Technical Assignment II:
2011 AE Senior Thesis
Office Building
Northeast, United States

October 19
2011

Patrick Laninger

Construction Management
Dr. Robert Leicht

EXECUTIVE SUMMARY

While Technical Assignment #1 provided a broad overview of the project schedule, costs, site, motivators, and construction methods, Technical Assignment #2 focuses more heavily on a few key construction topics. A more detailed project schedule provides an in-depth look at the construction phasing and time requirements associated with the project. The schedule also allows for a comprehensive analysis of the general conditions costs incurred during the project timeline, which vary with the differing phases of construction.

The detailed project schedule focuses on the construction activities for the erection of Building One. For the remainder of this thesis, schedules, estimates and analyses will only include information for Building One of the office building complex. This will ensure that the appropriate level of detail is addressed, and allow for a greater understanding of the means, methods, costs and material inputs associated with this portion of the project. Every time-dependent analysis will reference this detailed schedule for duration values. To facilitate future in-depth analyses of the project, the schedule is divided into excavation, structure, mechanical/electrical/plumbing, interior and envelope phases. Each of these divisions is further broken up into levels or areas, or a combination of both.

To better understand the material, labor and equipment commitments required to place the cast-in-place concrete structure, a detailed structural system estimate is included. This estimate highlights the material, labor and equipment requirements for the construction of one typical bay of the building. Unfortunately, when extrapolated to include the entire structure, the estimate proved to be flawed. Further investigation into the relationships between the estimated structural bay and the surrounding bay sizes and geometries is necessary before an accurate cost estimate can be completed.

In order to further understand some of the major BIM and LEED decisions that have shaped the outcome of the project, LEED and BIM Use evaluations were performed. These models are accurate representations of the manners in which LEED and BIM were implemented and explored on the project. They not only provide a snapshot of the types of technologies and procedures that were used on site, but also highlight the areas in which improvements could have been made to increase the project's sustainability and constructability while minimizing conflicts and system redesign.

Included within is a detailed breakdown of the areas where LEED credits were pursued, as well as some suggestions for the possibility of obtaining additional LEED credits with a few interior architectural modifications that would open the building up to more of the available day lighting aspects associated with the extensive glazing on the building. These modifications could lead to an increase in the amount of exterior views, allowing the building to gain further LEED credits.

While investigating the areas of building information modeling, it became quite clear that while the project team effectively utilized BIM technologies throughout the schematic design and design development phases, the 3D models that were readily available were not taken advantage of during the construction process.

TABLE OF CONTENTS

DETAILED PROJECT SCHEDULE

SEE APPENDIX A FOR DETAILED PROJECT SCHEDULE

INTRODUCTION

Although Technical Assignment #1 featured a full project schedule, including the construction dates and durations for the other structures on the office building campus, the attached schedule focuses on the activities associated with the construction of Building One. By narrowing the focus of the project schedule, accurate general conditions and building systems estimates can be produced through the input of detailed breakdowns of labor and material commitments. The schedule is divided into six main categories; Design/Coordination, Excavation/Prep, Structure, MEP, Interiors, and Building Envelope. Conclusively, these categories represent the main phases of building construction efforts, and lend themselves to a simple, yet comprehensive schedule, from which data can be extrapolated to provide duration values for other estimates and analyses.

DESIGN/COORDINATION

Upon receiving a notice to proceed, the Clark Construction Group and its design partners began transforming the Perkins + Will bridging documents into full-fledged construction documents that addressed the owner's architectural, structural and sustainable goals. This process took approximately one year, and although coordination efforts with all involved parties are reported to have begun at the conclusion of initial design, mechanical and electrical contractors were involved in the initial design process as consultants. These firms provided active feedback regarding all major design decisions, allowing the design build team to address major coordination concerns early in the design process. Through a fast-track approach, and because of the existence of bridging documents that established many of the building's characteristics, the design-build team was able to begin the planning and permitting process as soon as the design development was underway. Additionally, the procurement process began upon receipt of a notice to proceed, allowing the construction team to secure clearing, earthwork, and foundations subcontractors as early as possible, expediting the initial phases of construction. Procurement of the remaining trades continued to take place throughout the rest of the design and coordination efforts, with each subcontractor being chosen as their scopes of work were developed and refined.

EXCAVATION

Approximately five months into the design process, site preparation efforts began. The initial access, utility, and clearing activities were labor and equipment intense, as they established a temporary roads, utilities and cleared vegetation for a complex exceeding 2 million square feet and $500 million in total size. Once the site and temporary utilities were established, excavation efforts proceeded very rapidly. Building One's basement was excavated and shored in less than 100 days, allowing for Clark Concrete to begin their cast in place concrete activities as soon as possible. Additionally, main underground plumbing and electrical lines were routed to the building in order to facilitate the rapid construction and functionality of the building's system.

STRUCTURE

Prior to the first concrete pour, two tower cranes were erected (See Figure #1 Below) in order to provide complete access to the entire building footprint. This allowed for efficient concrete placement throughout the structural construction phase. The cranes were strategically placed outside of the building's footprint in order to avoid interference with the on grade and elevated slabs. Steel piles were driven into the ground and topped with concrete pile caps. A system of grade beams was then constructed in order to properly distribute the building's weight across the soil below the structure. The remaining structural activities are outlined in the schedule by floor. Each vertical lift consists of an elevated deck activity followed by the erection of walls and columns to the floor level above. Detailed information regarding the phasing breakdown of slabs, walls and columns across the building footprint is unavailable at this time, but will be included in future schedules and phasing analyses.

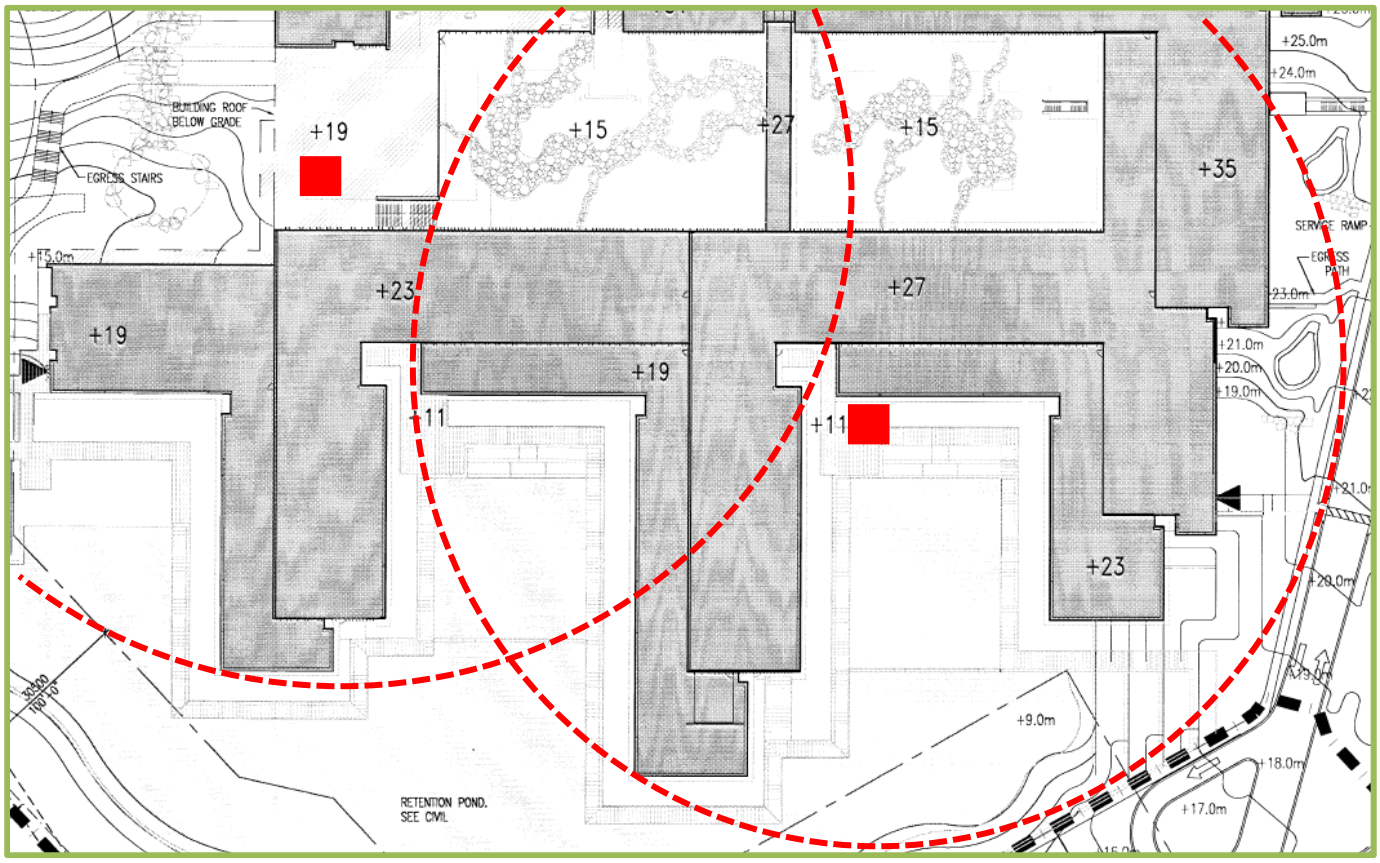


Figure #1: Tower Crane Locations – Base Image Courtesy of Clark Construction

MECHANICAL, ELECTRICAL AND PLUMBING

The construction of main mechanical, electrical and plumbing assemblies are shown in the schedule by floor and area. For phasing and communication purposes, Building One is divided into three sections; A, B and C (See Figure #2 Below). The area highlighted in blue represents the Child Care area located on Lower Level 9.

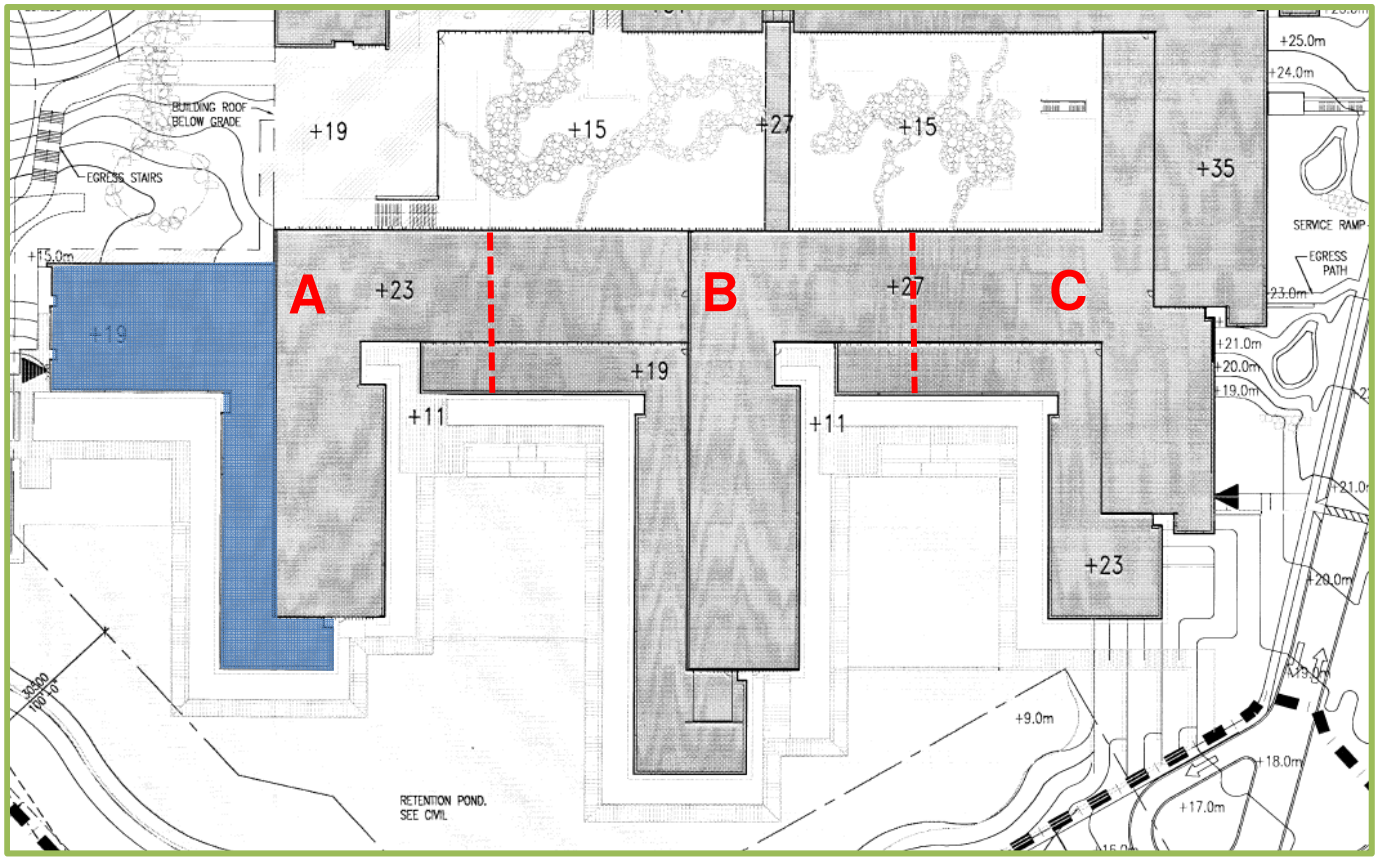


Figure #2: Building Areas – Base Image Courtesy of Clark Construction

After establishing control lines on the elevated decks and columns, main HVAC trunk lines and variable air volume boxes are hung from the elevated decks. These items are constructed prior to other MEP systems due to their space requirements and limited flexibility. Main plumbing lines are then installed according to the coordinated contract documents. These pipelines take precedence over sprinkler and electrical systems because of their slope requirements, which limit the ability to compromise their location and elevation in the event of a field conflict. Sprinkler lines follow the plumbing system, and are installed in a manner that provides the required sprinkler coverage throughout the building floor areas. Electrical cable trays are installed after the other major systems because of their dynamic nature. Conflicts can be avoided by rerouting the cable tray in a number of manners, including elevation changes (as long as they remain above future ceiling heights and out of the areas where architectural bulkheads are located) as well as an ability to shorten the height of the cable trays from 4" to 2" where space constraints prohibit the use of the tallest cable trays. These trays will eventually hold tele-data and security wiring, and as long as they provide a pathway to and from areas requiring connectivity, can be run in any manner that avoids conflict with other systems and architectural finishes.

INTERIOR ACTIVITIES

The attached project schedule outlines interior activities by floor and area, similar to the core MEP activities. Due to the project phasing techniques, it appears that each area takes roughly 200 days to complete. This is however slightly skewed because of the manner in which interior partitions are framed, roughed-in and enclosed. A first pass through each area establishes the framing for the demising partitions, followed by a second pass that completes the framing of full-height partitions. The 4-5 month duration for partition framing activities is therefore not necessarily reflective of a constant construction process. The framing contractor may spend a week or two in one area constructing one type of wall, move to another area, repeating this process, prior to moving back to the first area to construct a different type of partition. This approach allows the contractor to stockpile certain types and lengths of wall stud members, facilitating an efficient erection of these walls. In future iterations, the schedule may highlight these different passes if the information becomes available and is rendered useful.

