 2/25/08
18	2nd Level Columns South	4 days	Wed 1/30/08	Mon 2/4/08
19	2nd Level Columns North	4 days	Wed 2/13/08	Mon 2/18/08
20	3rd Level Slab South	16 days	Thu 2/7/08	Thu 2/28/08
21	3rd Level Slab North	15 days	Tue 2/19/08	Mon 3/10/08
22	3rd Level Columns South	4 days	Wed 2/20/08	Mon 2/25/08
23	3rd Level Columns North	4 days	Thu 2/28/08	Tue 3/4/08
24	4th Level Slab South	16 days	Tue 2/26/08	Tue 3/18/08
25	4th Level Slab North	15 days	Wed 3/5/08	Tue 3/25/08
26	4th Level Columns South	4 days	Mon 3/10/08	Thu 3/13/08
27	4th Level Columns North	4 days	Mon 3/17/08	Thu 3/20/08
28	5th Level Slab South	16 days	Fri 3/14/08	Fri 4/4/08
29	5th Level Slab North	15 days	Fri 3/21/08	Thu 4/10/08
30	5th Level Columns South	4 days	Tue 3/25/08	Fri 3/28/08
31	5th Level Columns North	4 days	Tue 4/1/08	Fri 4/4/08
32	Penthouse Slab South	17 days	Thu 3/27/08	Fri 4/18/08
33	Penthouse Slab North	15 days	Mon 4/7/08	Fri 4/25/08
34	Penthouse South Steel	20 days	Thu 4/17/08	Wed 5/14/08
35	Penthouse North Steel	21 days	Thu 5/15/08	Thu 6/12/08
36	Top Out Structure	0 days	Thu 6/12/08	Thu 6/12/08
37	**Exterior Skin**	**105 days**	**Mon 3/17/08**	**Fri 8/8/08**
38	1st Level Masonry	15 days	Mon 3/17/08	Fri 4/4/08
39	2nd Level Masonry	15 days	Mon 3/31/08	Fri 4/18/08
40	South Elev. Levels 3-6	20 days	Mon 4/14/08	Fri 5/9/08
41	West Elev. Levels 3-6	30 days	Mon 4/21/08	Fri 5/30/08
42	North Elev. Levels 3-6	25 days	Wed 5/14/08	Tue 6/17/08
43	South Elev. Waterproofing	20 days	Tue 5/6/08	Mon 6/2/08
44	South Elev. Stone	25 days	Mon 5/12/08	Fri 6/13/08
45	South Elev. Stucco/Glazing	15 days	Mon 6/2/08	Fri 6/20/08
46	South Elev. Curtain wall	4 days	Mon 6/23/08	Thu 6/26/08
47	South Elev. Penthouse Soffit	20 days	Mon 6/2/08	Fri 6/27/08
48	West Elev. Waterproofing	30 days	Mon 5/5/08	Fri 6/13/08
49	West Elev. Stone	30 days	Mon 5/19/08	Fri 6/27/08
50	West Elev. Stucco/Glazing	30 days	Mon 6/30/08	Fri 8/8/08
51	West Elev. Curtain wall	6 days	Mon 7/21/08	Mon 7/28/08
52	West Elev. Penthouse Soffit	28 days	Wed 6/4/08	Fri 7/11/08
53	North Elev. Waterproofing	5 days	Mon 6/9/08	Fri 6/13/08
54	North Elev. Stone	10 days	Mon 6/16/08	Fri 6/27/08



