



Office Building

Washington, D.C

Katey Andaloro
Construction Management

Final Report

Dr. John Messner

April 7, 2009

Detailed Project Schedule

General Schedule Summary

Notice to proceed for the project was given by the owner to the general contractor on August 14, 2006. After receipt of the notice to proceed, the general contractor began its mobilization of the site, and excavation and dewatering activities began in early September of 2006. The project required the excavating crew to remove soil at an approximate depth of forty-five feet below existing grade to reach the bottom of the project's foundation. Given limited site space and depth of the excavation to the mat foundation, a sheeting and shoring system with tie backs was used. As a result of the water table being approximately 25 feet above the bottom of the scheduled excavation and the soil content of the site having heavy clay content, installing the dewatering system prior to the beginning of excavation was critical to maintain the project's schedule. In August, 2008, work on the cast in place mat foundation system began. The forming and pour sequence for the mat foundation was broken into ten pours, proceeding from the south end of the site to north end of the site.

Once the foundation was complete, the concrete crews worked their way vertically towards the top of the building. The concrete operation reached original Ground Floor in January of 2008. Once above the Ground Floor, the concrete's reinforcement switched from mild steel reinforcement (rebar) to post tension cables. One of the most important factors in completing the post tension concrete floors was the time needed to cure the concrete to a proper strength, so that the cables could be stressed.

Because of this factor, concrete pours were often scheduled around when its adjacent pour could be stressed. The structural engineer's project specifications required that shoring occupying four levels below to the floor being poured to ensure that the weight of the freshly poured concrete floors could be supported until the concrete of the floor obtained the specified strength. The completion of the above grade structured occurred in June of 2008.

Interior finishes in the bathrooms, main lobby, lower level lobby, and M Street lobby are to begin in March of 2008. The remaining tenant build out of the project will commence outside of BBC's contact with the owner.



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Activity ID	Activity Name	Original Duration	Start	Finish
OFFICE BUILDING				
		819	21-Feb-06	21-Apr-09
Preconstruction				
		132	21-Feb-06	25-Aug-06
Construction				
		681	05-Sep-06	21-Apr-09
Excavation				
		252	05-Sep-06	29-Aug-07
Substructure				
		141	02-Jul-07	14-Jan-08
Concrete				
		141	02-Jul-07	14-Jan-08
	P3 Level - Garage	90	02-Jul-07	02-Nov-07
	P2 Level - Garage	54	27-Aug-07	08-Nov-07
	P1 Level - Garage	30	23-Oct-07	03-Dec-07
	Lower Level - Garage	46	12-Nov-07	14-Jan-08
Superstructure				
		195	12-Dec-07	09-Sep-08
Concrete				
		186	12-Dec-07	27-Aug-08
Structural Steel				
		132	10-Mar-08	09-Sep-08
Exterior Façade & Roof				
		554	08-Mar-07	21-Apr-09
Core				
		335	07-Jan-08	17-Apr-09
A1780	Core Work & Finishes	264	20-Mar-08*	24-Mar-09
Mechanical & Plumbing Rough In				
		277	07-Jan-08	27-Jan-09
Electrical Rough In				
		308	13-Feb-08	17-Apr-09
Sprinkler Rough In				
		161	14-Jan-08	25-Aug-08
Elevators				
		184	07-Jul-08	19-Mar-09
Finishes				
		98	12-Nov-08	27-Mar-09
Fit Out Lobbies				
		218	22-May-08	23-Mar-09
Sitework				
		136	10-Oct-08	17-Apr-09
Close Out				
		14	13-Mar-09	02-Apr-09

Figure 3: Schedule Summary

Schedule Overview

Provided on the next few pages are a more comprehensive project schedule than the previously submitted summary schedule. This construction schedule is mainly organized by trade and how the trades progress from one level in the office building to the next level. Formatting the activities in this manner clearly demonstrates the principles of the phrase, "parade of trades," thus allowing trade movements throughout the project to be legible. As shown in the schedule, structural trades work throughout the building in a relatively straight linear fashion, as the MEP trades overlap level construction while still proceeding upward through the building. This sequencing method allows for the substantial completion of the building, the project to be fast-tracked, and to have separate core-shell and fit-out packages with more than 10 contracts. A caution in using this technique is the possibility of trade congestion in a given work area or level of the project. Thus continuous trade coordination between the mechanical, electrical, plumbing, and finishing trades is key in completing the project on time.