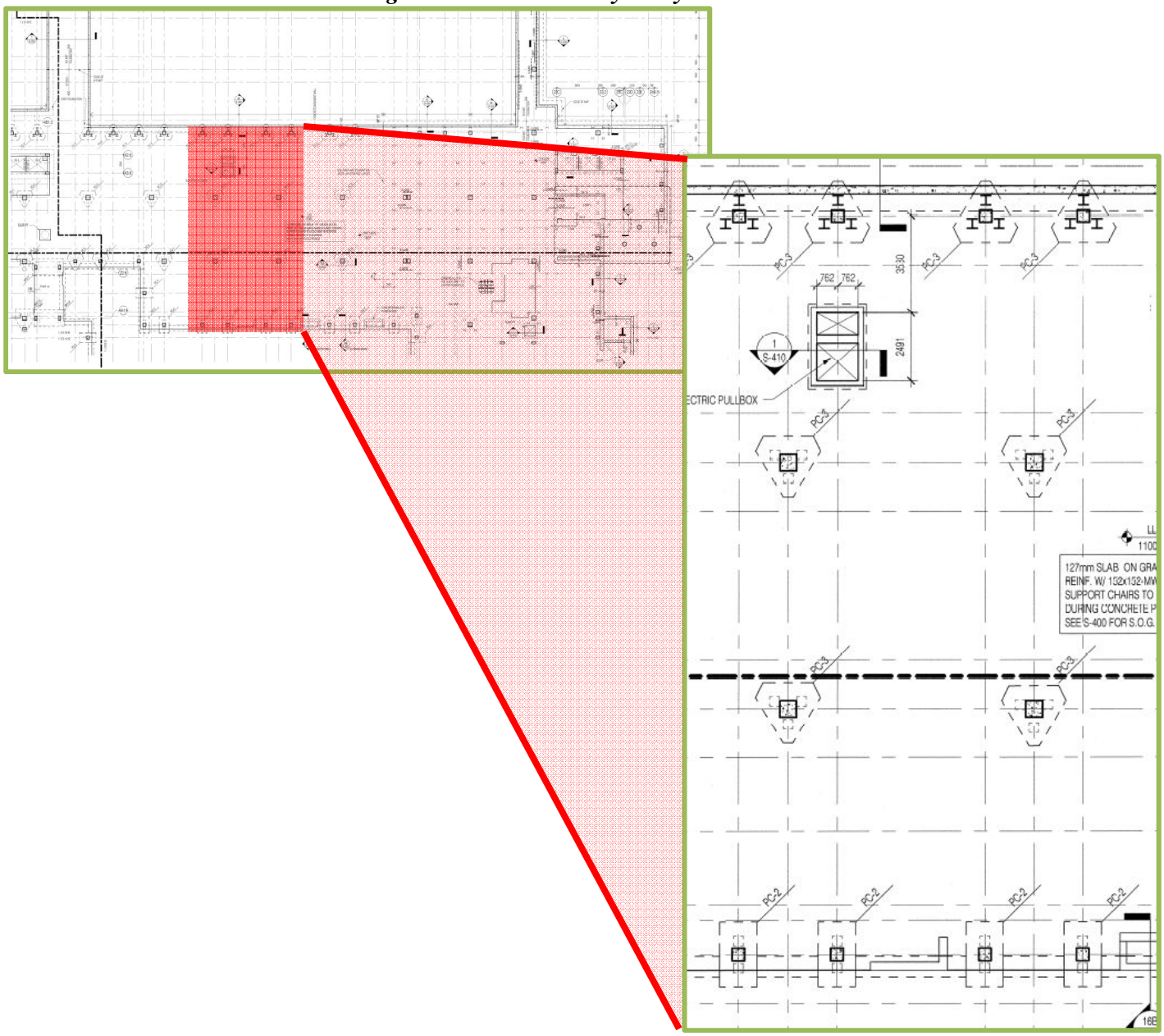
DETAILED STRUCTURAL SYSTEMS ESTIMATE

SEE APPENDIX B FOR DETAILED STRUCTURAL SYSTEM TAKEOFFS

STRUCTURAL ESTIMATE INTRODUCTION

A detailed structural concrete estimate was performed on a typical bay located in area C of Building One (See Figures #3). This estimate includes concrete grade beams, pile caps, slabs on grade, structural columns and elevated slabs. The following narrative explains the means and methods through which the estimate was reached.

Figure #3: Structural Bay Study Location



CONCRETE GRADE BEAMS

Concrete grade beams support the slab on grade at Lower Level 9. Figure #4 below shows the concrete and rebar details for the grade beams.

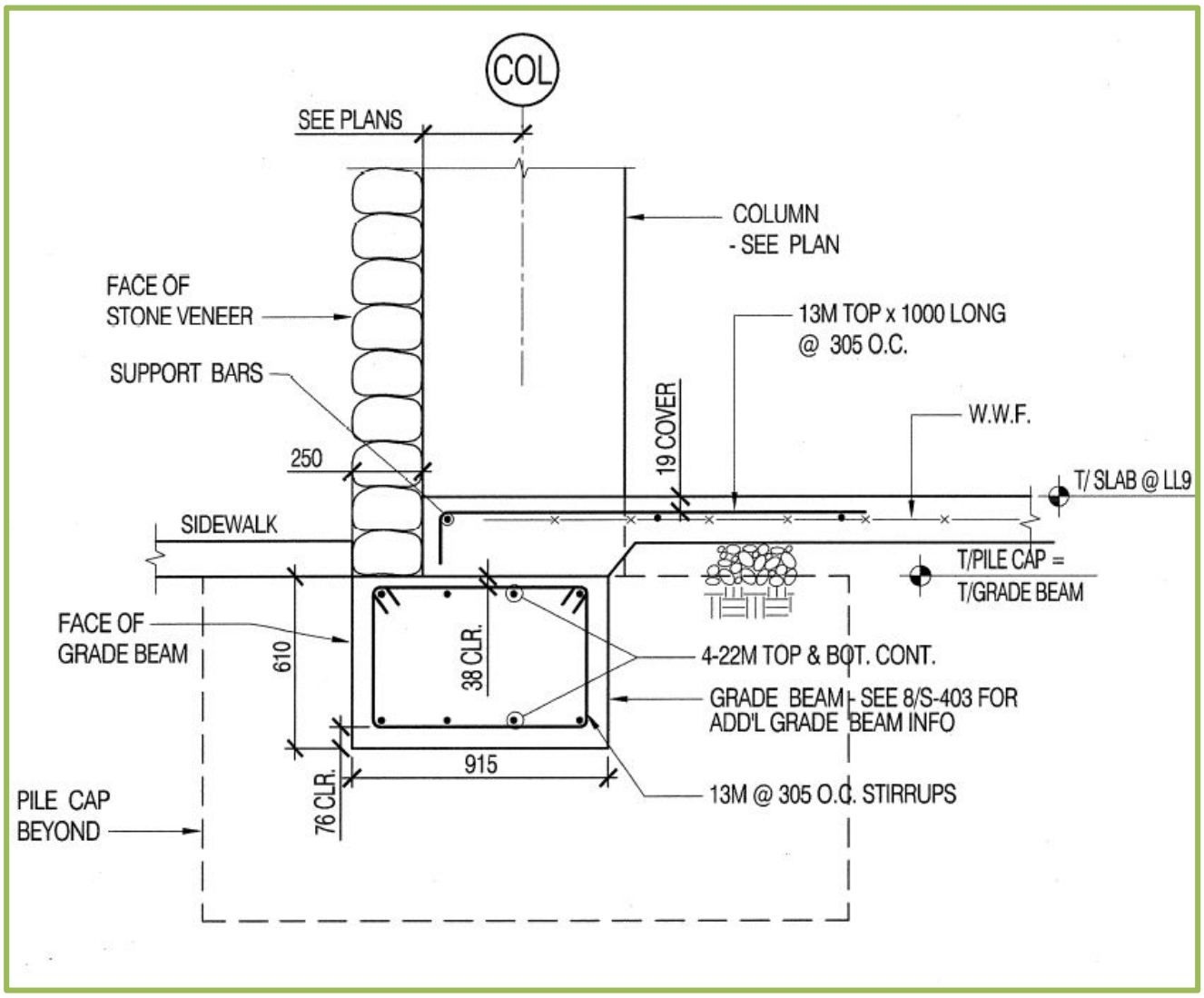


Figure #4: Foundation Grade Beam Section

PIER CAPS

The pier cap schedule (See Figures #5), in conjuction with a quantity taken from the foundation plans, was used to determine the concrete and rebar requirements for the caps. Formwork was not necessary due to the subterranean nature of pier caps and the ability to use the ground as natural formwork.

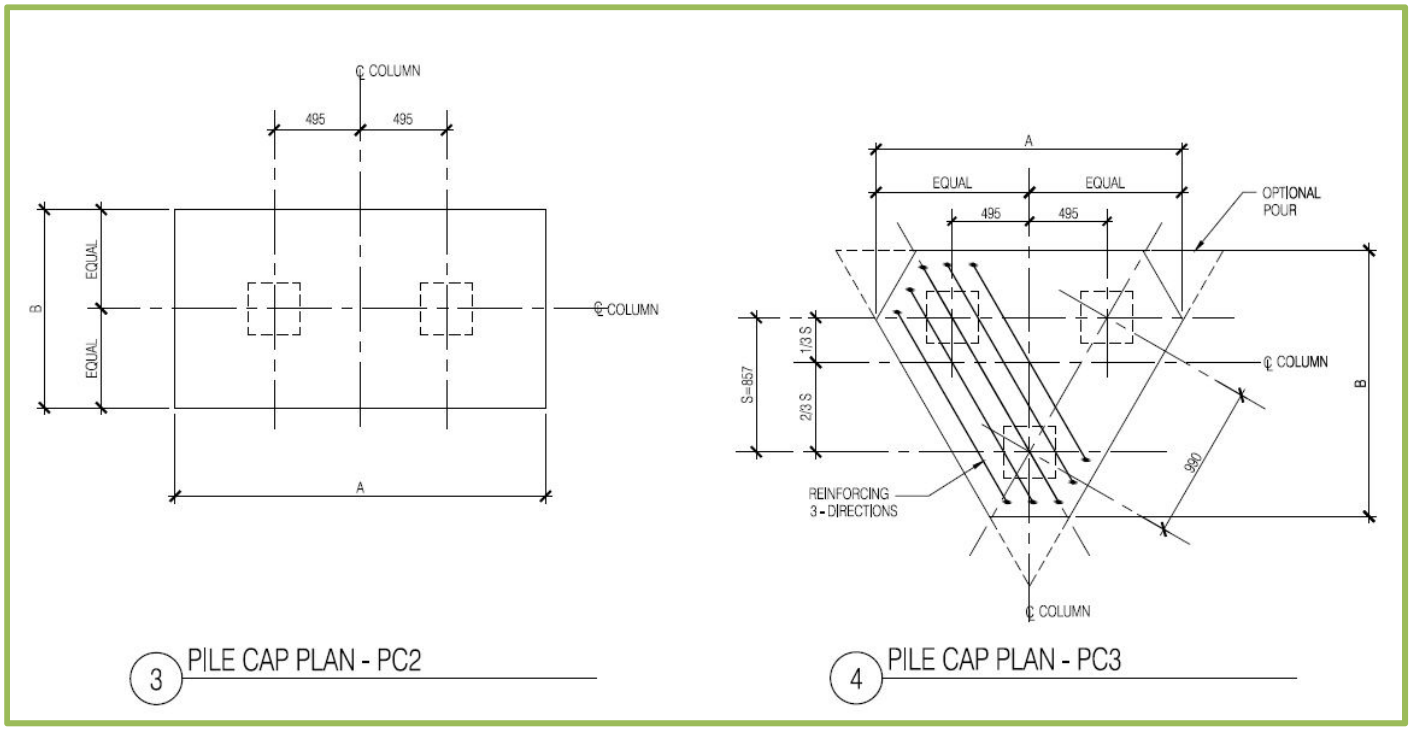


Figure #5: Pier Cap Schedule

SLAB ON GRADE

The slab on grade located on Lower Level 9 is approximately 3660 SF in size, 8" in thickness, and has #8 rebar running both directions at 1' O.C. It was assumed that the rebar spacing did not drastically change near areas of column penetration.

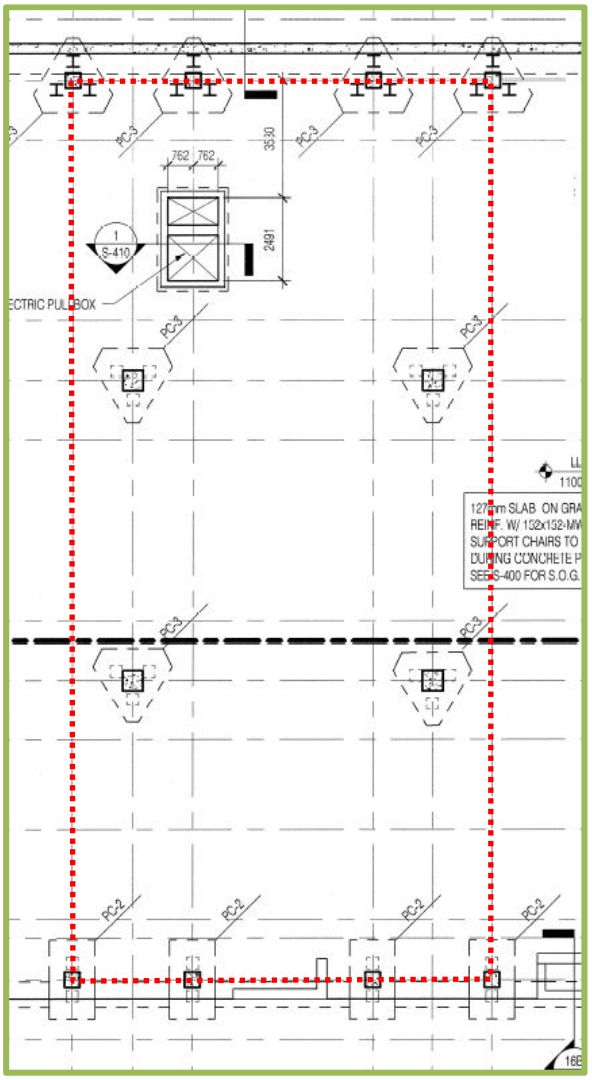


Figure #6: Slab on Grade Extents

STRUCTURAL COLUMNS

In order to estimate the costs associated with the placement of the cast-in-place concrete columns on this project, the columns within the chosen bay were first identified by their gridline designations. The column designation schedule (Figure #7 Below) shows the column types associated with each grid series designation.

Figure #7: Column Designation Schedule

GRID SERIES (X)	COLUMN TYPE	GRID SERIES (Y)	COLUMN TYPE	GRID SERIES (Z)	COLUMN TYPE	GRID SERIES (AA)	COLUMN TYPE
X-5	C5	Y-1	C1	Z-1	C1	AA-1A	C2
X-6A	C5	Y-2	C1	Z-2	C1	AA-1B	C2
X-6B	C5	Y-3	C1	Z-3	C1	AA-2A	C2
X-7A	C5	Y-4	C1	Z-4	C1	AA-2B	C2
X-7B	C5	Y-5	C4.1	Z-5	C4.1	AA-3A	C2
X-8A	C5	Y-6	C4	Z-6	C4	AA-3B	C2
X-8B	C5	Y-7	C4	Z-7A	C5	AA-4A	C2
X-9A	C5	Y-8	C4	Z-7B	C5	AA-5	C4.1
X-9B	C5	Y-9	C4	Z-8A	C5	AA1.6-6	C4
X-10A	C5	Y-10	C4	Z-8B	C4.1	AA-6D	C5
X-10B	C5	Y-11	C4	Z-9	C4.1	AA-8A.5	C2
X-11A	C5	Y-12.1	C8	Z-10	C4.1	AA-8B	C2
X-11B	C5	Y-12A.9	C8	Z-11	C4.1	AA-9A	C2
X-12A	C5	Y-13	C9.1	Z-12A.9	C8	AA-9B	C2
X-12B	C5	Y-14	C9	Z-13	C9.1	AA-10A	C2
X-13A	C5	Y-15	C9	Z-14	C9	AA-10B	C2
X-13B	C6	Y-16	C9	Z-15A	C6	AA-11A	C2
X-14A	C6	Y-17	C9	Z-15B	C6	AA-11B	C2
X-14B	C6	Y-18	C9	Z-16A	C6	AA-13	C9.1
X-15	C6	Y-19	C9	Z-16B	C9.1	AA1.6-14	C9
X-15C	C6	Y-20.1	C11	Z-17	C9.1	AA-16A.5	C5
X-16A	C6	Y-20A.9	C11	Z-18	C9.1	AA-16B	C5
X-16B	C6	Y-21	C9	Z-19	C9.1	AA-17A	C5
X-17A	C6	Y-22	C7.1	Z-20.1	C11	AA-17B	C5
X-17B	C6	Y1-24	C22	Z-20A.9	C11	AA-18A	C5
X-18A	C6	Y4-6	C3	Z-21	C9.1	AA-18B	C5
X-18B	C6	Y4-5B.5	C3	Z-22	C9	AA-19A	C5
X-19A	C6	Y6-14B.5	C10.1	Z1-23	C6	AA-19B	C5
X-19B	C6	Y6-14A1.5	C10.1	Z2-23	C6	AA-20A	C5

Once a column's type has been identified, detailed information about its dimensional and reinforcement properties can be found in the column sizes chart (Figure #8).