Project: Emory Detailed Schedule.mpp
Date: Wed 10/22/08

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

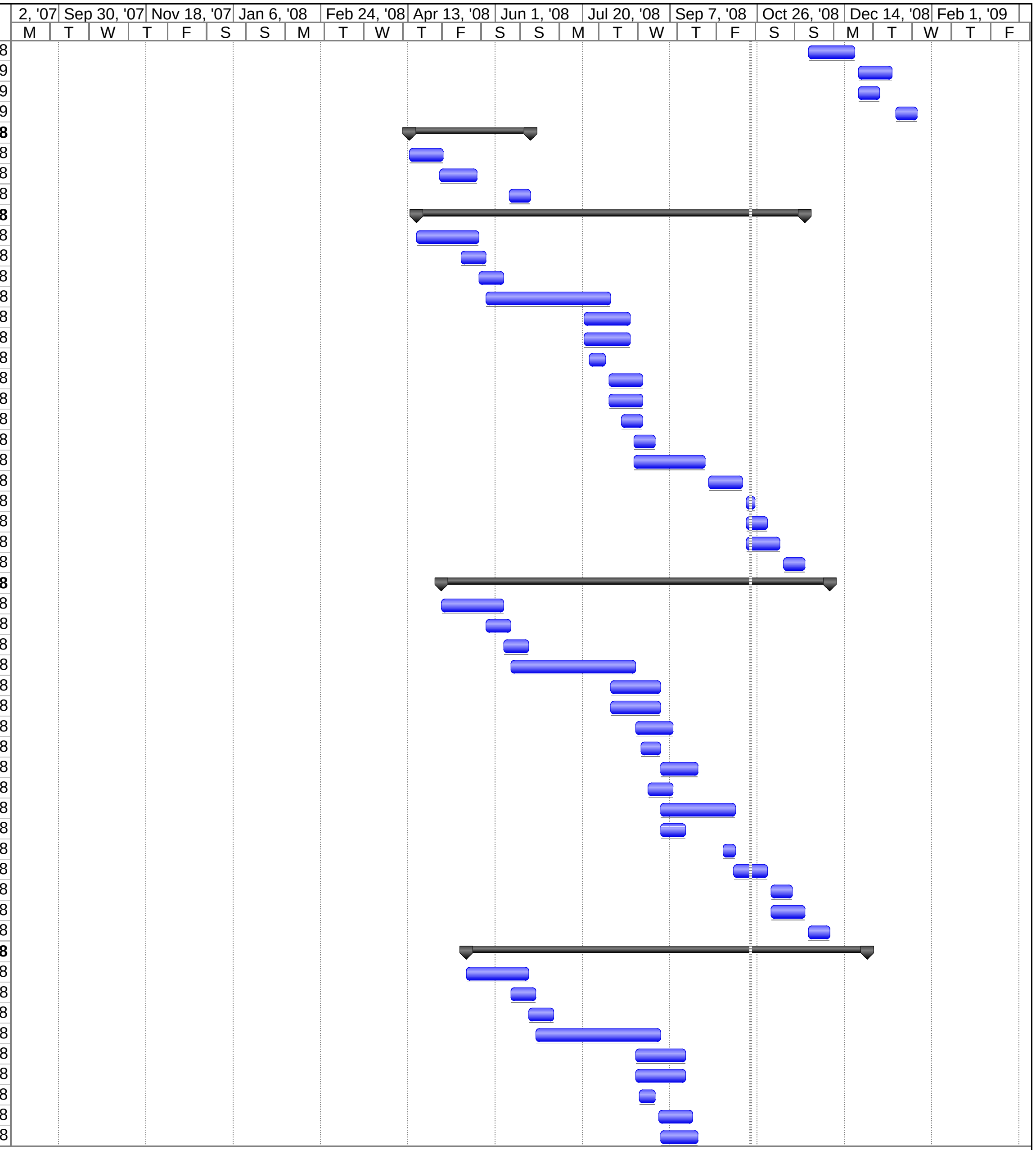
ID	Task Name	Duration	Start	Finish
55	North Elev. Stucco/Glazing	10 days	Mon 6/23/08	Fri 7/4/08
56	North Elev. Curtain wall	11 days	Tue 7/15/08	Tue 7/29/08
57	North Elev. Penthouse Soffit	15 days	Mon 6/16/08	Fri 7/4/08
58	East Elev. Waterproofing	5 days	Mon 6/9/08	Fri 6/13/08
59	East. Elev. Stone	5 days	Mon 6/16/08	Fri 6/20/08
60	East Elev. Stucco	5 days	Mon 6/23/08	Fri 6/27/08
61	Curtain Wall Layout	10 days	Mon 4/21/08	Fri 5/2/08
62	Curtain Wall South	30 days	Mon 5/5/08	Fri 6/13/08
63	Curtain Wall North	35 days	Mon 5/19/08	Fri 7/4/08
64	East Elev. Penthouse	35 days	Mon 6/2/08	Fri 7/18/08
65	Built Up Roof South	10 days	Mon 5/26/08	Fri 6/6/08
66	Roof Membrane South	10 days	Mon 5/26/08	Fri 6/6/08
67	Clay Tile South	17 days	Mon 6/9/08	Tue 7/1/08
68	Gutters and Downspouts South	13 days	Wed 6/11/08	Fri 6/27/08
69	Built Up Roof North	7 days	Mon 6/9/08	Tue 6/17/08
70	Roof Membrane North	10 days	Mon 6/9/08	Fri 6/20/08
71	Clay Tile North	16 days	Wed 7/2/08	Wed 7/23/08
72	Gutters and Downspouts North	12 days	Mon 7/7/08	Tue 7/22/08
73	Building Dry In	0 days	Fri 8/8/08	Fri 8/8/08
74	Penthouse Steel Spray on	15 days	Thu 7/24/08	Wed 8/13/08
75	**1st Floor Interior**	**152 days**	**Thu 3/13/08**	**Fri 10/10/08**
76	MEP/Spk. Overhead Rough Ins	25 days	Thu 3/13/08	Wed 4/16/08
77	Wall Framing/Door Frames	10 days	Mon 4/7/08	Fri 4/18/08
78	Bathroom Plumbing Rough In	10 days	Thu 4/17/08	Wed 4/30/08
79	Electrical Rough In/Pull Wire	50 days	Mon 4/21/08	Fri 6/27/08
80	Walls and Insulation	21 days	Mon 6/23/08	Mon 7/21/08
81	Duct and Plumbing Insulation	20 days	Mon 7/7/08	Fri 8/1/08
82	Install ACT Grid/Frame Gyp. Ceiling:	15 days	Mon 7/7/08	Fri 7/25/08
83	Hang Drywall/Finish	10 days	Mon 7/14/08	Fri 7/25/08
84	Set Spk. Heads/Light Fixtures/Diffus	30 days	Mon 7/21/08	Fri 8/29/08
85	Prime Paint	10 days	Mon 7/21/08	Fri 8/1/08
86	Ornamental Staircase	30 days	Mon 7/21/08	Fri 8/29/08
87	Finish Paint/Drop ACT	15 days	Mon 8/18/08	Fri 9/5/08
88	Bathroom Tile/Countertops	7 days	Mon 8/25/08	Tue 9/2/08
89	Terrazzo Flooring	10 days	Mon 8/25/08	Fri 9/5/08
90	Bathroom Partitions/Fixtures/Finishe	15 days	Wed 9/3/08	Tue 9/23/08
91	Carpet/Linoleum	15 days	Mon 9/8/08	Fri 9/26/08
92	Millwork	10 days	Mon 9/8/08	Fri 9/19/08
93	Interior Glazing and Door Installatior	10 days	Mon 9/29/08	Fri 10/10/08
94	**2nd Floor Interior**	**211 days**	**Fri 4/4/08**	**Fri 1/23/09**
95	MEP/Spk. Overhead Rough Ins	25 days	Fri 4/4/08	Thu 5/8/08
96	Wall Framing/Door Frames	10 days	Tue 4/29/08	Mon 5/12/08
97	Bathroom Plumbing Rough In	10 days	Fri 5/9/08	Thu 5/22/08
98	Electrical Rough In/Pull Wire	50 days	Tue 5/13/08	Mon 7/21/08
99	Duct and Plumbing Insulation	21 days	Mon 7/7/08	Mon 8/4/08
100	Terrazzo Flooring	54 days	Tue 7/15/08	Fri 9/26/08
101	Bathroom Tile/Countertops	7 days	Mon 8/25/08	Tue 9/2/08
102	Bathroom Partitions/Fixtures/Finishe	15 days	Wed 9/3/08	Tue 9/23/08
103	Walls and Insulation	10 days	Tue 8/26/08	Mon 9/8/08
104	Install ACT Grid/Frame Gyp. Ceiling:	15 days	Tue 8/26/08	Mon 9/15/08
105	Hang Drywall/Finish	10 days	Tue 9/2/08	Mon 9/15/08
106	Set Spk. Heads/Light Fixtures/Diffus	30 days	Tue 9/9/08	Mon 10/20/08
107	Prime Paint	10 days	Tue 9/9/08	Mon 9/22/08
108	Wood/Fabric Panels	10 days	Tue 9/23/08	Mon 10/6/08