The schedule of the project also utilizes a schedule with accelerated activities. This helped to create a more efficient project, and to create a buffer zone for any site issues such as weather conditions, unforeseen site conditions, and issues with material delivery.

Due to the events of construction and the complexity of the project, many items were left out but the milestone dates and general durations are noted.



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Excavation

Notice to proceed for the project was given by the owner to the general contractor on August 14, 2006. After receipt of the notice to proceed, the general contractor began its mobilization of the site, and excavation and dewatering activities began in early September of 2006. Given limited site space and depth of the excavation to the mat foundation, a sheeting and shoring system with tie backs was used. As a result of the water table being approximately 25 feet above the bottom of the scheduled excavation and the soil content of the site having heavy clay content, installing the dewatering system prior to the beginning of excavation was critical to maintain the project's schedule.

Structural Concrete

One key phase to highlight is the concrete pour schedule for both the substructure, concrete with mild steel reinforcement (rebar), and the superstructure, post tension slabs. The 200 item constraint did not allow for highly detailed phasing, but a more detailed schedule of concrete production would look something like this:

STRUCTURE								
P3 LEVEL GARAGE								
F02490	W/P Foundation Walls P3 to P2 - Pour #8	2	2	26SEP07	27SEP07	-44	W/P Foundation Walls P3 to P2 - Pour #8	
S01690	F/R/P Foundation Walls P3 to P2 - Pour #8	3	3	28SEP07	02OCT07	-44	F/R/P Foundation Walls P3 to P2 - Pour #8	
P2 LEVEL GARAGE								
S01081	F/R/P Elevated Deck Level P2 - Pour #5	2	2	10OCT07	11OCT07	44	F/R/P Elevated Deck Level P2 - Pour #5	
P1 LEVEL GARAGE								
S00250	F/R/P Elevated Deck Level P1 - Pour #1	2	2	12OCT07	15OCT07	44	F/R/P Elevated Deck Level P1 - Pour #1	
S00340	F/R/P Elevated Deck Level P1 - Pour #2	2	2	16OCT07	17OCT07	-44	F/R/P Elevated Deck Level P1 - Pour #2	
S00550	F/R/P Elevated Deck Level P1 - Pour #3	2	2	18OCT07	19OCT07	-44	F/R/P Elevated Deck Level P1 - Pour #3	
S00560	F/R/P Elevated Deck Level P1 - Pour #4	2	2	22OCT07	23OCT07	-44	F/R/P Elevated Deck Level P1 - Pour #4	
S01781	F/R/P Elevated Deck Level P1 - Pour #5	2	2	24OCT07	25OCT07	-44	F/R/P Elevated Deck Level P1 - Pour #5	
S01791	F/R/P Elevated Deck Level P1 - Pour #6	2	2	26OCT07	29OCT07	-44	F/R/P Elevated Deck Level P1 - Pour #6	
LOWER LEVEL								
S00400	F/R/P Elevated Deck Lower Lvl - Pour #1	2	2	30OCT07	31OCT07	-44	F/R/P Elevated Deck Lower Lvl - Pour #1	
S00430	F/R/P Elevated Deck Lower Lvl - Pour #2	2	2	01NOV07	02NOV07	-44	F/R/P Elevated Deck Lower Lvl - Pour #2	
S00580	F/R/P Elevated Deck Lower Lvl - Pour #3	2	2	05NOV07	06NOV07	-44	F/R/P Elevated Deck Lower Lvl - Pour #3	
S00610	F/R/P Elevated Deck Lower Lvl - Pour #4	2	2	07NOV07	08NOV07	-44	F/R/P Elevated Deck Lower Lvl - Pour #4	
S01981	F/R/P Elevated Deck Lower Lvl - Pour #5	2	2	09NOV07	12NOV07	44	F/R/P Elevated Deck Lower Lvl - Pour #5	
S01991	F/R/P Elevated Deck Lower Lvl - Pour #6	2	2	13NOV07	14NOV07	-44	F/R/P Elevated Deck Lower Lvl - Pour #6	
LEVEL 01								
S00470	F/R/P Elevated Deck Ground Floor - Pour #1	3	3	15NOV07	19NOV07	-44	F/R/P Elevated Deck Ground Floor - Pour #1	
S00510	F/R/P Elevated Deck Ground Floor - Pour #2	3	3	20NOV07	26NOV07	-44	F/R/P Elevated Deck Ground Floor - Pour #2	
S00640	Columns Ground to 02	8	8	11DEC07	20DEC07	-44	Columns Ground to 02	
S00660	F/R/P Elevated Deck Ground Floor - Pour #3	3	3	27NOV07	29NOV07	-44	F/R/P Elevated Deck Ground Floor - Pour #3	
S00700	F/R/P Elevated Deck Ground Floor - Pour #4	3	3	30NOV07	04DEC07	44	F/R/P Elevated Deck Ground Floor - Pour #4	
S00701	F/R/P Elevated Deck Ground Floor - Pour #5	3	3	05DEC07	07DEC07	-44	F/R/P Elevated Deck Ground Floor - Pour #5	