Figure #8: Column Sizing Chart

COLUMN MARK / LEVEL	C1	C2	C3	C3.1	C4	C4.1	C5	C6	C7	C7.1	C8	C9
3rd FLOOR												
2nd FLOOR												
GROUND FLOOR												
LOWER LEVEL 1												
LOWER LEVEL 2												
LOWER LEVEL 3												
LOWER LEVEL 4									610x610 8-25M	610x610 8-32M		
LOWER LEVEL 5									610x610 8-25M	610x610 8-25M		
LOWER LEVEL 6								457x457 8-36M	610x610 8-25M	610x610 8-25M		610x610 8-25M
LOWER LEVEL 7			305x610 6-22M	610x305 6-22M	610x610 8-25M	610x610 8-32M	457x457 8-36M	457x457 4-32M	610x610 8-25M	610x610 8-25M	610x457 10-36M	610x610 8-25M
LOWER LEVEL 8	610x610 8-25M	457x457 8-36M	305x610 6-22M	610x305 6-22M	610x610 8-25M	610x610 8-25M	457x457 4-32M	457x457 4-32M	610x610 8-32M	610x610 8-32M	610x457 6-36M	610x610 8-25M
LOWER LEVEL 9	610x610 8-25M	457x457 4-32M	305x610 6-22M	610x305 6-22M	610x610 8-25M	610x610 8-25M	457x457 4-32M	457x457 4-32M	610x610 8-32M	610x610 8-32M	610x457 6-36M	610x610 8-25M
DOWELS	8-22M	4-29M	6-19M	6-19M	8-22M	8-22M	4-29M	4-29M	8-29M	8-29M	6-32M	8-22M
REMARKS												

The information within the column sizing and reinforcement chart was used to estimate the column volume (for concrete estimates), the column area (for formwork estimates), and the approximate spacing and total length of rebar within the entire column (for reinforcement estimates). Rough spacing values from the column sizing chart were used to estimate the number of vertical and horizontal rebar pieces within the column. A detailed breakdown of the take-offs and cost values are included in Appendix B.

ELEVATED SLABS

The elevated slabs on this project are all identical in nature. The roof slabs are as large as the floor slabs because of the added dead load from the green roof materials above. Since the building tapers as it goes up, it was not possible to calculate the area, perimeter and rebar contents of one slab and apply it to all levels. The fact that each level has slightly different undulations in the façade perimeter also makes a difference as far as concrete formwork is concerned. Because drop panels occur rather frequently, varying the slab thickness from 6" to 8", an overall slab thickness of 6.2" was used for the entire area to account for the excess concrete in these drop panels. (See Appendix B for take-off details).

SUMMARY

To estimate the entire building's structural system, the costs associated with the roughly 3700 SF portion of the structure were extrapolated across the entire 390,000 SF. Unfortunately, the RS Means estimate is approximately 69% greater than the actual project costs (See Table #1). This could be a result of numerous aspects of the project, including the on-site presence of a concrete batch plant, the unique relationship between Clark Construction and Clark Concrete, or false generalizations in the estimate. Additionally, extrapolating the data from one bay across the entire building on a square foot basis is most likely not the most accurate manner to do so. The estimated bay is one of the larger bays in size and complexity, and a detailed analysis of how the other bays related to the estimated bay would be appropriate if one desired a more accurate estimate.

Table #1: Column Sizing Chart

Typical Bay Size	Typical Bay Price	Building Size	Estimated Building Price	Actual Building Price	% Difference
3700	423,482.61	390000	44,637,356.19	Approx. $27,000,000	69%

GENERAL CONDITIONS ESTIMATE

SEE APPENDIX C FOR GENERAL CONDITIONS ESTIMATE

GENERAL CONDITIONS SYNOPSIS

The following general conditions estimate applies to the construction of Building One of the office building complex. Costs associated with the construction of the remaining structures on the campus are not included with the estimate, as they do not apply to the focus of this thesis. The majority of the cost data used in this analysis was obtained through the RSMeans CostWorks web-based tool (included in Appendix C), however, some values were not obtainable or were drastically different from the project specific cost values. Particularly, the project staffing values available through RSMeans are extremely limited. Therefore, Clark Construction's weekly billing rates were used in conjunction with the adjusted time commitments discerned from the Building One specific project schedule. Additional gaps in the RSMeans reference database were subsidized through the use of Clark Construction's detailed general conditions estimate and shown in red in the overall general conditions estimate table.

The assumption was made that because the project is delivered with a fast-tracked, design-build approach, mobilization would occur once the preliminary design was completed in order to promote immediate ground breaking efforts. Consequently, the general conditions estimate spans from Monday, August 30th 2010 until Wednesday, January 25th 2012.

STAFFING REQUIREMENTS

Staffing requirements were taken directly from the staffing plans included in Technical Assignment #1. The following is a breakdown of these requirements as well as the weekly fees associated with varying levels of professional positions. Additionally, justifications of the time commitments of each position are explained below. The maximum time commitment of each position is 5 days a week for approximately 74 weeks. While some team members will be involved with the project for the entire 74 weeks of construction, others have varying degrees of involvement depending on their position and need. Quality control personnel were omitted from the general conditions estimate because the quality control roles on the project were fulfilled through the implementation of a 3rd party quality control subcontract. The cost of this service was transferred to the owner in initial project estimates. See Table #2 for Project Staffing Costs.

Nearly all Clark employees were involved with the project for the duration of construction; 74 weeks. The exceptions to this are as follows:

Project Vice-President: Involved with numerous projects at a time and devotes approximately ½ of their weekly hours to the project (37 Weeks Total).

General Superintendent VP and Superintendent: Involved with pre-planning of site logistics and mobilization efforts approximately 6 weeks in advance of project mobilization (80 Weeks Total).

Façade Superintendent: Involved with the project throughout the façade phase, from Monday, November 11th 2010 until Tuesday, August 2nd 2011 (40 Weeks Total).

Interiors Superintendent: Present during interior installations phase, from Friday, December 17th 2010 through Wednesday, January 25th 2012 (58 Weeks).

Field Engineering Staff: In order to establish initial project benchmarks and controls, the field engineering staff is dedicated full-time to the project 6 weeks prior to mobilization (80 Weeks Total).

Table #2 – Project Staffing Costs

POSITION	QTY	UNIT	LABOR UP	LABOR COST
OFFICE OPERATIONS				
Project Vice-President	37	WKS	6,368.00	235,616.00
Project Executive	74	WKS	6,078.00	449,772.00
Asst. Project Executive	74	WKS	4,266.00	315,684.00
Purchasing/Contract Exec.	74	WKS	3,249.00	240,426.00
Contract Manager	74	WKS	3,249.00	240,426.00
Head Scheduler	74	WKS	2,853.00	211,122.00
Office Manager	74	WKS	1,727.00	127,798.00
Asst. Office Manager	74	WKS	1,250.00	92,500.00
Payroll Accountant	74	WKS	1,250.00	92,500.00
Civil/Site Project Manager	74	WKS	3,759.00	278,166.00
Civil/Site APM	74	WKS	2,418.00	178,932.00
Civil/Site APM	74	WKS	2,418.00	178,932.00
Concrete/Int. Project Manager	74	WKS	3,759.00	278,166.00
Concrete/Int. APM	74	WKS	2,418.00	178,932.00
Façade Project Manager	74	WKS	3,759.00	278,166.00
Façade APM	74	WKS	2,418.00	178,932.00
Façade APM	74	WKS	2,418.00	178,932.00
MEP Project Manager	74	WKS	3,759.00	278,166.00
MEP Coordinator	37	WKS	3,759.00	139,083.00
MEP APM	74	WKS	2,418.00	178,932.00
MEP APM	74	WKS	2,418.00	178,932.00
			SUBTOTAL OFFICE	**4,510,115.00**
FIELD OPERATIONS				
General Superintendent VP	80	WKS	6,368.00	509,440.00
Superintendent	80	WKS	3,399.00	271,920.00
Assistant Superintendent	74	WKS	2,983.00	220,742.00
Assistant Superintendent	74	WKS	2,983.00	220,742.00
Façade Superintendent	40	WKS	3,399.00	135,960.00
Interiors Superintendent	58	WKS	3,399.00	197,142.00
Field Engineering Manager	80	WKS	2,983.00	238,640.00
Field Engineer	80	WKS	2,191.00	175,280.00
Asst. Field Engineer	80	WKS	1,572.00	125,760.00
Asst. Field Engineer	80	WKS	1,572.00	125,760.00
Safety Director	80	WKS	2,527.00	202,160.00
Safety Engineer	74	WKS	2,191.00	162,134.00
Safety Engineer	74	WKS	2,191.00	162,134.00
			SUBTOTAL FIELD	**2,747,814.00**
			SUBTOTAL OFFICE	**4,510,115.00**
			TOTAL	**7,257,929.00**

TEMPORARY FACILITIES & SERVICES

The sheer size of the project demanded extensive project facilities and temporary services in order to facilitate the smooth operation of day to day tasks. The office complex on this project consisted of 14 single wide trailer units; combined to form approximately 15 individual offices, open cubicle areas, 3 conference rooms, a field management area, a bathroom and a cafeteria. The long duration of the project prompted Clark Construction to purchase the trailer facilities so that they may claim depreciation as well as demobilize them and use them on several projects that they anticipate being awarded near the conclusion of the project.

Due to the large water and electricity requirements of the project, temporary service fees were astronomical. While RSMeans estimates for water services were assumed to be accurate, the electrical unit costs seemed inadequate considering the number of workers present on site each day and the number of tools requiring electricity that they carried with them. For this reason, the RSMeans values for electricity rates were tripled to account for this increased power density.

Table #3 – Temporary Facilities & Services Costs

TEMPORARY FACILITIES & SERVICES				
DESCRIPTION	**QUANTITY**	**UNIT**	**BARE TOTAL**	**TOTAL**
Office Trailers	14	Each	28,850.00	403,900.00
Office Furniture	18.5	Month	1,200.00	22,200.00
Temporary Fencing	3000	LF/12 Mo.	3.00	13,875.00
Vehicular Parking	2500	SF	7.27	18,175.00
Temporary Lighting	390000	CSF Floor	13.33	51,987.00
Power For Temporary Lighting	390000	CSF Floor/Month	2.85	205,627.50
Temporary Water	18.5	Month	2,100.00	38,850.00
Construction Power for Job Duration	390000	CSF Floor	110.00	429,000.00
Jobsite Signs (10"x10" Aluminum)	100	Each	64.95	6,495.00
Pest Control	14	Per Building	28.75	402.50
Temporary Toilets	60	Job	168.00	10,080.00
			TOTAL	**1,200,592.00**

KEY CONCERNS

Many times, the everyday tools and amenities that are utilized on a project are undercompensated in general conditions estimates. On a project of this scale, the number of cell phones, laptop computers, IT equipment, printing and document control materials and company cars are anything but small expenditures. For this reason, Clark Construction went at great lengths to account for all of these costs in their general conditions budget. Table #3 highlights these general office expenses in detail.

Table #3 – Key Concerns - Administrative Facility Maintenance & Supplies Costs

ADMISTRATIVE FACILITIES & SUPPLIES				
DESCRIPTION	**QUANTITY**	**UNIT**	**BARE TOTAL**	**TOTAL**
Trailer Cleaning	74	WKS	1,072.50	79,365.00
Postage & Shipping	19	Month	1,500.00	28,500.00
Office Equipment	19	Month	150.00	2,850.00
Office Supplies	19	Month	95.00	1,805.00
Personal Computers	19	Month	3,500.00	66,500.00
Local Area Network	19	Month	892.00	16,948.00
Computer Software	34	Per Person	750.00	25,500.00
Scheduling Software	1	Per Person	4,500.00	4,500.00
Telephone Bills	19	Month	210.00	3,990.00
Cell Phone Bills	19	Month	3,800.00	72,200.00
Jobsite Shed	19	Month	97.50	1,852.50
Printing/Copying Services	19	Month	4,722.00	89,718.00
Automobile - Project Executive	19	Month	650.00	12,350.00
Automobile - Senior Project Ma	19	Month	650.00	12,350.00
Truck - Senior Superintendent	19	Month	550.00	10,450.00
Truck - Superintendent	19	Month	550.00	10,450.00
Motor Vehicle Expenses (Gas/M	76	Month	400.00	30,400.00
Travel Expenses	1	Allowance	25,000.00	25,000.00
Moving/Relocation Expenses	1	Allowance	20,000.00	20,000.00
As-Built Drawings	1	Allowance	25,000.00	25,000.00
			TOTAL	**539,728.50**

SUMMARY

The remaining project general condition costs can be found in Appendix C and provide a more detailed representation of the costs associated with the daily operations (in addition to staffing, temporary facilities and key concerns) of a project of this magnitude. It is imperative that a general contractor perform accurate general condition estimates in order to minimize their exposure to monumental losses that could result from the overlooking of any number of items that are crucial to the daily operation of a project. Occasionally, expenditures that seem small in magnitude are overlooked. These small expenses tend to add up over time, for example, the purchasing of multiple updated copies of construction documents. If allowances have not been made for these expenditures, a company may find themselves bearing the full burden of these financial responsibilities, greatly reducing their overhead allowances and profit margins. General conditions expenses are commonly referred to the "make or break" aspects of a project budget, and cannot be carelessly estimated.

LEED EVALUATION

SEE APPENDIX D FOR LEED PROJECT CHECKLIST

Sustainability was a main priority of the project financiers, owners and occupants. The office complex will serve as the tenant's main headquarters for the next few decades, increasing the desire to create a sustainable structure that minimally impacts the surrounding landscape and natural surroundings. Consequently, the project is currently tracking to achieve a LEED Gold rating. Table #5 highlights the areas in which the project is projected to accrue LEED points. LEED Version 2.2 awards LEED Gold ratings to projects that achieve 39-51 points. Through the design-build project approach, HOK and Clark Construction were able to coordinate and evaluate which LEED points were attainable through design aspects, and which credits were more suitable for being pursued through unique and sustainable construction techniques and in-field decisions.

Table #5 – LEED Point Summary

LEED-NC

LEED-NC Version 2.2 Project Summary

Office Building

Northeast, United States

Yes	?	No		
10	2	2	Sustainable Sites	14 Points
3	1	1	Water Efficiency	5 Points
6	2	9	Energy & Atmosphere	17 Points
7	0	6	Materials & Resources	13 Points
11	1	3	Indoor Environmental Quality	15 Points
5	0	0	Innovation & Design Process	5 Points
42	6	21	Project Totals (Pre-Certification)	69 Points

SUSTAINABLE SITES

In order to achieve any of the fourteen available sustainable site credits, Clark Construction was first responsible for developing sedimentation and erosion control plans that, when implemented, achieved the sustainable sites prerequisite credit awarded for construction activity pollution prevention. Unfortunately, the site itself consisted of a few wetland areas, and the complex is not intended as a dense residential structure, eliminating the possibility of achieving site selection credits one and two. On the other hand, the site is considered a brownfield due to the presence of fly-ash content. Through a partnership with the Voluntary Cleanup Program, Clark Construction was able to earn LEED credits for the remediation and development of an existing brownfield.

Alternative transportation considerations account for three LEED credits, with the possibility of a fourth credit if it is determined necessary and locations for bicycle storage, changing rooms and showers can be agreed upon. Currently, the project is pursuing credits for its close vicinity to the metro station, reserving 5% of its parking spaces for low emission and fuel efficient vehicles, and a campus-wide parking strategy that promotes carpooling and the use of mass transit.