Project: Emory Detailed Schedule.mpp
Date: Wed 10/22/08

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

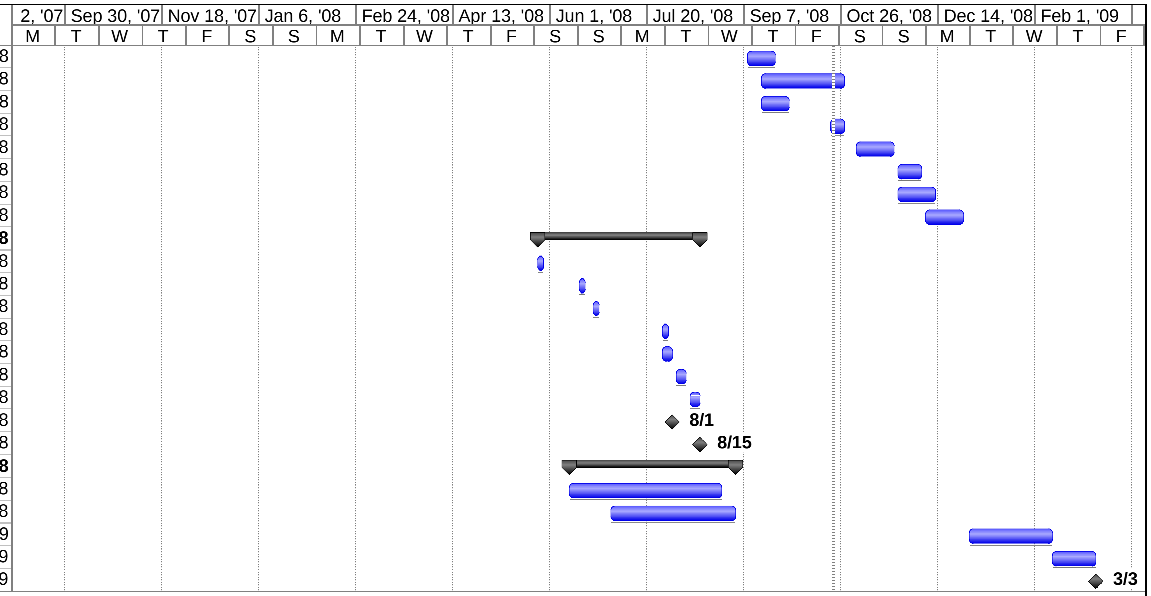
ID	Task Name	Duration	Start	Finish
109	Finish Paint/Drop ACT	20 days	Mon 11/24/08	Fri 12/19/08
110	Carpet/Linoleum	15 days	Mon 12/22/08	Fri 1/9/09
111	Millwork	10 days	Mon 12/22/08	Fri 1/2/09
112	Interior Glazing and Door Installatior	10 days	Mon 1/12/09	Fri 1/23/09
113	**Stairs**	**50 days**	**Mon 4/14/08**	**Fri 6/20/08**
114	North Stairs	15 days	Mon 4/14/08	Fri 5/2/08
115	Central Stairs	15 days	Thu 5/1/08	Wed 5/21/08
116	South Stairs	10 days	Mon 6/9/08	Fri 6/20/08
117	**3rd Floor Interior**	**156 days**	**Fri 4/18/08**	**Fri 11/21/08**
118	MEP/Spk. Overhead Rough Ins	25 days	Fri 4/18/08	Thu 5/22/08
119	Wall Framing/Door Frames	10 days	Tue 5/13/08	Mon 5/26/08
120	Bathroom Plumbing Rough In	10 days	Fri 5/23/08	Thu 6/5/08
121	Electrical Rough In/Pull Wire	50 days	Tue 5/27/08	Mon 8/4/08
122	Walls and Insulation	20 days	Mon 7/21/08	Fri 8/15/08
123	Duct and Plumbing Insulation	20 days	Mon 7/21/08	Fri 8/15/08
124	Bathroom Tile/Countertops	7 days	Thu 7/24/08	Fri 8/1/08
125	Bathroom Partitions/Fixtures/Finishe	15 days	Mon 8/4/08	Fri 8/22/08
126	Install ACT Grid/Frame Gyp. Ceiling:	15 days	Mon 8/4/08	Fri 8/22/08
127	Hang Drywall/Finish	10 days	Mon 8/11/08	Fri 8/22/08
128	Prime Paint	10 days	Mon 8/18/08	Fri 8/29/08
129	Set Spk. Heads/Light Fixtures/Diffus	30 days	Mon 8/18/08	Fri 9/26/08
130	Finish Paint	15 days	Mon 9/29/08	Fri 10/17/08
131	Drop ACT	5 days	Mon 10/20/08	Fri 10/24/08
132	Millwork	10 days	Mon 10/20/08	Fri 10/31/08
133	Carpet/Linoleum	15 days	Mon 10/20/08	Fri 11/7/08
134	Interior Glazing and Door Installatior	10 days	Mon 11/10/08	Fri 11/21/08
135	**4th Floor Interior**	**156 days**	**Fri 5/2/08**	**Fri 12/5/08**
136	MEP/Spk. Overhead Rough Ins	25 days	Fri 5/2/08	Thu 6/5/08
137	Wall Framing/Door Frames	10 days	Tue 5/27/08	Mon 6/9/08
138	Bathroom Plumbing Rough In	10 days	Fri 6/6/08	Thu 6/19/08
139	Electrical Rough In/Pull Wire	50 days	Tue 6/10/08	Mon 8/18/08
140	Walls and Insulation	20 days	Tue 8/5/08	Mon 9/1/08
141	Duct and Plumbing Insulation	20 days	Tue 8/5/08	Mon 9/1/08
142	Install ACT Grid/Frame Gyp. Ceiling:	15 days	Tue 8/19/08	Mon 9/8/08
143	Bathroom Tile/Countertops	7 days	Fri 8/22/08	Mon 9/1/08
144	Bathroom Partitions/Fixtures/Finishe	15 days	Tue 9/2/08	Mon 9/22/08
145	Hang Drywall/Finish	10 days	Tue 8/26/08	Mon 9/8/08
146	Set Spk. Heads/Light Fixtures/Diffus	30 days	Tue 9/2/08	Mon 10/13/08
147	Prime Paint	10 days	Tue 9/2/08	Mon 9/15/08
148	Drop ACT	5 days	Tue 10/7/08	Mon 10/13/08
149	Finish Paint	15 days	Mon 10/13/08	Fri 10/31/08
150	Millwork	10 days	Mon 11/3/08	Fri 11/14/08
151	Carpet/Linoleum	15 days	Mon 11/3/08	Fri 11/21/08
152	Interior Glazing and Door Installatior	10 days	Mon 11/24/08	Fri 12/5/08
153	**5th Floor Interior**	**161 days**	**Fri 5/16/08**	**Fri 12/26/08**
154	MEP/Spk. Overhead Rough Ins	25 days	Fri 5/16/08	Thu 6/19/08
155	Wall Framing/Door Frames	10 days	Tue 6/10/08	Mon 6/23/08
156	Bathroom Plumbing Rough In	10 days	Fri 6/20/08	Thu 7/3/08
157	Electrical Rough In/Pull Wire	50 days	Tue 6/24/08	Mon 9/1/08
158	Walls and Insulation	20 days	Tue 8/19/08	Mon 9/15/08
159	Duct and Plumbing Insulation	20 days	Tue 8/19/08	Mon 9/15/08
160	Bathroom Tile/Countertops	7 days	Thu 8/21/08	Fri 8/29/08
161	Bathroom Partitions/Fixtures/Finishe	15 days	Mon 9/1/08	Fri 9/19/08
162	Install ACT Grid/Frame Gyp. Ceiling:	15 days	Tue 9/2/08	Mon 9/22/08