Figure 4: Example of Pour Sections

Each floor is broken into four (4) or seven (7) sections to keep the pours manageable, proceeding from the south end of the site to north end of the site. The project specifications require that at least one floor be fully formed or shored with a minimum of four (4) floors reshored at any time. Some of these activities occur simultaneously, which keeps the job moving along.



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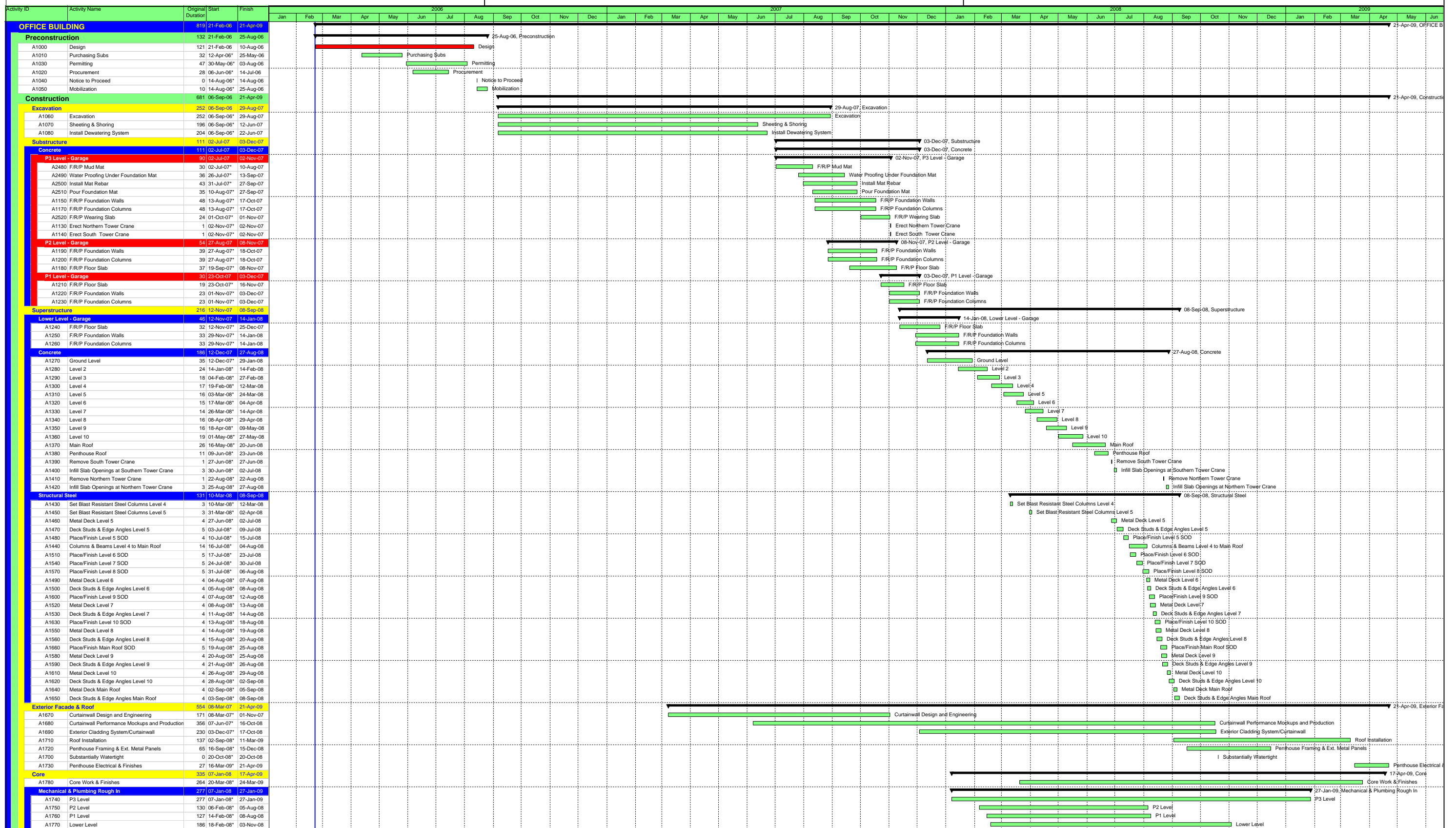
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Core MEP & Interior Finishes