Site development and storm water management techniques are responsible for the three remaining credits. Destroyed wetlands will be replaced by a large storm water retention pond and courtyards with bio-swales. This approach not only replaces valuable wetland-type areas, but also increase's the building's ability to prevent rapid rainwater runoff that causes erosion.

Heat island effects are reduced through the use of an eight story structured parking area that essentially reduces the overall square footage of impermeable, heat island surfaces by a factor of eight. Additionally, the rooftops of 90% of the buildings are vegetated, further reducing the heat island effect exhibited by the structures.

While the building itself is designed with light pollution reduction in mind, with sun shades and tinted windows that diffuse the light emitted from within, the site security lighting requirements may compromise the attainability of LEED Sustainable Sites credit #8. An exterior lighting redesign is pending, and all possibilities of obtaining this credit are actively being pursued.

WATER EFFICIENCY

While no innovative wastewater technologies, such as grey or black water systems, are being pursued on this project, the landscape design and green roof spaces lend themselves to dramatic water efficiency characteristics. Through future documentation, it is believed that the building will not require the use of any potable water for landscape irrigation. The bio-swales and storm water retention pond will collect and retain rainwater that can be used for irrigation during periods of little or no rainfall.

Within the building, low volume and dual flush toilets, water efficient urinals, and low-flow faucets with hand sensors have been calculated to provide water savings upwards of 30% compared to the LEED baseline.

ENERGY & ATMOSPHERE

In order to reach prerequisite baselines, a commissioning agency, RD^3, was brought onto the design-build team early on in the design process to facilitate a mechanical system layout and implementation of the appropriate control devices that will eventually result in a seamless commissioning effort. Girard Engineering created energy models for the entire complex, and will run analyses on the buildings once the façade structure has been completed and evaluated for approximate insulation values that can be used for minimum energy performance comparison tests. They are also responsible for using commissioning information to assist in the optimization of the building's energy performance once substantial completion has been achieved.

The project does not include any on-site renewable energy sources; however, the owner has begun exploring opportunities to enter Green Power purchase agreements with various energy providers in the area. They are also pursuing opportunities within energy measurement and verification techniques that would allow them to monitor their building's performance for years to come.

RD^3 Commissioning, in a partnership with the owner's representative, Tishman AEcom, is exploring available options for enhanced commissioning and refrigerant management plans that will provide the owner with additional building commissioning and energy performance measurement capabilities.

MATERIALS & RESOURCES

To qualify for material & resources accreditation, HOK Interiors designed built-in recycling and trash receptacles throughout the building that facilitate a green mindset of the occupants. Conversely, because the building is new construction, it does not qualify for Building and Material Reuse Credits, eliminating five available LEED credits from the Materials & Resources section. Fortunately, Clark Construction developed construction waste management plans and partnered with a waste sorting facility in the area to ensure that 75% of discarded building materials are diverted from landfills.

HOK's material specification efforts were monumental in the achievement of a 47.6% post-consumer recycled material content throughout the building's finishes. Their efforts also secured a 62.6% regional material benchmark. All specified wood products are FSC certified and were carefully chosen based on durability and sustainable harvesting properties. Ironically, the rapidly renewable materials credit is not being pursued, contrary to the large amount of wood products in the building. This is mainly attributed to the fact that high-end finishes that are not characteristic of tree species with rapid regrowth properties were specified for a number of wood adorned spaces.

INDOOR ENVIRONMENTAL QUALITY

Girard was responsible for securing the indoor environmental quality minimum indoor air quality performance prerequisite by complying both with ASHRAE 62.1 – 2004 for all mechanical systems. In order to maintain a building wide no smoking policy, HOK included designated exterior smoking areas that minimize the reentry of cigarette smoke into the building.

Girard's responsibilities also included outdoor air delivery monitoring systems that respond to CO^2 levels in the building by delivering fresh, outdoor air to densely occupied spaces. They also provided documentation that verifies that outdoor ventilation levels were increased 30% beyond ASHRAE 62.1 requirements in the preliminary ventilation design. Girard's HVAC design will also meet thermal comfort standards in accordance with ASHRAE 55. Girard will also develop a plan that determines whether a full building flush-out will be appropriate at the completion of the project, what the time commitments for this activity would entail, and an approximate cost for performing air quality testing to verify the success of the full building flush-out.
Clark Construction established and maintained a construction indoor air quality management plan that minimizes exhaust and smoke throughout the building. The plan also includes detailed requirements for material handling techniques that maintain ductwork cleanliness, and minimize the time that interior materials are stored outdoors, where they may be subjected to vehicle and equipment exhausts. Clark and the owner also developed a Thermal Comfort verification plan that will take place within the 12 month warranty period after project turnover. If more that 20% of the building's occupants are dissatisfied with the thermal comfort performance of the building, the owner will be responsible for contacting equipment manufactures in order to take corrective actions.

HOK Interiors specified low volatility organic compounds for adhesives, sealants, paints, coatings, flooring systems, composite materials and fiber products. The interior lighting design also features workspace task lighting, occupancy sensors and zoned switching that will minimize the number and intensity of the required lighting fixtures. In a partnership with Girard Engineering, they also addressed the need for increased ventilation and filter systems on janitorial closets and chemical storage rooms by locating these areas near possible air evacuation routes.

Contrary to the amount of glazing present on the building, day lighting and views LEED credits are not being pursued on the project. This may present itself as a viable area of further investigation. With a few minor layout changes, it is possible that at least 75% of the building's occupants could be provided with daylight and views.

INNOVATION & DESIGN PROCESS

There are currently 4 innovative design aspects of the project that are under documentation to obtain LEED credits. In its entirety, the project features 100% tiered parking, pervious paving, or shaded hardscape areas. This qualifies for an Exemplary Performance Innovation in Design credit award.

The previously mentioned low flow plumbing fixtures, coupled with the rainwater retention systems, are expected to account for a 40% reduction in water use for the entire complex. Due to the sheer size of the project, this reduction is monumental and will achieve an innovation in design credit.

Green Housekeeping plans and procedures are being developed by the owner to ensure that environmentally friendly cleaning products are used within the building throughout its lifetime. This ambitious undertaking also qualifies for an innovation in design credit. Additionally, the owner will furnish the complex with Greenguard Certified Furniture systems. Greenguard certifies materials and products that maintain indoor air quality levels through the use of non-volatile chemicals and pollutants[1].

Alternative project innovations have been developed in the event that one of the four aforementioned design innovations are not granted LEED status. Clark Construction has begun documenting the use of the existing central utility plant walls as the exterior walls of the newly construction CUP. This would qualify as an adaptive reuse innovation in design credit. HOK is pursuing the possibility of LEED recognition for the implementation of the rainwater collection pond that will serve as a wetland habitat upon completion.

Combined, the project's design-build team has approximately 35 LEED Accredited Professionals involved with the design and construction of the complex which qualifies for the LEED AP Innovation & Design Process credit.

REFLECTION

Overall, the design-build project team worked collaboratively to develop and plan the LEED credits that are currently under pursuit. Designers, engineers, and the construction management team provided valuable input within their specialized areas of expertise that produced a LEED project plan that will secure a LEED Gold rating for the project. The most notable of the LEED aspects on the project are the rainwater management techniques that are achieved through the widespread use of green roofs, bio-swales, and a rainwater retention pond. Combined, these sustainable aspects will result in a comprehensive rainwater collection and distribution system that will minimize the necessity for the use of treated city water for irrigation purposes. Additionally, the green roofs will limit the heat island effect that is associated with most buildings of this magnitude, furthering their sustainable effects.

BUILDING INFORMATION MODELING EVALUATION

SEE APPENDIX E FOR LEVEL 1 PROCESS MAP AND BIM USE ANALYSIS

BIM USE SUMMARY

Building Information Modeling (BIM) technology was heavily implemented during the schematic design and design development phases to provide the owner with accurate, up-to-date information about the building characteristics that were undergoing development. 3D modeling efforts were practiced by the A/E team as well as the subcontractors who were contracted to produce 3D coordination models that were monumental in minimizing design conflicts prior to the release of contract documents. However, while BIM tools were used throughout the design and coordination phases on the project, this information was not effectively transferred to field operations.

Table #6 – BIM Goals

Priority (1-3)	Goal Description	Potential BIM Uses
1- Most Important	**Value added objectives**	
3	Minimize In-Field Conflicts	3D Coordination, Subcontractor Design Review
3	Minimize Logistic Issues	3D Site Planning, 4D Modeling
1	Operations and Maintenance Information	O&M Compilation, As-Built Drawings
3	Capitalize on Sustainable Aspects	LEED Documentation, Engineering Analysis
2	Rapid Design Change Cost Evaluation	GC/Sub Cost Reviews
1	Educate Tradesmen	In-Field BIM Access

DESIGN PLANNING

WDG Architecture, HOK, Girard Engineering and Cagley Engineering are all very proficient with building modeling and analysis technology. Throughout the process of developing a building design from bridging documents provided by Perkins + Will, WDG Architecture and HOK continually updated their architectural and landscape models in order to maintain a complete understanding of the ramifications of each and every design addition or modification. These models also provided a means of conveying design decisions and details to the owner, owner's representative and future tenant, who could evaluate these decisions based upon their programming needs and desires. The ability to effectively communicate the nature of the interior and exterior spaces proved monumental in making the design-build team's task of incorporating stakeholder ideas and desires into the final design of the office building complex. The design team utilized Revit Architecture to produce easily read and understood graphics that were regularly used during owner and tenant design meetings. Due to the fact that Revit Architecture is the widely accepted industry norm for

building information modeling, the design and engineering teams were able to establish a central file that allowed each team to work on the model simultaneously, as well as see the updates and changes being made by one another in a real-time environment. These models not only helped evaluate and incorporate owner input regarding the building design, but also assisted the engineering team during their initial system design processes. 3D architectural models of the building proved extremely useful in maximizing system layout efficiency, as well as addressing space constraints and concerns early in the design phase.

Cagley & Associates, the structural designer on the project, utilized various structural modeling programs to design the structural concrete foundations and elevated structures. Their implementation of BIM not only provided valuable design assistance that alleviated the complexity of designing for blast loads and the other structural concerns presented by the owner during design meetings, but also produced 3D models that were incorporated into the architectural model for an in-depth understanding of spatial limitations. The ability to combine the structural and architectural models led to numerous discoveries that demanded changes to the architectural features, as well as unique structural solutions that remediated potential sources of conflict. For example, it was discovered that in order to meet blast resistance requirements on the Child Care Area, which is considered a "Level 3" potential threat area due to its proximity to the entrance road as well as the nature of the majority of its occupants (young children), the blast resistance properties of curtain walls would not be adequate with a normal concrete structure to provide the level of protection required. Alternatively, Cagley proposed that this area be constructed of smaller window units that could be affixed to the concrete edge beams with oversized shock absorbers (See Figures #9 and #10) that would result in an increased level of protection from explosive attacks.

Figure #9 – Aluminum & Neoprene Blast Isolator

Figure #10 – Child Care Area

Girard Engineering utilized building information modeling for mechanical analyses of the building's architectural spaces. By importing the architectural model into Trane Trace, Girard was able to evaluate the energy efficiency of the building, ultimately allowing them to design the mechanical system in a manner concurrent with the project's LEED goals. Energy modeling is essentially a prerequisite for the analyses required for proper LEED documentation and accreditation. Additionally, Girard provided 3D models of their preliminary mechanical system designs that were incorporated into the architectural and structural models for a further understanding of the dynamic relationships between the building systems.

LOGISTICS PLANNING

Clark Construction primarily utilized 2D construction documents for their logistics planning efforts. Subcontractor input was incorporated into the site layout plans for each phase of the project construction. Figure #11 shows tower crane layouts and swing radiuses that were developed by Clark Construction and Clark Concrete to address staging and space constraint concerns associated with the structural concrete phase of construction. The plan incorporated the locations as well as a combination of the sizes and swing radii of the various cranes owned by Clark Logistics that could be used on the project. The plan allowed for a thorough investigation of the possible combinations of crane sizes and locations that eventually led to a finalized tower crane plan that was used on the project.

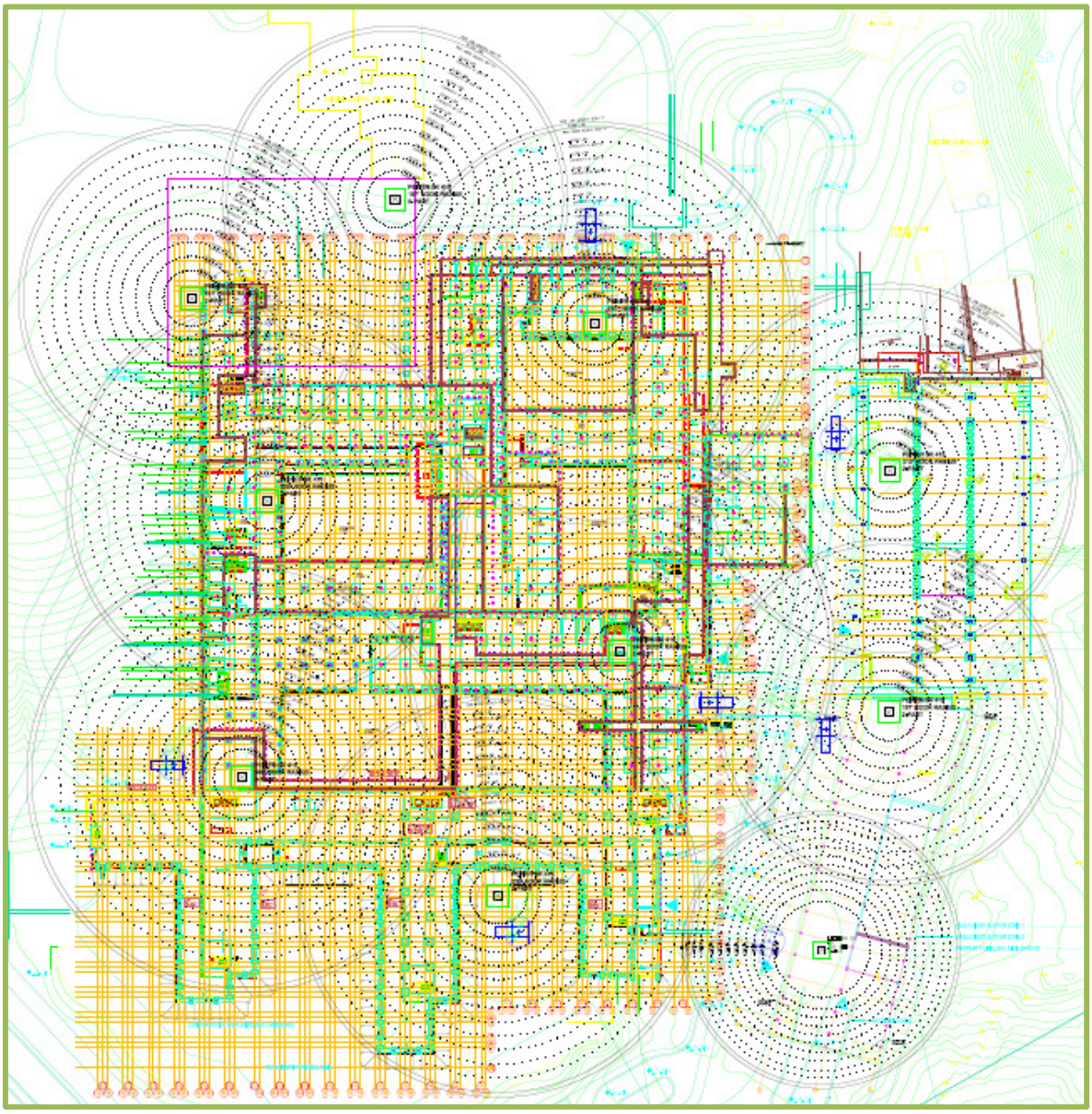


Figure #11 – Tower Crane Size and Location Investigation

Minimal 4D modeling was implemented, mainly due to the experience levels of the superintendent staff, who were more comfortable using traditional planning methods over the modeling technology intense 4D planning methods. However, in-house, prior to being awarded the project, Clark Construction's preconstruction team assembled a 4D model that was used to create an animation of the planned project schedule and site logistic layouts. This animation assisted Clark Construction in its attempt to win the project contract.