Project: Emory Detailed Schedule.mpp
Date: Wed 10/22/08

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

ID	Task Name	Duration	Start	Finish
163	Hang Drywall/Finish	10 days	Tue 9/9/08	Mon 9/22/08
164	Set Spk. Heads/Light Fixtures/Diffus	30 days	Tue 9/16/08	Mon 10/27/08
165	Prime Paint	10 days	Tue 9/16/08	Mon 9/29/08
166	Drop ACT	5 days	Tue 10/21/08	Mon 10/27/08
167	Finish Paint	15 days	Mon 11/3/08	Fri 11/21/08
168	Millwork	10 days	Mon 11/24/08	Fri 12/5/08
169	Carpet/Linoleum	15 days	Mon 11/24/08	Fri 12/12/08
170	Interior Glazing and Door Installatior	15 days	Mon 12/8/08	Fri 12/26/08
171	**MEP Installation/Start Up**	**60 days**	**Mon 5/26/08**	**Fri 8/15/08**
172	Automatic Transfer Switch	3 days	Mon 5/26/08	Wed 5/28/08
173	Set 25 KV Loop Switch	3 days	Mon 6/16/08	Wed 6/18/08
174	Transformer	3 days	Mon 6/23/08	Wed 6/25/08
175	Generator	3 days	Mon 7/28/08	Wed 7/30/08
176	Energize 25 KV Loop Switch	5 days	Mon 7/28/08	Fri 8/1/08
177	AHU & ERU Start Up	5 days	Mon 8/4/08	Fri 8/8/08
178	Chill Water Start up	5 days	Mon 8/11/08	Fri 8/15/08
179	Permanent Power	0 days	Fri 8/1/08	Fri 8/1/08
180	Conditioned Air	0 days	Fri 8/15/08	Fri 8/15/08
181	**Elevators**	**60 days**	**Wed 6/11/08**	**Tue 9/2/08**
182	4500 lb Elevator	55 days	Wed 6/11/08	Tue 8/26/08
183	3500 lb Elevator	45 days	Wed 7/2/08	Tue 9/2/08
184	Lansdscaping	30 days	Tue 12/30/08	Mon 2/9/09
185	Occupancy	16 days	Tue 2/10/09	Tue 3/3/09
186	Substantial Completion	0 days	Tue 3/3/09	Tue 3/3/09