The main element in the finishing work on this project is the MEP work. The building is seeking LEED Silver certification, thus the mechanical and electrical equipment are very large and highly efficient. Procurement for these items took place as soon as the notice to proceed was given. Coordinating this work is one of the most important challenges in completing the building core.

Interior finishes in the bathrooms, main lobby, lower level lobby, and M Street lobby are to begin in March of 2008. The remaining tenant build out of the project will commence outside of BBC's contract with the owner.

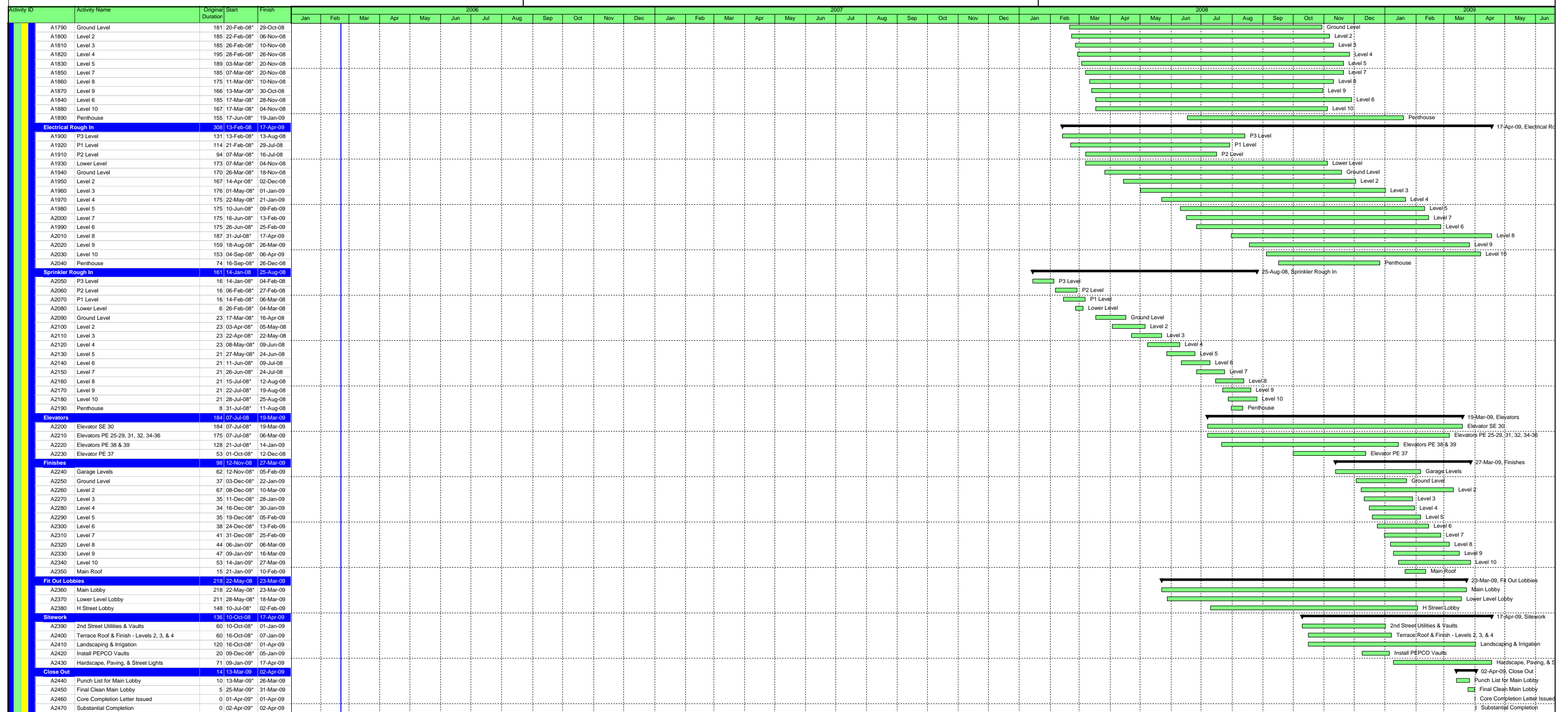


█ Actual Work
 █ Critical Remaining Work
 ▶ Summary
 █ Remaining Work
 ◆ Milestone

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█ Actual Work
 █ Critical Remaining Work
 ▶ Summary
█ Remaining Work
 ◆ Milestone

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Project Estimate Summary

Table 3: D4Cost 2002 Estimate

Please reference Appendix A for original D4Cost Data.

D4Cost 2002 Estimate				
Code	Division Name	%	Sq. Cost	Projected
00	Bidding Requirements	4.67	\$6.18	\$4,581,205.00
01	General Requirements	4.47	\$5.91	\$4,379,911.00
02	Site Work	4.73	\$6.26	\$4,637,096.00
03	Concrete	13.04	\$17.25	\$12,782,384.00
04	Masonry	2.56	\$3.38	\$2,506,310.00