COST EVALUATION

While minimal cost loading was incorporated into the building models, the accuracy of the models regarding all approved and potential changes was maintained throughout the project duration. This made rapid estimating of proposed changes possible through the ability to create drawings, view 3D sections and details, and quickly analyze all of the potential effects on the surrounding building systems. Upon proposing a change to the contract documents, the owner and tenant were swiftly provided with cost and schedule estimates that allowed them to make educated decisions on whether or not to proceed with the change.

COORDINATION

In addition to the preliminary design modeling completed by the A/E team, subcontractors were contracted to provide 3D Navisworks models of their complete systems that were utilized by John J. Kirlin (the mechanical contractor) to assemble total system layouts and analyze areas requiring further coordination. Once all of the mechanical and electrical models were combined, Kirlin was responsible for making minor changes that permitted all of the systems to be installed without conflict. The fire protection and electrical contractors were then required to review these coordination documents and make comments on the alterations proposed by Kirlin. If all of the coordination-based changes were deemed satisfactory, these subcontractors would sign off on the drawings and they were sent to the engineering team for further analysis. If the coordinated systems maintained design intent and engineering requirements, they were approved and released as official construction documents. These approved drawings then became the basis upon which the field staff installed their work.

SUSTAINABILITY

As previously mentioned, Girard Engineering implemented Trane Trace for their LEED analysis on the building's mechanical systems. Additionally, HOK and WDG Architecture coordinated their landscape and architectural models to provide shading in hardscaped areas as to minimize the heat island effects of the building complex. Clark Construction utilized the architectural models to determine appropriate areas for material laydown that would minimize the contamination of said materials from construction vehicle exhaust.

CONSTRUCTION

Although building information modeling technologies were heavily implemented during the design and planning stages of the project, these efforts, aside from coordination drawing production, were not effectively transferred to the field. Aside from 2D coordination drawings that were distributed to field personnel, the existence of fully coordinated NavisWorks models was entirely overlooked. As with all "coordinated" drawings, conflicts still existed, whether they were the result of poor coordination or improper installation of materials. Rather than reference the coordinated model, contractors commonly disputed over the 2D coordination drawings instead. Very rarely was the NavisWorks model utilized to determine the source of the conflict.

Occasionally, the architectural model was used to explain assembly details to tradesmen who were having difficulties understanding the manner in which the architects and engineers intended their systems to be installed or assembled. On these occasions, 3D sections and details were used to educate the tradesmen on the proper manner in which to install their work.

TURNOVER

While the most recent 3D architectural, engineering and coordination models will be turned over to the owner at the conclusion of the project, no efforts were made to embed these models with detailed information regarding the systems and equipment contained within the building. The most accurate as-built drawings are two-dimensional and contain detailed surveying information obtained by the Clark surveying team. The as-built drawings focus on the structural and façade systems, although some information is included regarding the location of major mechanical and electrical equipment. As-built system details are contained within the approved coordination drawings, although some of those details may vary slightly depending on the existence and magnitude of any in-field coordination remediation.

EVALUATION

From a design standpoint, the use of building information modeling techniques was very appropriate for the project's size, scope and owner requirements. The maintenance of accurate virtual models assisted in numerous project development aspects including ease of owner input, rapid cost estimations, and a comprehensive understanding of the ways that design decisions affected the architectural and engineered features of the structure.

Throughout the project planning process, 2D building and site plans and subcontractor assistance allowed the logistics personnel to effectively plan the progression of work throughout the project timeline.

Additional subcontractor support during throughout coordination efforts aided in effectively analyzing the interdependencies and relationships between the mechanical, electrical, plumbing and fire protection systems. This comprehensive approach to planning the system layouts minimized in-field coordination issues, allowing for an efficient and rapid installation of the building systems which was crucial to maintaining the project schedule.

Unfortunately, the NavisWorks model created by J. J. Kirlin that incorporated all of the MEP subcontractors' systems into a complete coordination model was widely underutilized. As previously mentioned, most conflicts were resolved through the use of the 2D coordination drawings which were more often than not cluttered and not easily understood. The NavisWorks model was rarely referenced primarily because of the technologically inexperienced subcontractor field staff. If each subcontractor had designated a technologically competent individual as their point of contact for resolving in-field coordination conflicts, the Navis model could have been readily available and easily accessed in the event of a conflict occurrence. The location and elevation of the conflict could be quickly located and the 3D model could be analyzed in an attempt to pinpoint the cause of the conflict and establish possible resolutions in an extremely efficient manner. Instead, time was wasted trying to decipher the 2D versions of the model and come up with an agreeable solution that everyone assumed would maintain design intents and requirements.

Once field application of building information modeling that was particular helpful in the understanding of various curtain wall and masonry intersection details was the use of 3D sections and details taken from the architectural and structural models. In order to convey the details associated with waterproofing the complex joints between masonry and glazing installations, the architectural and façade models were used to provide subcontractors with highly readable 3D examples of these locations. This helped the tradesmen understand exactly what was expected of them and resulted in workmanship quality that frequently exceeded design requirements and helped minimize issues associated with improper waterproofing techniques and poor installation execution. Figure #12 shows an example of one such problem area that was addressed through the use of 3D section models.

Figure #12 – Expansion Joint Waterproofing

BIBLIOGRAPHY

1.) Greenguard. "Greenguard Environmental Institute." *GREENGUARD Environmental Institute - Certifying Low-Emitting Products, Creating Healthier Indoor Environments*. Greenguard Environmental Institute, 2011. Web. 17 Oct. 2011. <http://www.greenguard.org/en/index.aspx>.Greenguard certifies materials and products that maintain indoor air quality levels through the use of non-volatile chemicals and pollutants.

APPENDIX A – DETAILED PROJECT SCHEDULE

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Notice to Proceed	0 days	Mon 8/31/09	Mon 8/31/09
Design/Coordination	**520 days**	**Mon 9/7/09**	**Fri 9/2/11**
Design	260 days	Mon 9/7/09	Fri 9/3/10
Preliminary Design Complete	0 days	Fri 9/3/10	Fri 9/3/10
Coordination	265 days	Mon 8/30/10	Fri 9/2/11
Preliminary Coordination Complete	0 days	Fri 9/2/11	Fri 9/2/11
Planning/Permitting	85 days	Mon 9/7/09	Fri 1/1/10
Procurement	520 days	Mon 9/7/09	Fri 9/2/11
Building 1 Excavation/Prep	**201 days**	**Mon 2/8/10**	**Mon 11/15/10**
Site Access/Utilities	123 days	Mon 2/8/10	Wed 7/28/10
Clear and Grub	20 days	Mon 5/10/10	Fri 6/4/10
Drive External Sheeting Piles	21 days	Mon 5/24/10	Mon 6/21/10
Excavate To Level 9	69 days	Mon 6/21/10	Thu 9/23/10
Drive Internal Sheeting Piles	12 days	Thu 9/23/10	Fri 10/8/10
Drill/Test Tiebacks	21 days	Thu 9/23/10	Thu 10/21/10
Install U/G Plumbing	31 days	Thu 9/23/10	Thu 11/4/10
Install U/G Electric	31 days	Thu 9/23/10	Thu 11/4/10
Remove Tie-Back Benches	5 days	Mon 11/1/10	Fri 11/5/10
Backfill U/G Utilities	6 days	Mon 11/8/10	Mon 11/15/10
Building 1 - Structure	**123 days**	**Thu 7/1/10**	**Mon 12/20/10**
Building 1 - Lower Level 9	**69 days**	**Thu 7/1/10**	**Tue 10/5/10**
Install Tower Crane Bases B1 LL9	16 days	Thu 7/1/10	Thu 7/22/10
Erect Cranes B1 LL9	5 days	Fri 7/23/10	Thu 7/29/10
Pile Caps B1 LL9	15 days	Wed 7/28/10	Tue 8/17/10
Grade Beams B1 LL9	15 days	Tue 8/17/10	Mon 9/6/10
Mat Slabs B1 LL9	15 days	Mon 8/2/10	Fri 8/20/10
Elev. Pits B1 LL9	15 days	Mon 8/9/10	Fri 8/27/10
Walls & Columns B1 LL9	40 days	Mon 8/9/10	Fri 10/1/10
U/G Plumbing B1 LL9	30 days	Wed 8/11/10	Tue 9/21/10
U/G Electric B1 LL9	30 days	Wed 8/11/10	Tue 9/21/10
SOG B1 LL9	30 days	Wed 8/25/10	Tue 10/5/10
Building 1 - Lower Level 8	**40 days**	**Wed 9/1/10**	**Tue 10/26/10**
Level 8 B1	40 days	Wed 9/1/10	Tue 10/26/10
Walls & Columns to Level 7 B1	10 days	Thu 9/16/10	Wed 9/29/10
Building 1 - Lower Level 7	**39 days**	**Thu 9/30/10**	**Tue 11/23/10**
Level 7 B1	35 days	Thu 9/30/10	Wed 11/17/10
Walls & Columns to Level 6 B1	10 days	Wed 11/10/10	Tue 11/23/10
Building 1 - Lower Level 6	**20 days**	**Tue 11/23/10**	**Mon 12/20/10**
Level 6 B1	20 days	Tue 11/23/10	Mon 12/20/10

Project: Summary Schedule
Date: Mon 10/17/11

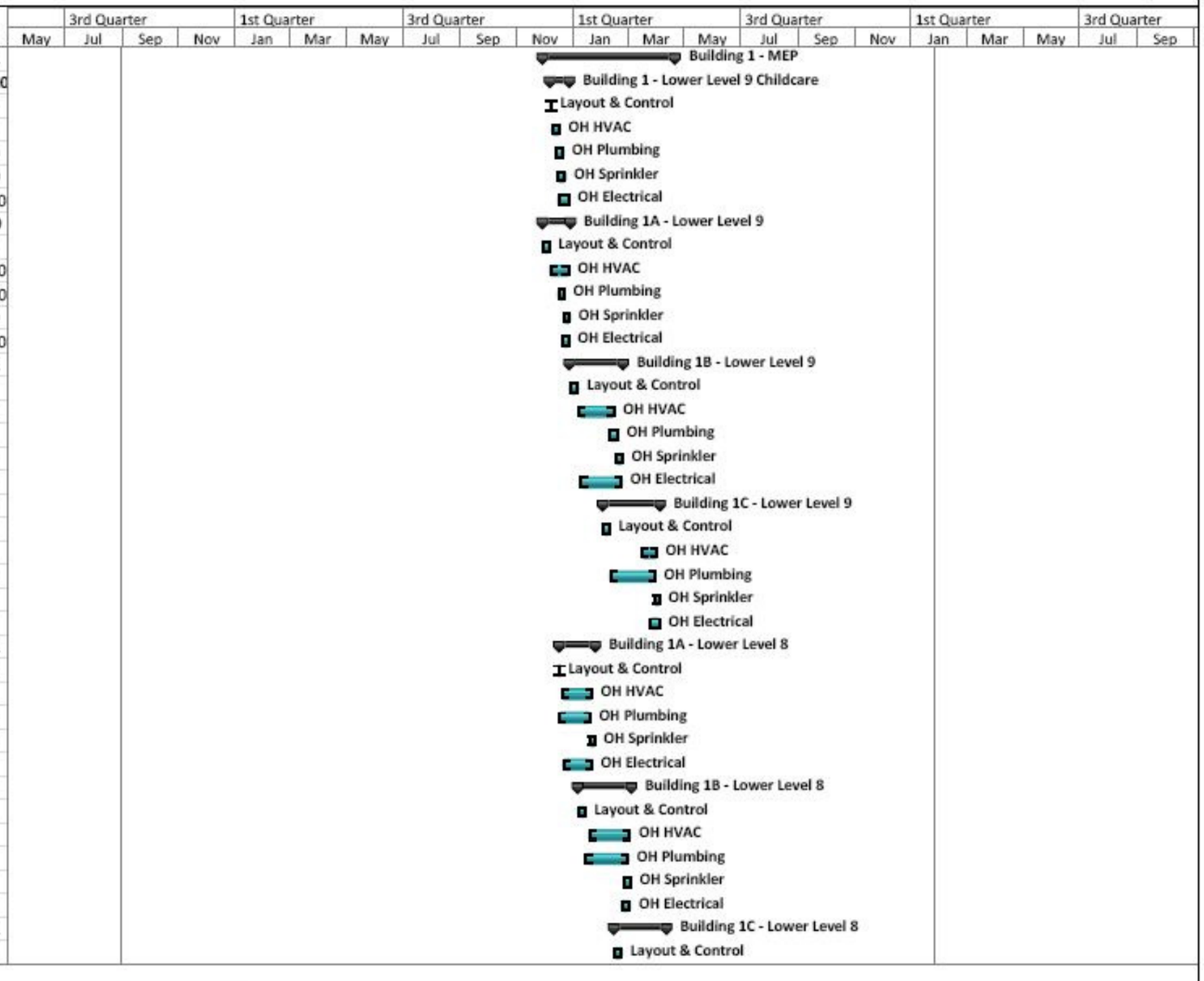
Milestone ◆ Summary ▬ Manual Task ▬

Page 1

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Building 1 - MEP	**103 days**	**Mon 11/29/10**	**Wed 4/20/11**
Building 1 - Lower Level 9 Childcare	**15 days**	**Tue 12/7/10**	**Mon 12/27/10**
Layout & Control	2 days	Tue 12/7/10	Wed 12/8/10
OH HVAC	7 days	Thu 12/9/10	Fri 12/17/10
OH Plumbing	7 days	Mon 12/13/10	Tue 12/21/10
OH Sprinkler	7 days	Wed 12/15/10	Thu 12/23/10
OH Electrical	8 days	Thu 12/16/10	Mon 12/27/10
Building 1A - Lower Level 9	**22 days**	**Mon 11/29/10**	**Tue 12/28/10**
Layout & Control	6 days	Mon 11/29/10	Mon 12/6/10
OH HVAC	15 days	Tue 12/7/10	Mon 12/27/10
OH Plumbing	5 days	Thu 12/16/10	Wed 12/22/10
OH Sprinkler	5 days	Wed 12/22/10	Tue 12/28/10
OH Electrical	6 days	Mon 12/20/10	Mon 12/27/10
Building 1B - Lower Level 9	**42 days**	**Tue 12/28/10**	**Wed 2/23/11**
Layout & Control	8 days	Tue 12/28/10	Thu 1/6/11
OH HVAC	27 days	Fri 1/7/11	Mon 2/14/11
OH Plumbing	8 days	Wed 2/9/11	Fri 2/18/11
OH Sprinkler	6 days	Wed 2/16/11	Wed 2/23/11
OH Electrical	33 days	Sun 1/9/11	Tue 2/22/11
Building 1C - Lower Level 9	**44 days**	**Wed 2/2/11**	**Mon 4/4/11**
Layout & Control	6 days	Wed 2/2/11	Wed 2/9/11
OH HVAC	13 days	Wed 3/16/11	Fri 4/1/11
OH Plumbing	35 days	Thu 2/10/11	Wed 3/30/11
OH Sprinkler	4 days	Wed 3/30/11	Mon 4/4/11
OH Electrical	7 days	Fri 3/25/11	Mon 4/4/11
Building 1A - Lower Level 8	**27 days**	**Fri 12/17/10**	**Mon 1/24/11**
Layout & Control	1 day	Fri 12/17/10	Fri 12/17/10
OH HVAC	25 days	Mon 12/20/10	Fri 1/21/11
OH Plumbing	24 days	Fri 12/17/10	Wed 1/19/11
OH Sprinkler	4 days	Wed 1/19/11	Mon 1/24/11
OH Electrical	24 days	Tue 12/21/10	Fri 1/21/11
Building 1B - Lower Level 8	**42 days**	**Thu 1/6/11**	**Fri 3/4/11**
Layout & Control	7 days	Thu 1/6/11	Fri 1/14/11
OH HVAC	33 days	Tue 1/18/11	Thu 3/3/11
OH Plumbing	33 days	Fri 1/14/11	Tue 3/1/11
OH Sprinkler	6 days	Fri 2/25/11	Fri 3/4/11
OH Electrical	8 days	Tue 2/22/11	Thu 3/3/11
Building 1C - Lower Level 8	**41 days**	**Mon 2/14/11**	**Mon 4/11/11**
Layout & Control	7 days	Mon 2/14/11	Tue 2/22/11