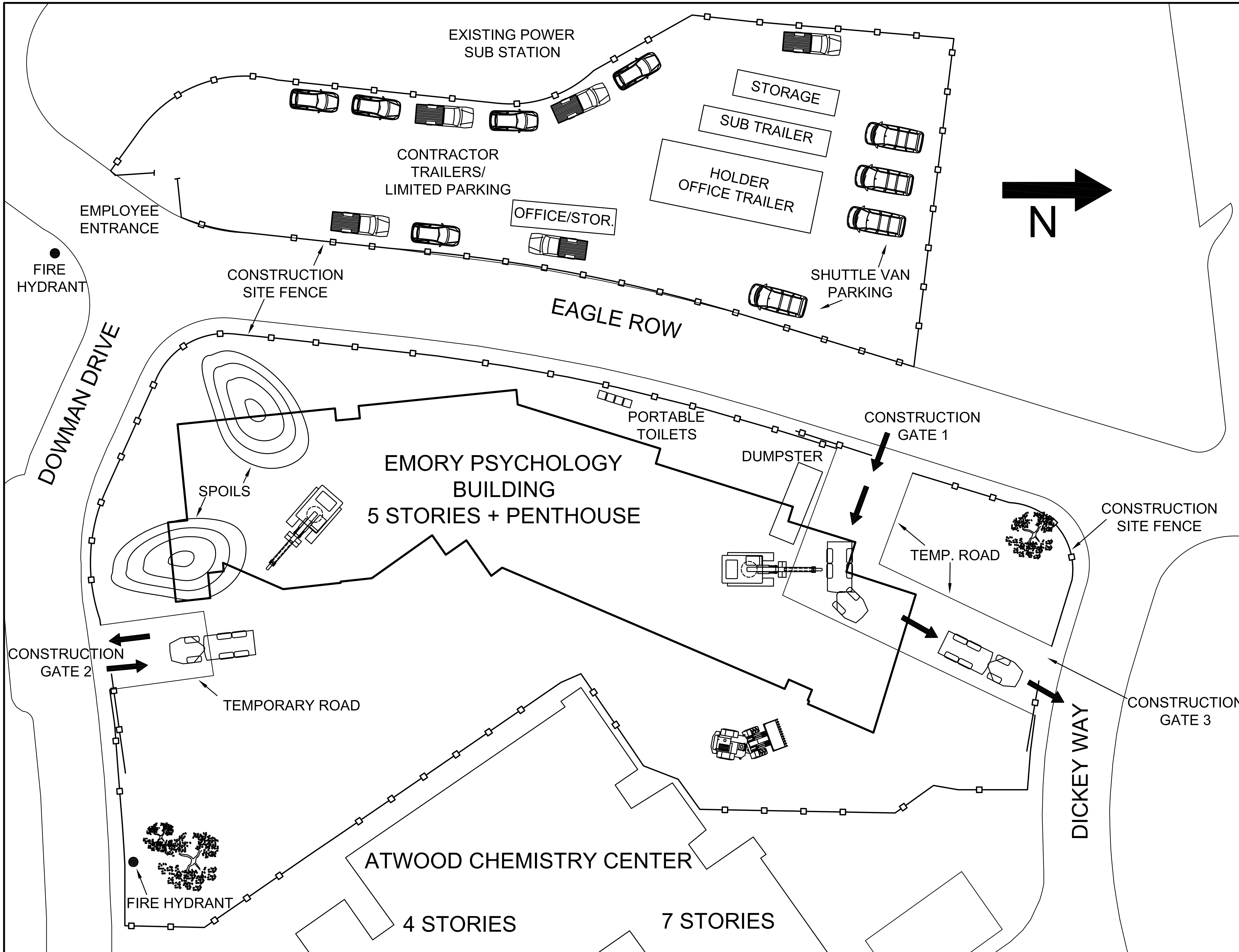


Project: Emory Detailed Schedule.mpp
Date: Wed 10/22/08

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

Appendix B

Site Logistics Plans



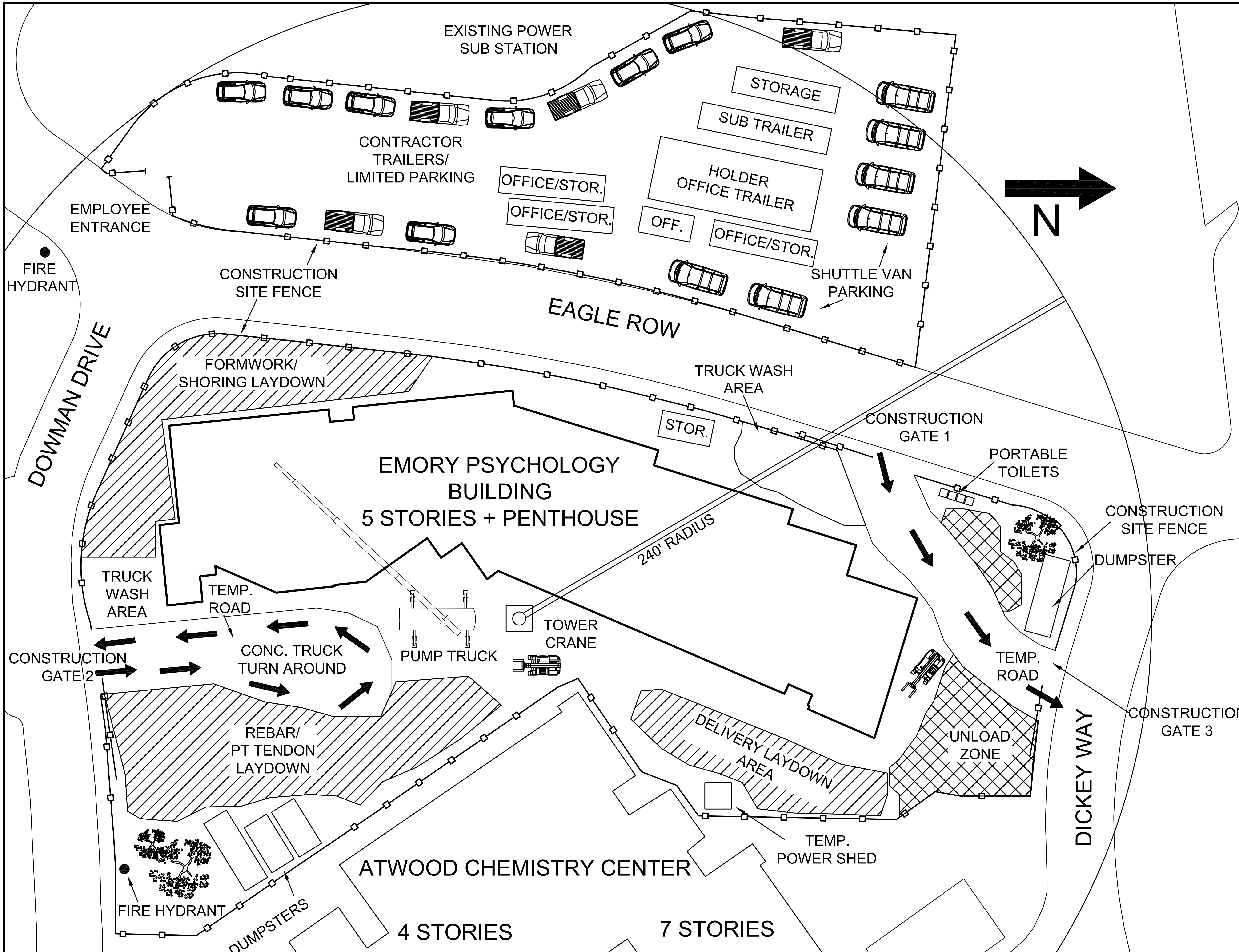
EMORY PSYCHOLOGY BUILDING

ATLANTA, GA

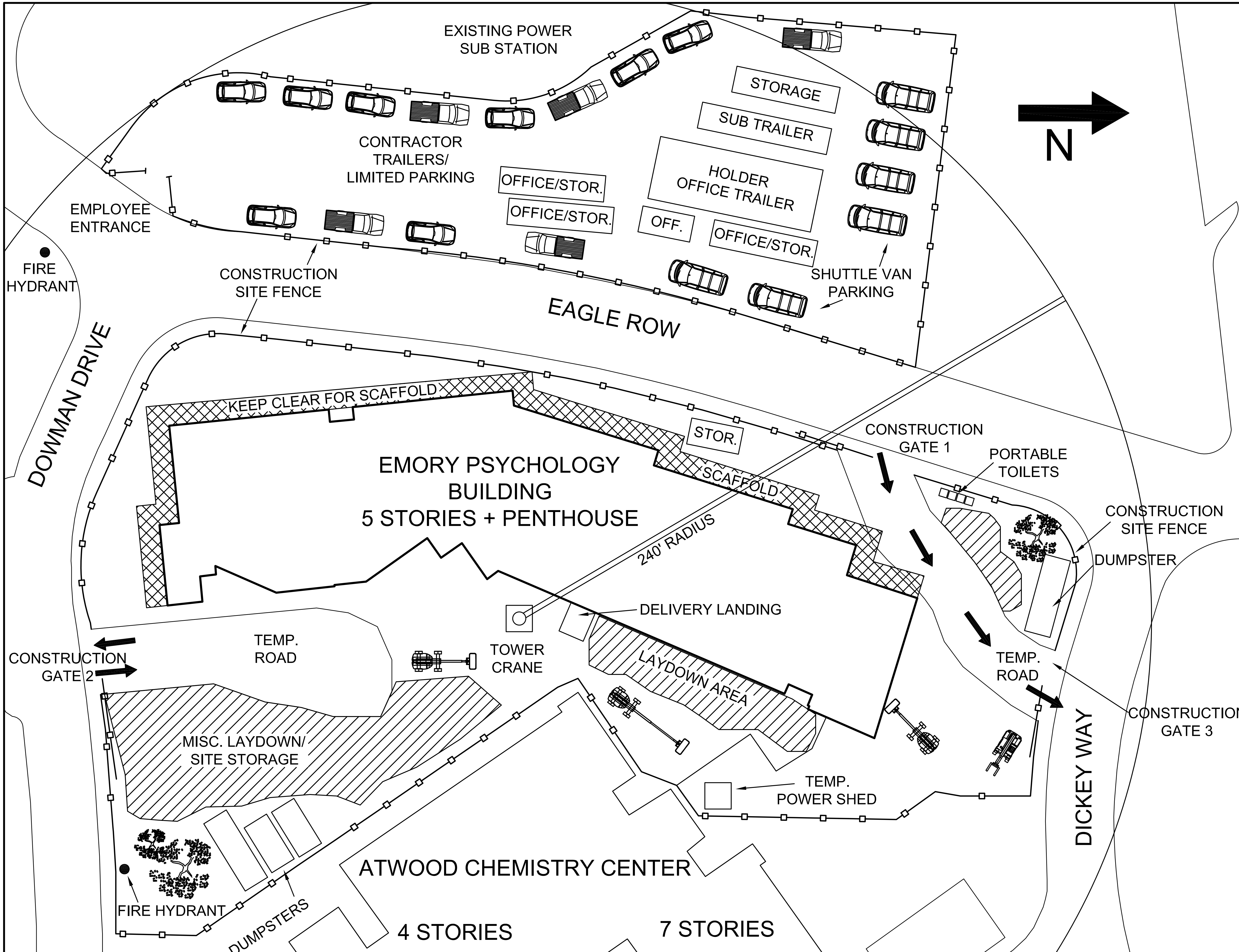
CHRIS RENSHAW

OCTOBER 24, 2008

EXCAVATION SITE PLAN



EMORY PSYCHOLOGY BUILDING
ATLANTA, GA
CHRIS RENSHAW
OCTOBER 24, 2008
STRUCTURE SITE PLAN



EMORY PSYCHOLOGY BUILDING

ATLANTA, GA

CHRIS RENSHAW

OCTOBER 24, 2008

INTERIORS/ FINISHES SITE PLAN

Appendix C:

Detailed Estimate Take-Offs

Drilled Piers						
Name	**Qty.**	**Dia.**	**Area (SF)**	**Depth (total ft.)**	**Volume (CF)**	**CY**
DP 3.0 (8 #8, #3@16")	19	3	28.3	794	22449.8	831.5
DP 3.0A (16 #9, #3@14")	22	3	28.3	794	22449.8	831.5
DP 3.0B (20 #9, #3@10")	5	3	28.3	193	5456.9	202.1
DP 3.5 (12 #8, #3@16")	9	3.5	38.5	455	17510.5	648.5
DP 3.5 A (20#9, #4@16)	3	3.5	38.5	116	4464.2	165.3
DP 4.0 (12#9, #3@18)	6	4	50.3	240	12063.7	446.8
Totals	64			2592	84395.0	3125.7
					WF = 5%	156.3
					Total	**3282.0**

Drilled Pier Rebar									
Name	**Qty.**	**Depth**	**lbs/ft**	**lbs**	**Cages**	**lbs each**	**lbs**	**lbs total**	**tons**
DP 3.0 (8 #8, #3@16")	19	794	21.36	16959.84	653	3.54	2311.6	19271.5	9.64
DP 3.0A (16 #9, #3@14")	22	794	54.4	43193.6	747	3.54	2644.4	45838.0	22.92
DP 3.0B (20 #9, #3@10")	5	193	68	13124	247	3.54	874.4	13998.4	7.00
DP 3.5 (12 #8, #3@16")	9	455	32.04	14578.2	369	4.13	1524.0	16102.2	8.05
DP 3.5 A (20#9, #4@16)	3	116	68	7888	96	4.13	396.5	8284.5	4.14
DP 4.0 (12#9, #3@18)	6	240	40.8	9792	178	4.73	841.9	10633.9	5.32
		2592		105535.64			8592.8	114128.4	57.06
								WF = 5%	2.85
								Total	**59.92**

Grade Beams				
Name	**Area (SF)**	**Total Length (ft)**	**Volume (CF)**	**CY**
GB-1	6	464	2784	103.1
			WF = 5%	5.2
			Total	**108.3**

Grade Beam Rebar								
Name	**Length**	**(13) #6 lbs/ft**	**lbs**	**#3@12"**	**lbs each**	**lbs**	**total lbs**	**tons**