05	Metals	6.68	\$8.83	\$6,544,552.00
06	Wood, Plastics, and Composites	0.49	\$0.65	\$481,758.00
07	Thermal and Moisture Protection	2.48	\$3.28	\$2,430,767.00
08	Openings	4.69	\$6.20	\$4,596,309.00
09	Finishes	5.92	\$7.82	\$5,799,472.00
10	Specialties	1.05	\$1.39	\$1,028,425.00
11	Equipment	0.21	\$0.28	\$210,652.00
12	Furnishings	1.06	\$1.40	\$1,036,175.00
13	Special Construction	0.19	\$0.25	\$182,922.00
14	Conveying Systems	1.66	\$2.19	\$1,626,478.00
15	Mechanical	10.83	\$14.33	\$10,617,964.00
16	Electrical	11.61	\$15.35	\$11,374,770.00
21	Fire Suppression	1.82	\$2.41	\$1,783,436.00
22	Plumbing	1.6	\$2.12	\$1,570,989.00
23	HVAC	5.99	\$7.92	\$5,872,991.00
26	Electrical	5.71	\$7.55	\$5,598,030.00
27	Communications	2.62	\$3.47	\$2,568,774.00
31	Earthwork	2.47	\$3.27	\$2,423,567.00
32	Exterior Improvements	2.43	\$3.21	\$2,378,540.00
33	Utilities	1.01	\$1.34	\$989,899.00
Total Building Costs		100	\$132.22	\$98,003,372



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Final Report

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R.S. Means 2008 Estimate

Please reference Appendix B for R.S. Means sources for square foot costs.

Tables 4 & 5: Office Building Space - R.S. Means 2008 Estimate
10 Floors, 554,812 SF, 1,172 LF Perimeter, 12'-0" Floor Height Avg.