Project: Summary Schedule
Date: Mon 10/17/11

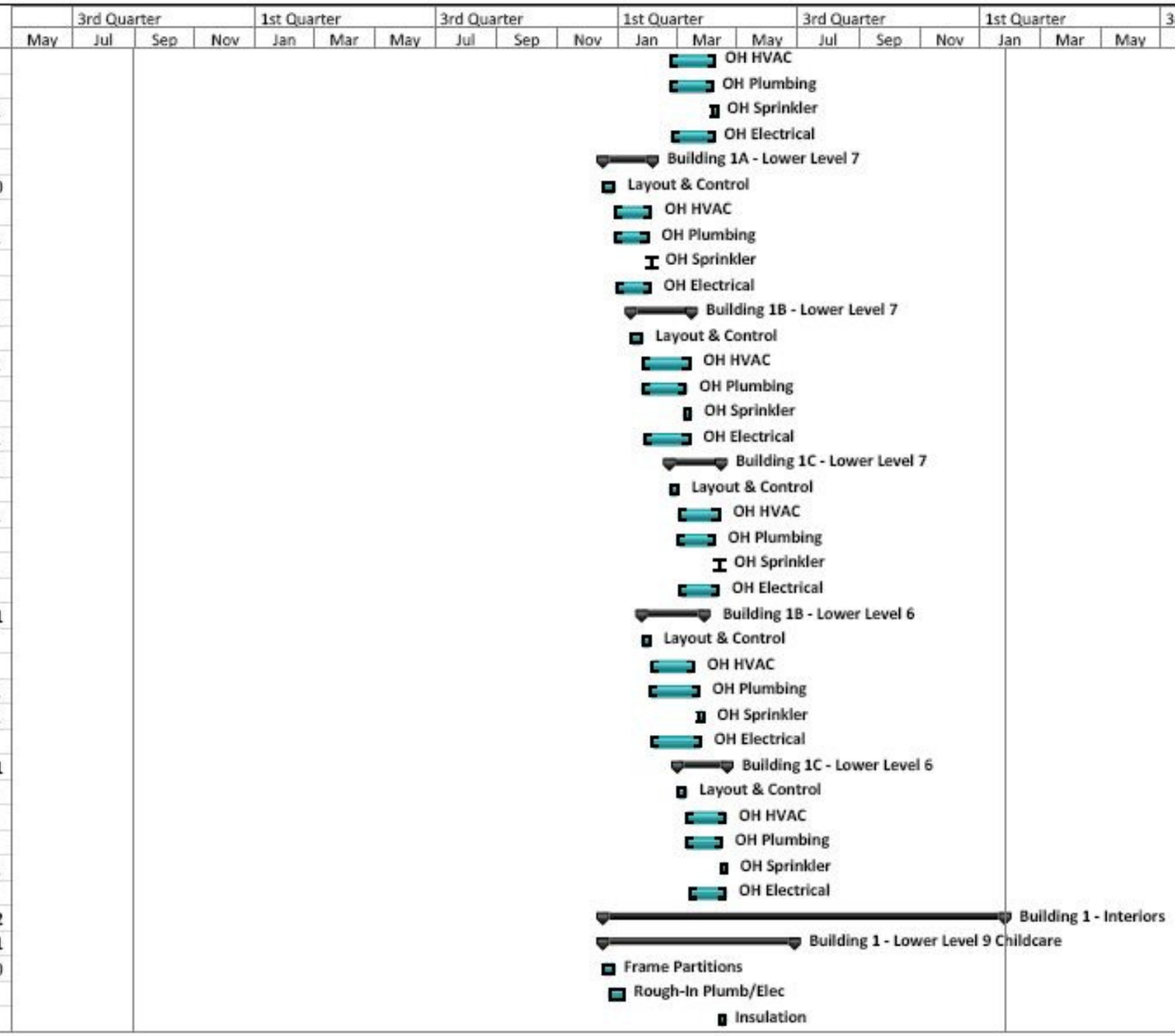
Milestone ◆ Summary Manual Task

Page 2

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
OH HVAC	33 days	Wed 2/23/11	Fri 4/8/11
OH Plumbing	32 days	Tue 2/22/11	Wed 4/6/11
OH Sprinkler	4 days	Wed 4/6/11	Mon 4/11/11
OH Electrical	32 days	Thu 2/24/11	Fri 4/8/11
Building 1A - Lower Level 7	**36 days**	**Fri 12/17/10**	**Fri 2/4/11**
Layout & Control	8 days	Fri 12/17/10	Tue 12/28/10
OH HVAC	27 days	Wed 12/29/10	Thu 2/3/11
OH Plumbing	25 days	Tue 12/28/10	Mon 1/31/11
OH Sprinkler	2 days	Thu 2/3/11	Fri 2/4/11
OH Electrical	25 days	Thu 12/30/10	Wed 2/2/11
Building 1B - Lower Level 7	**43 days**	**Fri 1/14/11**	**Tue 3/15/11**
Layout & Control	8 days	Fri 1/14/11	Tue 1/25/11
OH HVAC	34 days	Wed 1/26/11	Mon 3/14/11
OH Plumbing	33 days	Tue 1/25/11	Thu 3/10/11
OH Sprinkler	6 days	Tue 3/8/11	Tue 3/15/11
OH Electrical	33 days	Thu 1/27/11	Mon 3/14/11
Building 1C - Lower Level 7	**38 days**	**Tue 2/22/11**	**Thu 4/14/11**
Layout & Control	7 days	Tue 2/22/11	Wed 3/2/11
OH HVAC	30 days	Thu 3/3/11	Wed 4/13/11
OH Plumbing	28 days	Wed 3/2/11	Fri 4/8/11
OH Sprinkler	2 days	Wed 4/13/11	Thu 4/14/11
OH Electrical	28 days	Fri 3/4/11	Tue 4/12/11
Building 1B - Lower Level 6	**45 days**	**Tue 1/25/11**	**Mon 3/28/11**
Layout & Control	7 days	Tue 1/25/11	Wed 2/2/11
OH HVAC	32 days	Thu 2/3/11	Fri 3/18/11
OH Plumbing	36 days	Wed 2/2/11	Wed 3/23/11
OH Sprinkler	4 days	Wed 3/23/11	Mon 3/28/11
OH Electrical	36 days	Fri 2/4/11	Fri 3/25/11
Building 1C - Lower Level 6	**36 days**	**Wed 3/2/11**	**Wed 4/20/11**
Layout & Control	7 days	Wed 3/2/11	Thu 3/10/11
OH HVAC	28 days	Fri 3/11/11	Tue 4/19/11
OH Plumbing	27 days	Thu 3/10/11	Fri 4/15/11
OH Sprinkler	4 days	Fri 4/15/11	Wed 4/20/11
OH Electrical	27 days	Mon 3/14/11	Tue 4/19/11
Building 1 - Interiors	**289 days**	**Fri 12/17/10**	**Wed 1/25/12**
Building 1 - Lower Level 9 Childcare	**137 days**	**Fri 12/17/10**	**Mon 6/27/11**
Frame Partitions	8 days	Fri 12/17/10	Tue 12/28/10
Rough-In Plumb/Elec	12 days	Thu 12/23/10	Fri 1/7/11
Insulation	5 days	Wed 4/13/11	Tue 4/19/11



Project: Summary Schedule
Date: Mon 10/17/11

Milestone ◆ Summary Manual Task

Page 3

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Close-In Inspection	1 day	Wed 4/20/11	Wed 4/20/11
Hang/Finish Partitions	14 days	Thu 4/21/11	Tue 5/10/11
Prime Paint	5 days	Thu 5/5/11	Wed 5/11/11
Set Door Frames	5 days	Fri 5/6/11	Thu 5/12/11
Install Ceiling Grid	10 days	Tue 5/10/11	Mon 5/23/11
HVAC/Lights at Grid	7 days	Tue 5/17/11	Wed 5/25/11
Sprinkler Drops	8 days	Thu 5/26/11	Mon 6/6/11
Casework	10 days	Tue 5/31/11	Mon 6/13/11
Ceiling Close-In Inspection	1 day	Tue 6/7/11	Tue 6/7/11
Drop Ceiling Tile	5 days	Wed 6/8/11	Tue 6/14/11
Install Doors & Hardware	11 days	Mon 6/13/11	Mon 6/27/11
Plumbing Fixtures	7 days	Fri 6/10/11	Mon 6/20/11
Final Paint	5 days	Mon 6/13/11	Fri 6/17/11
Wall Trims	5 days	Thu 6/16/11	Wed 6/22/11
Floor Finishes	7 days	Fri 6/17/11	Mon 6/27/11
Air Balance	3 days	Tue 6/21/11	Thu 6/23/11
Punchlist	1 day	Fri 6/24/11	Fri 6/24/11
Building 1A - Lower Level 9	**225 days**	**Mon 1/10/11**	**Fri 11/18/11**
Frame Partitions	72 days	Mon 1/10/11	Tue 4/19/11
Rough-In Plumb/Elec	74 days	Tue 1/11/11	Fri 4/22/11
Insulation	5 days	Tue 4/26/11	Sat 4/30/11
Close-In Inspection	1 day	Tue 4/26/11	Tue 4/26/11
Hang/Finish Partitions	16 days	Wed 4/13/11	Wed 5/4/11
Prime Paint	3 days	Fri 10/7/11	Tue 10/11/11
Set Door Frames	2 days	Tue 5/3/11	Wed 5/4/11
Install Ceiling Grid	4 days	Thu 4/14/11	Tue 4/19/11
HVAC/Lights at Grid	4 days	Fri 4/15/11	Wed 4/20/11
Sprinkler Drops	4 days	Fri 4/15/11	Wed 4/20/11
Casework	5 days	Mon 10/24/11	Fri 10/28/11
Ceiling Close-In Inspection	1 day	Tue 9/27/11	Tue 9/27/11
Drop Ceiling Tile	2 days	Tue 10/11/11	Wed 10/12/11
Install Doors & Hardware	4 days	Tue 10/25/11	Fri 10/28/11
Plumbing Fixtures	4 days	Mon 10/17/11	Thu 10/20/11
Final Paint	2 days	Fri 10/21/11	Mon 10/24/11
Wall Trims	4 days	Tue 10/25/11	Fri 10/28/11
Floor Finishes	2 days	Fri 10/28/11	Mon 10/31/11
Air Balance	6 days	Wed 11/9/11	Wed 11/16/11
Punchlist	2 days	Thu 11/17/11	Fri 11/18/11
Building 1B - Lower Level 9	**225 days**	**Thu 2/24/11**	**Wed 1/4/12**

Project: Summary Schedule
Date: Mon 10/17/11

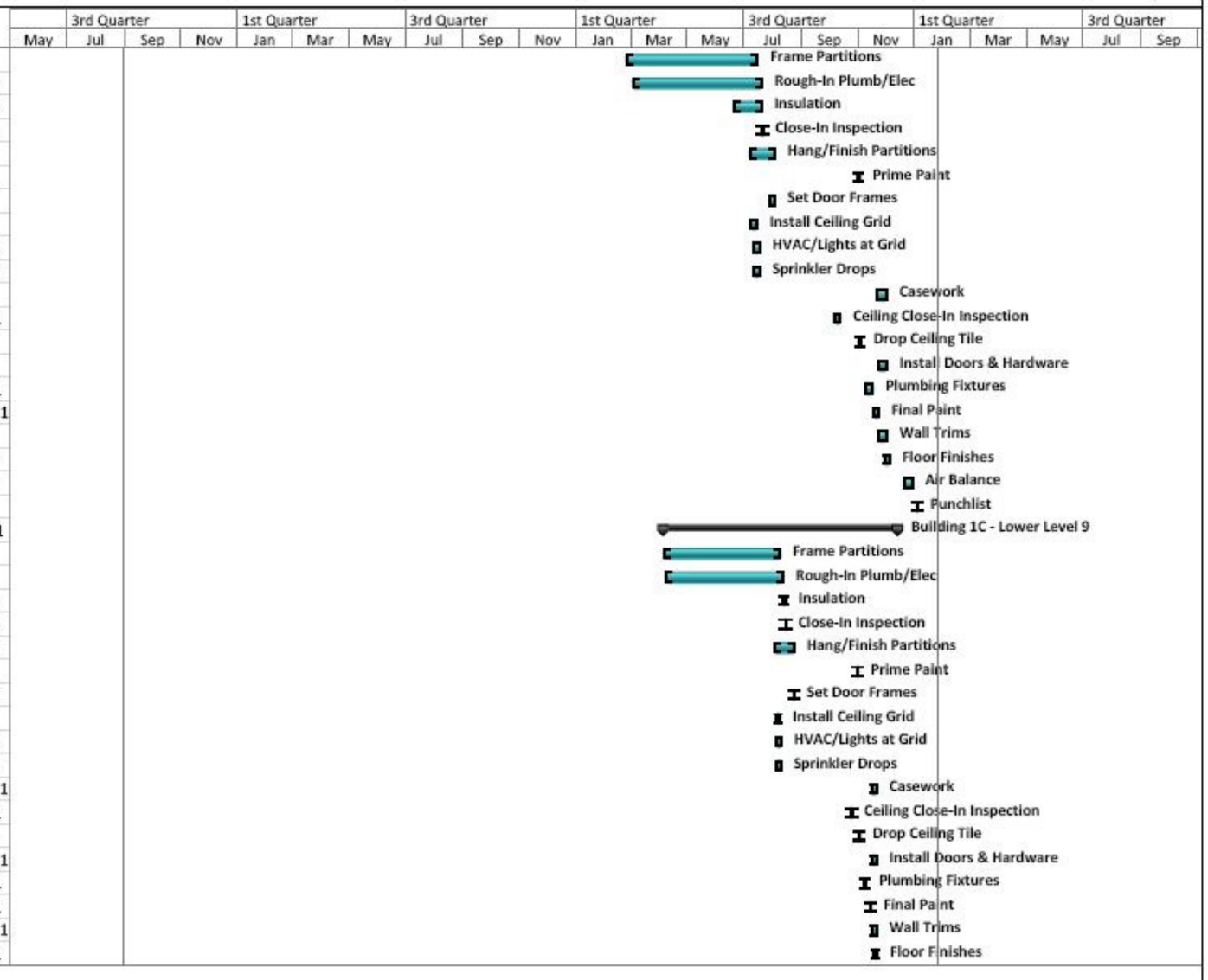
Milestone ◆ Summary Manual Task

Page 4

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Frame Partitions	102 days	Thu 2/24/11	Fri 7/15/11
Rough-In Plumb/Elec	100 days	Thu 3/3/11	Wed 7/20/11
Insulation	23 days	Mon 6/20/11	Wed 7/20/11
Close-In Inspection	1 day	Thu 7/21/11	Thu 7/21/11
Hang/Finish Partitions	20 days	Thu 7/7/11	Wed 8/3/11
Prime Paint	4 days	Mon 10/31/11	Thu 11/3/11
Set Door Frames	4 days	Fri 7/29/11	Wed 8/3/11
Install Ceiling Grid	6 days	Fri 7/8/11	Fri 7/15/11
HVAC/Lights at Grid	6 days	Mon 7/11/11	Mon 7/18/11
Sprinkler Drops	6 days	Mon 7/11/11	Mon 7/18/11
Casework	10 days	Mon 11/21/11	Fri 12/2/11
Ceiling Close-In Inspection	5 days	Fri 10/7/11	Thu 10/13/11
Drop Ceiling Tile	4 days	Tue 11/1/11	Fri 11/4/11
Install Doors & Hardware	8 days	Wed 11/23/11	Fri 12/2/11
Plumbing Fixtures	7 days	Wed 11/9/11	Thu 11/17/11
Final Paint	4 days	Fri 11/18/11	Wed 11/23/11
Wall Trims	8 days	Wed 11/23/11	Fri 12/2/11
Floor Finishes	5 days	Tue 11/29/11	Mon 12/5/11
Air Balance	9 days	Tue 12/20/11	Fri 12/30/11
Punchlist	2 days	Tue 1/3/12	Wed 1/4/12
Building 1C - Lower Level 9	**181 days**	**Tue 4/5/11**	**Tue 12/13/11**
Frame Partitions	91 days	Tue 4/5/11	Tue 8/9/11
Rough-In Plumb/Elec	91 days	Fri 4/8/11	Fri 8/12/11
Insulation	2 days	Fri 8/12/11	Mon 8/15/11
Close-In Inspection	1 day	Mon 8/15/11	Mon 8/15/11
Hang/Finish Partitions	16 days	Wed 8/3/11	Wed 8/24/11
Prime Paint	2 days	Mon 10/31/11	Tue 11/1/11
Set Door Frames	2 days	Tue 8/23/11	Wed 8/24/11
Install Ceiling Grid	4 days	Thu 8/4/11	Tue 8/9/11
HVAC/Lights at Grid	4 days	Fri 8/5/11	Wed 8/10/11
Sprinkler Drops	4 days	Fri 8/5/11	Wed 8/10/11
Casework	5 days	Tue 11/15/11	Mon 11/21/11
Ceiling Close-In Inspection	1 day	Tue 10/25/11	Tue 10/25/11
Drop Ceiling Tile	3 days	Tue 11/1/11	Thu 11/3/11
Install Doors & Hardware	4 days	Wed 11/16/11	Mon 11/21/11
Plumbing Fixtures	4 days	Mon 11/7/11	Thu 11/10/11
Final Paint	2 days	Mon 11/14/11	Tue 11/15/11
Wall Trims	4 days	Wed 11/16/11	Mon 11/21/11
Floor Finishes	3 days	Fri 11/18/11	Tue 11/22/11