GB-1	464	19.526	9060.06	464	5.264	2442.50	11502.56	5.75
							WF = 5%	0.29
							Total	**6.04**

SOG Forms		
Perimeter	**Height**	**SF**
800	1.5	1200
	WF = 10%	120
		1320

SOG			
Area (SF)	**Depth (ft)**	**Volume (CF)**	**CY**
26700	0.4166	11123	412
Turn Down			
Length			
446	1.02	455	17
464	0.851	395	15
Pits			
Elevator	Volume	total	
2	203	406	15
Utility			
2	108	216	8
Equip. Pad			
540	0.25	135	5
			471
		WF = 5%	24
		Total	**495**

Formwork									
Needed	**Height**	**Qty.**	**SFCA (each)**	**SFCA Total**	**Mat. Rate**	**Mat. Cost**	**Labor Rate**	**Labor Cost**	**Total**
24" DIA	13	3	N/A	N/A	11.75	$ 504.08	8.95	$ 383.96	$ 888.03
24" DIA	16	11	N/A	N/A	11.75	$ 2,274.80	8.95	$ 1,732.72	$ 4,007.52
16"x16"	13	1	69.33	69.33	0.73	$ 55.67	5.15	$ 392.75	$ 448.43
16"x16"	16	1	85.33	85.33	2.24	$ 210.25	6.55	$ 614.80	$ 825.06
30"x30"	13	2	130	260	0.59	$ 168.74	4.85	$ 1,387.10	$ 1,555.84
30"x30"	16	2	160	320	1.81	$ 637.12	6.05	$ 2,129.60	$ 2,766.72
24"x24"	13	39	104	4056	0.81	$ 3,613.90	5.1	$ 22,754.16	$ 26,368.06
24"x24"	16	29	128	3712	2.49	$ 10,167.17	6.4	$ 26,132.48	$ 36,299.65
						$ 17,631.72		**$ 55,527.57**	**$ 73,159.30**

Elevated Slabs				
Slab	**Area**	**Depth**	**Volume**	**CY**
2	21900	0.41666667	9125	337.963
3	21900	0.41666667	9125	337.963
4	21900	0.41666667	9125	337.963
5	21900	0.41666667	9125	337.963
Roof	21900	0.5	10950	405.5556
	109500			1757
			WF 5%	87.87037
			Total	**1845**

Elevated Slab Rebar					
Rebar	Bottom				
Avg. Bays	#4 @18	Bars	Length	Lb/Ft	Tons
75	18	1350	12	0.668	5.4108
	Top				
Locations	#4 @12	Bars	Length	Lb/Ft	Tons
70	8	560	18	0.668	3.36672
				Avg Slab	8.77752
				Slabs	5
				Total	43.8876
				WF = 5%	2.19438
				Total	**46.08**

Elevated Beam Rebar						
Name	**#8 Bars**	**Length**	**lb/ft**	**lbs/beam**	**Beams**	**tons/floor**
Avg. Beam	4	15	2.67	160.2	89	7.13
					Floors	4.00
					Tons	28.52
					WF = 5%	1.43
					Total	**29.94**