Exterior Wall	S.F. Area	250,000	554,812	300,000
	L.F. Perimeter	640	1,006	700
Precast Concrete Panel	R/Conc. Frame	\$125.60	\$117.07	\$124.20
	Perimeter Adjustment	\$2.15	-\$0.29	\$1.75
	Story Height Adjustment	\$1.10	\$0.49	\$1.00

Square Footage Estimate	\$117.07
Perimeter Adjustment	-\$0.48
Story Height Adjustment	\$0.49
Adjusted Square Foot Cost	\$117.08

Table 6 & 7: Underground Parking Garage Space - R.S. Means 2008 Estimate
4 Floors, 186,388 SF, 1,172 LF Perimeter, 12'-0" Floor Height Avg.

Exterior Wall	S.F. Area	150,000	186,388	175,000
	L.F. Perimeter	1,100	1,224	1,185
Precast Concrete Panel	R/Conc. Frame	\$62.35	\$61.40	\$61.70
	Perimeter Adjustment	\$0.75	\$0.46	\$0.55
	Story Height Adjustment	\$0.70	\$0.63	\$0.65

Square Footage Estimate	\$61.40
Perimeter Adjustment	-\$0.24
Story Height Adjustment	\$0.63
Adjusted Square Foot Cost	\$61.79



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Final Report

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Table 8: Total Cost - R.S. Means 2008 Estimate

	SQUARE FOOTAGE	COST/SF	TOTAL COST
Office Building Space	554,812	\$117.08	\$64,957,400
Underground Parking Garage Space	186,388	\$61.79	\$11,517,000
		Elevators	\$2,854,300
			\$79,328,700
	R.S. Means Location Factor (Washington, DC)		0.98
	Total Estimate		\$77,742,126

The D4Cost estimate and R.S. Means estimate proved to be roughly accurate. The D4Cost estimate wavered from the actual project cost by only -\$1,000,000 and the R.S. Means wavered from the actual building cost by +\$740,000..

However, comparing D4's individual system costs with project's actual individual systems cost shows that, though D4 can be use to estimate the total cost, it is not accurate in estimating the individual system costs. Therefore, D4 should only be used to get approximate estimate of the overall building cost and not for the individual systems cost. Overall the D4Cost estimate was still pretty accurate and shows how potentially useful the software package can be.

R.S. Means on the other hand should only be used to estimate the building cost. This method does not account for greater building areas then listed, LEED designs, or various other features of the building. R.S. Means also does not account for post tensioned concrete, which can increase the cost, as well as a very expensive curtain wall system.



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Detailed Structural Systems Estimate

The Office Building utilizes a cast in place concrete structural system. The foundation is a 4'-6" thick, 5,000 psi normal weight concrete mat foundation that rests on a 4" mud mat. Below grade parking levels are 9" reinforced concrete flat slabs with 5-1/2" drop panels at select column locations. Floors above grade are 12" post-tensioned two-way slabs with 4-1/4" drop panels at all columns and around the slab perimeter. The top 9 floors including the roof slab are post tensioned concrete while the bottom 5 floors are cast in place reinforced concrete and the mat foundation.

Data was taken from the 2008 R.S. Means Construction Data manual which contains costs based on projects from 2007 and the latter part of 2006. Assumptions were made in order to simplify the detailed estimate. Slab thicknesses were considered uniform throughout each floor though there were areas with thicker or thinner slab depths. An overall average was utilized and considered uniform throughout. Waste factors were considered and are included in the take-offs. Crane usage was included in the equipment subcategory of the concrete placement estimates.

The structural systems summary sheet can be found on the following page. The estimated total after being adjusted for the location is **\$28,540,038**. The calculated value is slightly greater than the structural total detailed in Technical Assignment 1. This is due to the fact that the total in Technical Assignment 1 includes the pre-cast concrete while this estimate is only the pumped structural concrete. Overall this estimate is accurate based on the previous cost analysis and this detailed estimate.