Project: Summary Schedule
Date: Mon 10/17/11

Milestone ◆ Summary Manual Task

Page 5

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Air Balance	5 days	Mon 12/5/11	Fri 12/9/11
Punchlist	2 days	Mon 12/12/11	Tue 12/13/11
Building 1A - Lower Level 8	**221 days**	**Tue 1/25/11**	**Tue 11/29/11**
Frame Partitions	66 days	Tue 1/25/11	Tue 4/26/11
Rough-In Plumb/Elec	66 days	Fri 1/28/11	Fri 4/29/11
Insulation	9 days	Wed 4/20/11	Sun 5/1/11
Close-In Inspection	1 day	Mon 5/2/11	Mon 5/2/11
Hang/Finish Partitions	128 days	Wed 4/20/11	Fri 10/14/11
Prime Paint	2 days	Thu 10/13/11	Fri 10/14/11
Set Door Frames	2 days	Wed 5/11/11	Thu 5/12/11
Install Ceiling Grid	4 days	Thu 4/21/11	Tue 4/26/11
HVAC/Lights at Grid	4 days	Fri 4/22/11	Wed 4/27/11
Sprinkler Drops	4 days	Fri 4/22/11	Wed 4/27/11
Casework	5 days	Mon 10/31/11	Fri 11/4/11
Ceiling Close-In Inspection	2 days	Thu 10/6/11	Fri 10/7/11
Drop Ceiling Tile	2 days	Fri 10/14/11	Mon 10/17/11
Install Doors & Hardware	4 days	Tue 11/1/11	Fri 11/4/11
Plumbing Fixtures	4 days	Thu 10/20/11	Tue 10/25/11
Final Paint	2 days	Wed 10/26/11	Thu 10/27/11
Wall Trims	4 days	Tue 11/1/11	Fri 11/4/11
Floor Finishes	3 days	Thu 11/3/11	Mon 11/7/11
Air Balance	5 days	Thu 11/17/11	Wed 11/23/11
Punchlist	2 days	Mon 11/28/11	Tue 11/29/11
Building 1B - Lower Level 8	**224 days**	**Mon 3/7/11**	**Thu 1/12/12**
Frame Partitions	101 days	Mon 3/7/11	Mon 7/25/11
Rough-In Plumb/Elec	99 days	Mon 3/14/11	Thu 7/28/11
Insulation	8 days	Mon 8/1/11	Wed 8/10/11
Close-In Inspection	2 days	Fri 7/29/11	Mon 8/1/11
Hang/Finish Partitions	22 days	Fri 7/15/11	Mon 8/15/11
Prime Paint	5 days	Thu 11/10/11	Wed 11/16/11
Set Door Frames	4 days	Wed 8/10/11	Mon 8/15/11
Install Ceiling Grid	6 days	Mon 7/18/11	Mon 7/25/11
HVAC/Lights at Grid	6 days	Tue 7/19/11	Tue 7/26/11
Sprinkler Drops	6 days	Tue 7/19/11	Tue 7/26/11
Casework	7 days	Mon 12/5/11	Tue 12/13/11
Ceiling Close-In Inspection	4 days	Wed 10/26/11	Mon 10/31/11
Drop Ceiling Tile	4 days	Mon 11/14/11	Thu 11/17/11
Install Doors & Hardware	6 days	Tue 12/6/11	Tue 12/13/11
Plumbing Fixtures	8 days	Tue 11/22/11	Thu 12/1/11

Project: Summary Schedule
Date: Mon 10/17/11

Milestone ◆ Summary Manual Task

Page 6

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Final Paint	4 days	Fri 12/2/11	Wed 12/7/11
Wall Trims	6 days	Tue 12/6/11	Tue 12/13/11
Floor Finishes	5 days	Thu 12/8/11	Wed 12/14/11
Air Balance	8 days	Fri 12/30/11	Tue 1/10/12
Punchlist	2 days	Wed 1/11/12	Thu 1/12/12
Building 1C - Lower Level 8	**183 days**	**Tue 4/12/11**	**Thu 12/22/11**
Frame Partitions	91 days	Tue 4/12/11	Tue 8/16/11
Rough-In Plumb/Elec	91 days	Fri 4/15/11	Fri 8/19/11
Insulation	8 days	Tue 8/23/11	Thu 9/1/11
Close-In Inspection	2 days	Mon 8/22/11	Tue 8/23/11
Hang/Finish Partitions	67 days	Wed 8/10/11	Thu 11/10/11
Prime Paint	2 days	Wed 11/9/11	Thu 11/10/11
Set Door Frames	2 days	Wed 8/31/11	Thu 9/1/11
Install Ceiling Grid	4 days	Thu 8/11/11	Tue 8/16/11
HVAC/Lights at Grid	4 days	Fri 8/12/11	Wed 8/17/11
Sprinkler Drops	4 days	Fri 8/12/11	Wed 8/17/11
Casework	5 days	Mon 11/28/11	Fri 12/2/11
Ceiling Close-In Inspection	2 days	Thu 11/3/11	Fri 11/4/11
Drop Ceiling Tile	3 days	Thu 11/10/11	Mon 11/14/11
Install Doors & Hardware	4 days	Tue 11/29/11	Fri 12/2/11
Plumbing Fixtures	4 days	Thu 11/17/11	Tue 11/22/11
Final Paint	4 days	Wed 11/23/11	Mon 11/28/11
Wall Trims	4 days	Tue 11/29/11	Fri 12/2/11
Floor Finishes	3 days	Thu 12/1/11	Mon 12/5/11
Air Balance	5 days	Wed 12/14/11	Tue 12/20/11
Punchlist	2 days	Wed 12/21/11	Thu 12/22/11
Building 1A - Lower Level 7	**212 days**	**Wed 2/9/11**	**Thu 12/1/11**
Frame Partitions	63 days	Wed 2/9/11	Fri 5/6/11
Rough-In Plumb/Elec	63 days	Fri 2/11/11	Tue 5/10/11
Insulation	6 days	Fri 5/13/11	Fri 5/20/11
Close-In Inspection	2 days	Thu 5/12/11	Fri 5/13/11
Hang/Finish Partitions	18 days	Wed 4/27/11	Fri 5/20/11
Prime Paint	2 days	Fri 10/21/11	Mon 10/24/11
Set Door Frames	2 days	Thu 5/19/11	Fri 5/20/11
Install Ceiling Grid	2 days	Wed 5/4/11	Thu 5/5/11
HVAC/Lights at Grid	2 days	Thu 5/5/11	Fri 5/6/11
Sprinkler Drops	2 days	Thu 5/5/11	Fri 5/6/11
Casework	2 days	Mon 11/7/11	Tue 11/8/11
Ceiling Close-In Inspection	2 days	Fri 10/14/11	Mon 10/17/11

Project: Summary Schedule
Date: Mon 10/17/11

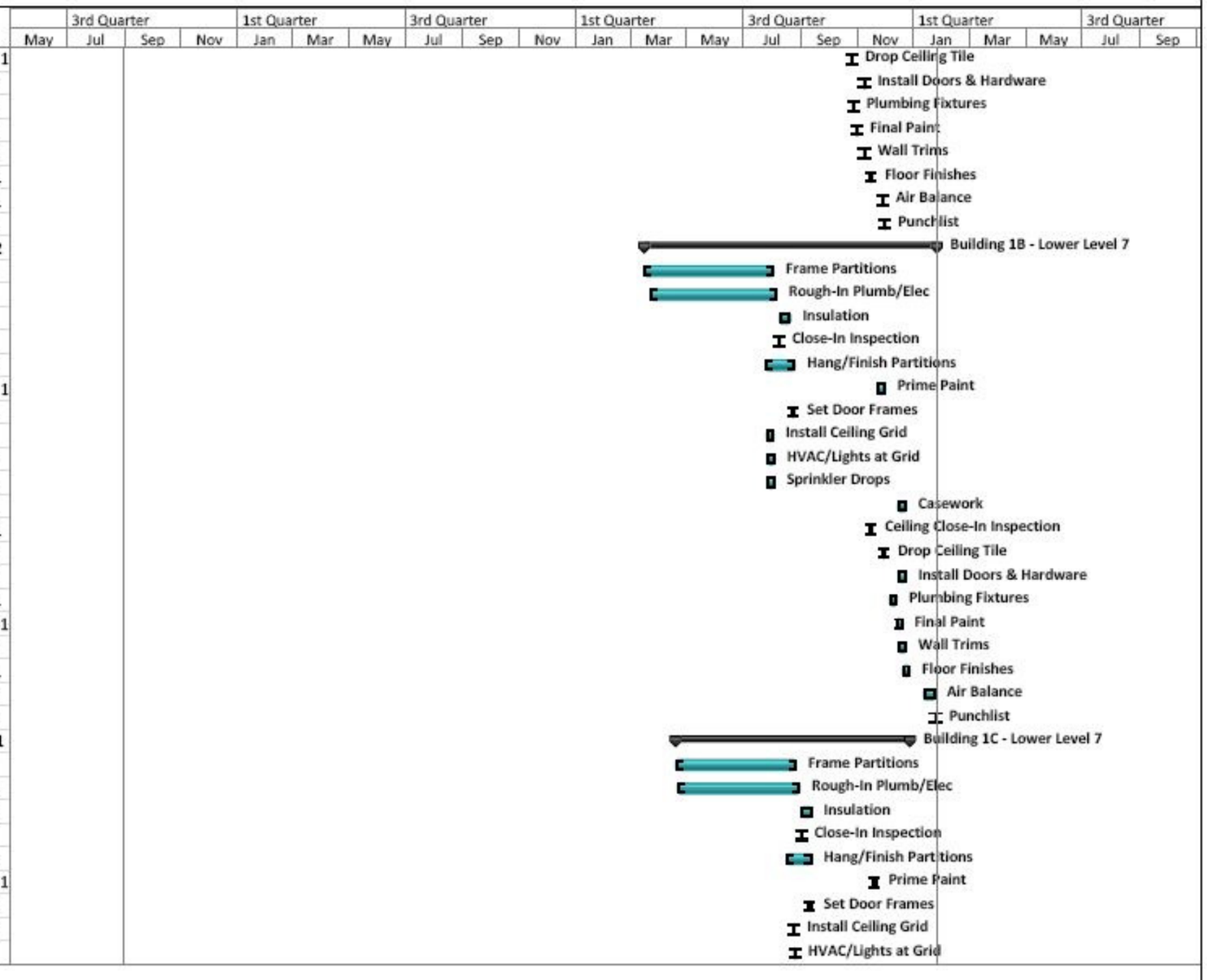
Milestone ◆ Summary Manual Task

Page 7

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Drop Ceiling Tile	2 days	Tue 10/25/11	Wed 10/26/11
Install Doors & Hardware	2 days	Tue 11/8/11	Wed 11/9/11
Plumbing Fixtures	2 days	Thu 10/27/11	Fri 10/28/11
Final Paint	2 days	Mon 10/31/11	Tue 11/1/11
Wall Trims	2 days	Tue 11/8/11	Wed 11/9/11
Floor Finishes	4 days	Mon 11/14/11	Thu 11/17/11
Air Balance	2 days	Mon 11/28/11	Tue 11/29/11
Punchlist	2 days	Wed 11/30/11	Thu 12/1/11
Building 1B - Lower Level 7	**226 days**	**Wed 3/16/11**	**Wed 1/25/12**
Frame Partitions	100 days	Wed 3/16/11	Tue 8/2/11
Rough-In Plumb/Elec	98 days	Wed 3/23/11	Fri 8/5/11
Insulation	10 days	Tue 8/9/11	Sat 8/20/11
Close-In Inspection	2 days	Mon 8/8/11	Tue 8/9/11
Hang/Finish Partitions	24 days	Mon 7/25/11	Thu 8/25/11
Prime Paint	6 days	Wed 11/23/11	Wed 11/30/11
Set Door Frames	4 days	Mon 8/22/11	Thu 8/25/11
Install Ceiling Grid	6 days	Tue 7/26/11	Tue 8/2/11
HVAC/Lights at Grid	6 days	Wed 7/27/11	Wed 8/3/11
Sprinkler Drops	6 days	Wed 7/27/11	Wed 8/3/11
Casework	7 days	Thu 12/15/11	Fri 12/23/11
Ceiling Close-In Inspection	4 days	Mon 11/14/11	Thu 11/17/11
Drop Ceiling Tile	4 days	Mon 11/28/11	Thu 12/1/11
Install Doors & Hardware	6 days	Fri 12/16/11	Fri 12/23/11
Plumbing Fixtures	6 days	Tue 12/6/11	Tue 12/13/11
Final Paint	4 days	Wed 12/14/11	Mon 12/19/11
Wall Trims	6 days	Fri 12/16/11	Fri 12/23/11
Floor Finishes	6 days	Tue 12/20/11	Tue 12/27/11
Air Balance	8 days	Thu 1/12/12	Mon 1/23/12
Punchlist	2 days	Tue 1/24/12	Wed 1/25/12
Building 1C - Lower Level 7	**181 days**	**Tue 4/19/11**	**Tue 12/27/11**
Frame Partitions	94 days	Tue 4/19/11	Fri 8/26/11
Rough-In Plumb/Elec	94 days	Thu 4/21/11	Tue 8/30/11
Insulation	7 days	Fri 9/2/11	Mon 9/12/11
Close-In Inspection	2 days	Thu 9/1/11	Fri 9/2/11
Hang/Finish Partitions	19 days	Wed 8/17/11	Mon 9/12/11
Prime Paint	2 days	Fri 11/18/11	Mon 11/21/11
Set Door Frames	2 days	Fri 9/9/11	Mon 9/12/11
Install Ceiling Grid	2 days	Wed 8/24/11	Thu 8/25/11
HVAC/Lights at Grid	2 days	Thu 8/25/11	Fri 8/26/11