Elevated Beams						
Beam	**Area**	**Total Length**	**Volume**	**CY**	**LF Contact**	**SFCA**
CB-1	1.583	170	269.11	9.97	4.167	708.39
CB-2	1.347	60	80.82	2.99	3.67	220.2
CB-3	1.347	100	134.70	4.99	3.67	367
CB-4	1.347	41	55.23	2.05	3.67	150.47
CB-5	1.347	416	560.35	20.75	3.67	1526.72
CB-6	1.347	104	140.09	5.19	3.67	381.68
CB-7	1.347	52	70.04	2.59	3.67	190.84
CB-8	1.347	89	119.88	4.44	3.67	326.63
CB-9	1.347	14	18.86	0.70	3.67	51.38
CB-10	1.347	8	10.78	0.40	3.67	29.36
CB-11	1.347	10	13.47	0.50	3.67	36.7
CB-12	1.347	26	35.02	1.30	3.67	95.42
CB-13	1.347	15	20.21	0.75	3.67	55.05
CB-14	1.347	96	129.31	4.79	3.67	352.32
CB-15	1.347	72	96.98	3.59	3.67	264.24
CB-16	1.347	24	32.33	1.20	3.67	88.08
CB-17	1.347	24	32.33	1.20	3.67	88.08
CB-18	1.347	26	35.02	1.30	3.67	95.42
CB-19	1.347	24	32.33	1.20	3.67	88.08
CB-20	1.347	24	32.33	1.20	3.67	88.08
CB-21	1.347	20	26.94	1.00	3.67	73.4
CB-22	2.64	26	68.64	2.54	5	130
CB-24	3.167	4	12.67	0.47	5	20
CB-25	3.958	26	102.91	3.81	5.67	147.42
CB-26	1.333	9	12.00	0.44	3.67	33.03
CB-27	3.354	29	97.27	3.60	4.83	140.07
CB-28	1.333	18	23.99	0.89	3.67	66.06
CB-29	1.333	14	18.66	0.69	3.67	51.38
CB-30	1.333	9	12.00	0.44	3.67	33.03
CB-31	2.556	22	56.23	2.08	5	110
CB-32	2.556	18	46.01	1.70	5	90
CB-33	2.667	15	40.01	1.48	4.167	62.505
CB-34	3.556	10	35.56	1.32	5.33	53.3
CB-35	2.667	14	37.34	1.38	4.167	58.338
CB-36	3.778	29	109.56	4.06	5.5	159.5
CB-37	2.667	26	69.34	2.57	4.167	108.342
CB-117	2.667	20	53.34	1.98	4.167	83.34
CB-118	2.667	11	29.34	1.09	4.167	45.837
CB-119	2.667	52	138.68	5.14	4.167	216.684
CB-120	2.667	26	69.34	2.57	4.167	108.342
CB-121	2.667	26	69.34	2.57	4.167	108.342
CB-122	2.667	26	69.34	2.57	4.167	108.342
CB-127	3.556	12	42.67	1.58	5.33	63.96
CB-128	3.556	20	71.12	2.63	5.33	106.6
CB-129	3.556	24	85.34	3.16	5.33	127.92
CB-130	3.556	50	177.80	6.59	5.33	266.5

CB-131	3.556	24	85.34	3.16	5.33	127.92
CB-132	3.556	24	85.34	3.16	5.33	127.92
CB-133	2.667	24	64.01	2.37	4.167	100.008
CB-134	2.667	24	64.01	2.37	4.167	100.008
CB-135	2.667	24	64.01	2.37	4.167	100.008
CB-136	2.667	24	64.01	2.37	4.167	100.008
CB-138	3.556	53	188.47	6.98	5.33	282.49
CB-139	3.556	78	277.37	10.27	5.33	415.74
CB-140	3.556	26	92.46	3.42	5.33	138.58
CB-141	2.667	5	13.34	0.49	4.167	20.835
CB-142	2.667	26	69.34	2.57	4.167	108.342
CB-143	2.667	78	208.03	7.70	4.167	325.026
PTB-39	4.75	50	237.50	8.80	6.167	308.35
PTB-40	4	24	96.00	3.56	5.66	135.84
PTB-41	2	24	48.00	1.78	4.167	100.008
PTB-42	2	24	48.00	1.78	4.167	100.008
PTB-43	3.167	7	22.17	0.82	5.167	36.169
PTB-44	5.934	50	296.70	10.99	6.5	325
PTB-45	4	24	96.00	3.56	5.66	135.84
PTB-46	2	24	48.00	1.78	4.167	100.008
PTB-47	2	24	48.00	1.78	4.167	100.008
PTB-48	2.667	34	90.68	3.36	4.167	141.678
PTB-49	2.667	12	32.00	1.19	4.167	50.004
PTB-50	2.667	20	53.34	1.98	4.167	83.34
PTB-51	3.333	34	113.32	4.20	5.167	175.678
PTB-52	3.333	37	123.32	4.57	5.167	191.179
PTB-53	2.667	34	90.68	3.36	4.167	141.678
PTB-54	2.667	37	98.68	3.65	4.167	154.179
PTB-55	2.667	22	58.67	2.17	4.167	91.674
PTB-56	2.667	22	58.67	2.17	4.167	91.674
PTB-57	2.667	37	98.68	3.65	4.167	154.179
PTB-59	2.667	29	77.34	2.86	4.167	120.843
PTB-60	2.667	53	141.35	5.24	4.167	220.851
PTB-61	2.667	58	154.69	5.73	4.167	241.686
PTB-62	2.667	88	234.70	8.69	4.167	366.696
PTB-63	3.556	12	42.67	1.58	5.33	63.96
PTB-64	2.667	29	77.34	2.86	4.167	120.843
PTB-65	2.667	47	125.35	4.64	4.167	195.849
PTB-66	2.667	29	77.34	2.86	4.167	120.843
PTB-67	2.667	41	109.35	4.05	4.167	170.847
PTB-68	3.111	22	68.44	2.53	5	110
PTB-69	3.55	16	56.80	2.10	5.33	85.28
PTB-70	3.556	25	88.90	3.29	5.33	133.25
	227.06	3350.00	7783.03	288.26		14291
			Total*4	1153.04		57163
			WF 5%	57.65	WF 10%	5716
			Total	**1211**		**62879**