Please reference Appendix C for the Detailed Structural System Estimate Take-Offs

Detailed Cost Analysis of the Structure									
Level	Description	Amount	Material Price	Material Cost	Labor Price	Labor Cost	Equipment Price	Equipment Cost	Total Cost
Reinforcement	Mat Foundation	550 Ton	\$935.00	\$514,250	\$430.00	\$236,500	\$30.35	\$16,693	\$767,443
	Composite Decking	21 Ton	\$935.00	\$19,635	\$430.00	\$9,030	\$30.35	\$637	\$29,302
	P2 Level	402 Ton	\$935.00	\$375,870	\$430.00	\$172,860	\$30.35	\$12,201	\$560,931
	P1 Level	402 Ton	\$935.00	\$375,870	\$430.00	\$172,860	\$30.35	\$12,201	\$560,931
	Lower Level	402 Ton	\$935.00	\$375,870	\$430.00	\$172,860	\$30.35	\$12,201	\$560,931
	Ground Level	402 Ton	\$935.00	\$375,870	\$430.00	\$172,860	\$30.35	\$12,201	\$560,931
	Level 2	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 3	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 4	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 5	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 6	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 7	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 8	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 9	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Level 10	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Roof	25 Ton	\$935.00	\$23,375	\$430.00	\$10,750	\$30.35	\$759	\$34,884
	Columns	505 Ton	\$935.00	\$472,175	\$430.00	\$430.00	\$30.35	\$15,327	\$487,932
	Shear Walls	166 Ton	\$935.00	\$155,210	\$430.00	\$71,380	\$30.35	\$5,038	\$231,628
	SUB-TOTAL	3100	\$935.00	\$2,898,500	\$430.00	\$430.00	\$30.35	\$94,085	\$2,993,015
Cast in Place Concrete	Composite Decking	352 CY	\$109.00	\$38,368	\$14.90	\$5,245	\$5.55	\$1,954	\$45,566
	Columns	1167 CY	\$109.00	\$18,203	\$34.00	\$5,678	\$16.95	\$2,831	\$26,712
	Slabs	32420 CY	\$109.00	\$3,533,780	\$18.20	\$590,044	\$9.15	\$296,643	\$4,420,467
	Shear Walls	2732 CY	\$109.00	\$297,788	\$26.50	\$72,398	\$1,320.00	\$3,606,240	\$3,976,426
		SUB-TOTAL	35671	\$109.00	\$3,888,139	\$23.40	\$834,701	\$337.91	\$12,053,588
Structural Steel	Steel	334 Ton	\$2,300.00	\$768,200	\$380.00	\$126,920	\$132.00	\$44,088	\$939,208
	PT Cables	400000 LB	\$1.79	\$716,000	\$0.79	\$316,000	\$0.03	\$12,000	\$1,044,000
Location Factor: 98%	TOTAL STRUCTURAL ESTIMATE :		\$28,540,038			Total Labor Cost:		\$2,232,565	
	Total Material Cost:		\$8,270,839			Total Equipment Cost:		\$4,057,840	



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General Conditions Estimate

Table 9: Displays the Total Cost of Each Sub-Category

General Conditions Estimate		
Supervision Subtotal		\$2,448,785
Temporary Facilities Subtotal		\$173,474
Temporary Utilities Subtotal		\$80,529
Equipment Rental Subtotal		\$11,368
General Costs Subtotal		\$478,857
Location Factor	98.00%	\$59,866
COMPLETE TOTAL		\$3,053,152

Please reference Appendix D for the General Conditions Calculation Sheet.

The total duration of this project is 2.6 years, totaling 32 months of work. The general conditions estimate is divided into five sub-categories: supervision, temporary facilities, temporary utilities, equipment rental, and general cost. The unit costs and total costs calculated for this estimate were performed using R.S. Means 2008, ICE 2000 estimating software, and certain values from other projects similar in size and scope. Also of importance, there is no crane expense included in the general conditions. The crane is owned and operated by the concrete contractor and is included in their scope of work. The general conditions estimate does not include insurance, bonding, fee, contingency, or any project overhead expenses. These would be included in the general contractor's fee. A 5.75% sales tax was added to all materials purchased for general conditions. Lastly a location factor was included to adjust the total cost of general conditions.

The total value calculated was **\$3,053,152** a little more than 3% of the total contract value; this value is quite low compared to the original value.