Columns													
Floors 1,3-5	**Qty.**	**Height**	**Area**	**CF**	**CY**	**Tot. CY**	**Avg lbs/ft**	**lbs rebar**	**#3 Band**	**lbs each**	**lbs Band**	**total lbs**	**tons**
24" DIA (8 #7, #3@12")	11	13	3.1	40.8	1.5	16.6	14.308	494.20	14	2.953	454.8	949.0	0.47
16"x16" (8 #7, #3@12")	4	13	1.8	23.1	0.9	3.4	14.308	101.70	14	3	168.0	269.7	0.13
30"x30" (12 #8, #3@12")	8	13	6.3	81.3	3.0	24.1	32.04	1602.00	14	6.267	701.9	2303.9	1.15
24"x24" (8 #8, #3@10")	150	13	4	52.0	1.9	288.9	21.36	12816.00	18	4.512	12182.4	24998.4	12.50
						333.0							14.26
2nd Floor	**Qty.**	**Height**	**Area**	**CF**	**CY**	**Total CY**	**Avg lbs/ft**	**lbs rebar**	**#3 cage**	**lbs each**	**lbs cage**	**total lbs**	**tons**
24" DIA (8 #7, #3@12")	11	16	3.1	50.2	1.9	20.5	14.308	2518.21	19	2.95	617.18	3135.39	1.57
16"x16" (8 #7, #3@12")	1	16	1.8	28.4	1.1	1.1	14.308	228.93	19	3.00	57.00	285.93	0.14
30"x30" (12 #8, #3@12")	2	16	6.3	100.0	3.7	7.4	32.04	1025.28	19	6.27	238.15	1263.43	0.63
24"x24" (8 #8, #3@10")	29	16	4	64.0	2.4	68.7	21.36	9911.04	22	4.51	2878.66	12789.70	6.39
						97.7							8.737
						430.7							23
					WF	21.5						WF 5%	1.15
					Tot.	**452.2**						Total	**24.15**

Full Structural Estimate

			Labor		Material		Equipment		Total	
Item	**Qty.**	**Unit**	**Cost/Unit**	**Cost**	**Cost/Unit**	**Cost**	**Cost/Unit**	**Cost**	**Cost/Unit**	**Cost**
Drilled Pier Excavation	2592	VLF	$ 10.35	$ 26,827.20	$ -	$ -	14.72	$ 38,154.24	$ 25.07	$ 64,981.44
Drilled Pier Concrete	3282	CY	$ 11.35	$ 37,250.70	$ 109.00	$ 357,738.00	$ 0.37	$ 1,214.34	$ 120.72	$ 396,203.04
Drilled Pier Rebar	59.92	Ton	$ 530.00	$ 31,757.60	$ 1,550.00	$ 92,876.00	$ 22.50	$ 1,348.20	$ 2,102.50	$ 125,981.80
Grade Beams Concrete	108.3	CY	$ 10.60	$ 1,147.98	$ 109.00	$ 11,804.70	$ 8.95	$ 969.29	$ 128.55	$ 13,921.97
Grade Beams Rebar	6.04	Ton	$ 680.00	$ 4,107.20	$ 1,475.00	$ 8,909.00	$ 22.50	$ 135.90	$ 2,177.50	$ 13,152.10
Retaining wall Concrete	7960	CY	$ 18.10	$ 144,076.00	$ 109.00	$ 867,640.00	$ 6.60	$ 52,536.00	$ 133.70	$ 1,064,252.00
Retaining wall Rebar	20.7	Ton	$ 544.50	$ 11,271.15	$ 1,550.00	$ 32,085.00	$ 22.50	$ 465.75	$ 2,117.00	$ 43,821.90
Retaining wall Forms	14291	SFCA	$ 6.65	$ 95,035.15	$ 9.40	$ 134,335.40	$ -	$ -	$ 16.05	$ 229,370.55
SOG Concrete	495	CY	$ 16.70	$ 8,266.50	$ 109.00	$ 53,955.00	$ 6.10	$ 3,019.50	$ 131.80	$ 65,241.00
SOG Forms	1320	SFCA	$ 1.44	$ 1,900.80	$ 4.84	$ 6,388.80	$ -	$ -	$ 6.28	$ 8,289.60
SOG Rebar	30705	SF	$ 0.25	$ 7,676.25	$ 0.33	$ 10,132.65	$ -	$ -	$ 0.58	$ 17,808.90
SOG Finish	26700	SF	$ 0.43	$ 11,481.00	$ -	$ -	$ -	$ -	$ 0.43	$ 11,481.00
Column Forms		SFCA	$ -	$ 55,527.57	$ -	$ 17,631.72	$ -	$ -	$ -	$ 73,159.29
Column Concrete	452.2	CY	$ 23.50	$ 10,626.70	$ 127.00	$ 57,429.40	$ 8.60	$ 3,888.92	$ 159.10	$ 71,945.02
Column Rebar	24.15	Ton	$ 620.00	$ 14,973.00	$ 1,550.00	$ 37,432.50		$ -	$ 2,170.00	$ 52,405.50
Elev. Slab Forms	73736	SFCA	$ 3.33	$ 245,540.88	$ 1.47	$ 108,391.92	$ -	$ -	$ 4.80	$ 353,932.80
Elev. Beam Forms	62879	SFCA	$ 4.85	$ 304,963.15	$ 1.11	$ 69,795.69	$ -	$ -	$ 5.96	$ 374,758.84
Elev. Slab Concrete	3056	CY	$ 15.50	$ 47,368.00	$ 111.00	$ 339,216.00	$ 5.65	$ 17,266.40	$ 132.15	$ 403,850.40
Elev. Slab Rebar	46.08	Ton	$ 490.00	$ 22,579.20	$ 1,550.00	$ 71,424.00	$ -	$ -	$ 2,040.00	$ 94,003.20
Elev. Beam Rebar	29.94	Ton	$ 620.00	$ 18,562.80	$ 1,550.00	$ 46,407.00	$ -	$ -	$ 2,170.00	$ 64,969.80
Elev. Slab Finish	119300	SFCA	$ 0.43	$ 51,299.00	$ -	$ -	$ -	$ -	$ 0.43	$ 51,299.00
Structural Steel W	5843	LF	$ 2.95	$ 17,236.85	$ 51.60	$ 301,498.80	$ 2.11	$ 12,328.73	$ 56.66	$ 331,064.38
Structural Steel C	432	LF	$ 32.40	$ 13,996.80	$ 10.56	$ 4,561.92	$ 4.02	$ 1,736.64	$ 46.98	$ 20,295.36
Decking	5288	SF	$ 0.47	$ 2,485.36	$ 3.06	$ 16,181.28	$ 0.05	$ 264.40	$ 3.58	$ 18,931.04
Post Tensioning Allowanc	1	LS		$ 20,000.00		$ 50,000.00		$ 10,000.00		$ 80,000.00
				$ 1,205,956.84		**$ 2,695,834.78**		**$ 143,328.31**		**$ 4,045,119.93**