Project: Summary Schedule
Date: Mon 10/17/11

Milestone ◆ Summary Manual Task

Page 8

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Sprinkler Drops	2 days	Thu 8/25/11	Fri 8/26/11
Casework	2 days	Mon 12/5/11	Tue 12/6/11
Ceiling Close-In Inspection	3 days	Thu 11/10/11	Mon 11/14/11
Drop Ceiling Tile	2 days	Tue 11/22/11	Wed 11/23/11
Install Doors & Hardware	2 days	Tue 12/6/11	Wed 12/7/11
Plumbing Fixtures	2 days	Mon 11/28/11	Tue 11/29/11
Final Paint	2 days	Wed 11/30/11	Thu 12/1/11
Wall Trims	2 days	Tue 12/6/11	Wed 12/7/11
Floor Finishes	4 days	Fri 12/9/11	Wed 12/14/11
Air Balance	2 days	Wed 12/21/11	Thu 12/22/11
Punchlist	3 days	Fri 12/23/11	Tue 12/27/11
Building 1B - Lower Level 6	**216 days**	**Tue 3/29/11**	**Tue 1/24/12**
Frame Partitions	95 days	Tue 3/29/11	Mon 8/8/11
Rough-In Plumb/Elec	95 days	Fri 4/1/11	Thu 8/11/11
Insulation	84 days	Mon 8/15/11	Thu 12/8/11
Close-In Inspection	2 days	Fri 8/12/11	Mon 8/15/11
Hang/Finish Partitions	93 days	Tue 8/2/11	Thu 12/8/11
Prime Paint	2 days	Wed 12/7/11	Thu 12/8/11
Set Door Frames	2 days	Thu 9/1/11	Fri 9/2/11
Install Ceiling Grid	4 days	Wed 8/3/11	Mon 8/8/11
HVAC/Lights at Grid	4 days	Thu 8/4/11	Tue 8/9/11
Sprinkler Drops	4 days	Thu 8/4/11	Tue 8/9/11
Casework	6 days	Tue 12/27/11	Tue 1/3/12
Ceiling Close-In Inspection	2 days	Tue 11/29/11	Wed 11/30/11
Drop Ceiling Tile	2 days	Thu 12/8/11	Fri 12/9/11
Install Doors & Hardware	5 days	Wed 12/28/11	Tue 1/3/12
Plumbing Fixtures	4 days	Wed 12/14/11	Mon 12/19/11
Final Paint	2 days	Tue 12/20/11	Wed 12/21/11
Wall Trims	5 days	Wed 12/28/11	Tue 1/3/12
Floor Finishes	4 days	Fri 12/30/11	Wed 1/4/12
Air Balance	6 days	Fri 1/13/12	Fri 1/20/12
Punchlist	2 days	Mon 1/23/12	Tue 1/24/12
Building 1C - Lower Level 6	**190 days**	**Thu 4/21/11**	**Wed 1/11/12**
Frame Partitions	94 days	Thu 4/21/11	Tue 8/30/11
Rough-In Plumb/Elec	94 days	Tue 4/26/11	Fri 9/2/11
Insulation	7 days	Wed 9/7/11	Thu 9/15/11
Close-In Inspection	2 days	Tue 9/6/11	Wed 9/7/11
Hang/Finish Partitions	17 days	Wed 8/24/11	Thu 9/15/11
Prime Paint	2 days	Wed 11/30/11	Thu 12/1/11

Project: Summary Schedule
Date: Mon 10/17/11

Milestone ◆ Summary Manual Task

Page 9

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Set Door Frames	2 days	Wed 9/14/11	Thu 9/15/11
Install Ceiling Grid	4 days	Thu 8/25/11	Tue 8/30/11
HVAC/Lights at Grid	4 days	Fri 8/26/11	Wed 8/31/11
Sprinkler Drops	4 days	Fri 8/26/11	Wed 8/31/11
Casework	5 days	Wed 12/14/11	Tue 12/20/11
Ceiling Close-In Inspection	2 days	Tue 11/22/11	Wed 11/23/11
Drop Ceiling Tile	2 days	Thu 12/1/11	Fri 12/2/11
Install Doors & Hardware	4 days	Thu 12/15/11	Tue 12/20/11
Plumbing Fixtures	4 days	Wed 12/7/11	Mon 12/12/11
Final Paint	2 days	Tue 12/13/11	Wed 12/14/11
Wall Trims	4 days	Thu 12/15/11	Tue 12/20/11
Floor Finishes	3 days	Mon 12/19/11	Wed 12/21/11
Air Balance	5 days	Tue 1/3/12	Mon 1/9/12
Punchlist	2 days	Tue 1/10/12	Wed 1/11/12
Building 1 - Envelope	**177 days**	**Mon 11/29/10**	**Tue 8/2/11**
Building 1A	**97 days**	**Mon 11/29/10**	**Tue 4/12/11**
Rooftop Equipment	5 days	Mon 11/29/10	Fri 12/3/10
Roof Membrane	19 days	Thu 3/17/11	Tue 4/12/11
Scaffolding	5 days	Mon 11/29/10	Fri 12/3/10
Frame/Sheath/Wrap Stud Walls	16 days	Mon 12/6/10	Mon 12/27/10
Stone	10 days	Tue 12/28/10	Mon 1/10/11
Brick	22 days	Tue 1/11/11	Wed 2/9/11
Windows	13 days	Thu 2/10/11	Mon 2/28/11
Curtainwall	12 days	Tue 3/1/11	Wed 3/16/11
Building 1B	**153 days**	**Mon 12/6/10**	**Wed 7/6/11**
Rooftop Equipment	5 days	Mon 12/6/10	Fri 12/10/10
Roof Membrane	34 days	Fri 5/20/11	Wed 7/6/11
Scaffolding	5 days	Mon 12/6/10	Fri 12/10/10
Frame/Sheath/Wrap Stud Walls	22 days	Mon 12/13/10	Tue 1/11/11
Stone	13 days	Wed 1/12/11	Fri 1/28/11
Brick	32 days	Mon 1/31/11	Tue 3/15/11
Windows	20 days	Wed 3/16/11	Tue 4/12/11
Curtainwall	27 days	Wed 4/13/11	Thu 5/19/11
Building 1C	**172 days**	**Mon 12/6/10**	**Tue 8/2/11**
Rooftop Equipment	5 days	Mon 12/6/10	Fri 12/10/10
Roof Membrane	19 days	Thu 7/7/11	Tue 8/2/11
Scaffolding	5 days	Mon 12/13/10	Fri 12/17/10
Frame/Sheath/Wrap Stud Walls	17 days	Mon 12/20/10	Tue 1/11/11
Stone	9 days	Mon 1/31/11	Thu 2/10/11

Project: Summary Schedule
Date: Mon 10/17/11

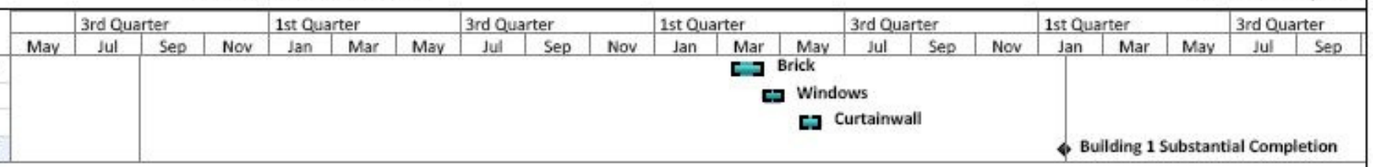
Milestone ◆ Summary Manual Task

Page 10

OFFICE BUILDING
NORTHEAST UNITED STATES

2011 AE SENIOR THESIS | PATRICK LANINGER, CONSTRUCTION MANAGEMENT | SUMMARY PROJECT SCHEDULE - TECH ONE, SEPTEMBER 23, 2011

Task Name	Duration	Start	Finish
Brick	21 days	Wed 3/16/11	Wed 4/13/11
Windows	13 days	Thu 4/14/11	Mon 5/2/11
Curtainwall	13 days	Fri 5/20/11	Tue 6/7/11
Building 1 Substantial Completion	0 days	Wed 1/25/12	Wed 1/25/12



Project: Summary Schedule
Date: Mon 10/17/11

Milestone ◆ Summary Manual Task

Page 11

OFFICE BUILDING
NORTHEAST UNITED STATES

APPENDIX B – DETAILED STRUCTURAL ESTIMATE

COLUMN TAKEOFFS

Column	Type	Length (in)	Width (in)	Height (ft)	Volume (CY)	Area (SF)	Vert. Size/Spacing	# Vert. Rebar	Vert. Length	Total LF	Horiz. Size/Spacing	# Horiz. Rebar	Horiz. Length	Total LF
X-17A	C6	18	18	48	108	288	#8 - 1.5 IN	24	48	1152	#8 - 6 IN	96	72	576
X-17B	C6	18	18	48	108	288	#8 - 1.5 IN	24	48	1152	#8 - 6 IN	96	72	576
X-18A	C6	18	18	48	108	288	#8 - 1.5 IN	24	48	1152	#8 - 6 IN	96	72	576
X-18B	C6	18	18	48	108	288	#8 - 1.5 IN	24	48	1152	#8 - 6 IN	96	72	576
Y-17	C9	24	24	48	192	384	#8 - 1 IN	36	48	1728	#8 - 6 IN	96	96	768
Y-18	C9	24	24	48	192	384	#8 - 1 IN	36	48	1728	#8 - 6 IN	96	96	768
Z-17	C9	24	24	24	96	192	#8 - 1 IN	36	24	864	#8 - 6 IN	96	96	768
Z-18	C9	24	24	24	96	192	#8 - 1 IN	36	24	864	#8 - 6 IN	96	96	768
AA-17A	C5	18	18	24	54	144	#8 - 1.5 IN	24	24	576	#8 - 6 IN	96	72	576
AA-17B	C5	18	18	24	54	144	#8 - 1.5 IN	24	24	576	#8 - 6 IN	96	72	576
AA-18A	C5	18	18	24	54	144	#8 - 1.5 IN	24	24	576	#8 - 6 IN	96	72	576
AA-18B	C5	18	18	24	54	144	#8 - 1.5 IN	24	24	576	#8 - 6 IN	96	72	576
				Total	**1224**	**2880**	-	-	-	**12096**	-	-	-	**7680**

SOG TAKEOFFS

Slab on Grade						
Area (SF)	Perimeter (FT)	Thickness (IN)	SF Formwork	CY Concrete	Rebar Size/Spacing	Total Rebar (LF)
3660	250	8	167	90	#8 Bars @ 12" O.C.	14400

ELEVATED SLAB TAKEOFFS

LL8 Slab						
Area (SF)	Perimeter (FT)	Thickness (IN)	SF Formwork	CY Concrete	Rebar Size/Spacing	Total Rebar (LF)
3550	280	6.2	145	68	#10 Bars @ 12" O.C.	7200
LL7 Slab						
Area (SF)	Perimeter (FT)	Thickness (IN)	SF Formwork	CY Concrete	Rebar Size/Spacing	Total Rebar (LF)
3550	280	6.2	145	68	#5 Bars @ 12" O.C.	7200
LL6 Slab						
Area (SF)	Perimeter (FT)	Thickness (IN)	SF Formwork	CY Concrete	Rebar Size/Spacing	Total Rebar (LF)
2560	210	6.2	109	49	#5 Bars @ 12" O.C.	5332
LL5 Slab						
Area (SF)	Perimeter (FT)	Thickness (IN)	SF Formwork	CY Concrete	Rebar Size/Spacing	Total Rebar (LF)
2560	210	6.2	109	49	#8 Bars @ 12" O.C.	5332

PIER CAP TAKEOFFS

Pier Caps									
Type	**Quantity**	**Length (FT)**	**Width (FT)**	**Depth (FT)**	**Long Bars**	**Short Bars**	**Volume**	**Total # 12 Rebar (LF)**	**Total # 4 Rebar (LF)**
PC-2	2	8	4.5	4	4 - #12 Bars	6 - #4 Bars	11	64	54
PC-3	8	8.5	7.5	4	3 - #12 Bars (3 Way)		76	192	-

GRADE BEAM TAKEOFFS

Grade Beams					
Length (FT)	Height (FT)	Width (FT)	CY Concrete	8 - #8 Horizontal Bars (LF)	#4 Stirrups @ 1' OC (LF)
84	2	3	19	672	840

COST INFORMATION

Concrete									
Item	CY Concrete	Material UP	Material Cost	Labor UP	Labor Cost	Equipment UP	Equipment Cost	Total Cost	RS Means Item
Columns	1224	103.00	126,072.00	-	-	-	-	126,072.00	Normal Weight Concrete - 4000 PSI
Slab on Grade	90	99.00	8,910.00	-	-	-	-	8,910.00	Normal Weight Concrete - 3000 PSI
Elevated Slabs	234	99.00	23,166.00	-	-	-	-	23,166.00	Normal Weight Concrete - 3000 PSI
Grade Beams	19	103.00	1,957.00	-	-	-	-	1,957.00	Normal Weight Concrete - 4000 PSI
Pier Caps	87	103.00	8,961.00	-	-	-	-	8,961.00	Normal Weight Concrete - 4000 PSI
Subtotals	**1654**	-	**169,066.00**	-	-	-	-	**169,066.00**	
Formwork									
Item	**SF Formwork**	**Material UP**	**Material Cost**	**Labor UP**	**Labor Cost**	**Equipment UP**	**Equipment Cost**	**Total Cost**	
Columns	2880	0.67	1,929.60	2.97	8,553.60	-	-	10,483.20	Steel Framed Plywood Forms - 24"x24"
Slab on Grade	173	1.80	311.40	6.10	1,055.30	-	-	1,366.70	Curb Forms - 6-12" High On Grade
Elevated Slabs	24947	1.74	43,407.78	3.87	96,544.89	-	-	139,952.67	Flat Plate - Drop Panels - Job-built Plywood
Subtotals	**28000**	-	**45,648.78**	-	**106,153.79**	-	-	**151,802.57**	

Reinforcement											
Item	LF Rebar	Size	LB/LF	Tonnage	Material UP	Material Cost	Labor UP	Labor Cost	Equipment UP	Equipment Cost	Total Cost
Columns	19776	#8	2.67	26.40	900.00	23,760.86	675.00	17,820.65	-	-	41,581.51
Slab on Grade	7200	#8	2.67	9.61	855.00	8,218.26	675.00	6,488.10	-	-	14,706.36
Elevated Slabs	12532	#5	1.04	6.54	955.00	6,241.34	535.00	3,496.46	-	-	9,737.80
Elevated Slabs	5332	#8	2.67	7.12	955.00	6,797.90	535.00	3,808.25	-	-	10,606.15
Elevated Slabs	7200	#10	4.30	15.49	955.00	14,793.71	535.00	8,287.58	-	-	23,081.29
Grade Beams	840	#8	2.67	1.12	955.00	1,070.94	535.00	599.95	-	-	1,670.89
Grade Beams	672	#4	0.67	0.22	855.00	191.90	740.00	166.09	-	-	357.99
Pier Caps	54	#4	0.67	0.02	855.00	15.42	740.00	13.35	-	-	28.77
Pier Caps	256	#11	5.31	0.68	810.00	550.85	430.00	292.43	-	-	843.28
Subtotals			-	**67.201366**	-	**61,641.19**	-	**40,972.85**	-	-	**102,614.04**
Grand Totals			-	-	-	**276,355.97**	-	**147,126.64**	-	-	**423,482.61**

COST COMPARISON

Typical Bay Size	Typical Bay Price	Building Size	Estimated Building Price	Actual Building Price	% Difference
3700	423,482.61	390000	44,637,356.19	Approx. $27,000,000	69%

APPENDIX C – GENERAL CONDITIONS ESTIMATE

PROJECT MANAGEMENT							
OFFICE OPERATIONS							
Description	Quantity	Unit	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total
Project Vice-President	37	WKS	-	6,368.00	-	6,368.00	235,616.00
Project Executive	74	WKS	-	6,078.00	-	6,078.00	449,772.00
Asst. Project Executive	74	WKS	-	4,266.00	-	4,266.00	315,684.00
Purchasing/Contract Exec.	74	WKS	-	3,249.00	-	3,249.00	240,426.00
Contract Manager	74	WKS	-	3,249.00	-	3,249.00	240,426.00
Head Scheduler	74	WKS	-	2,853.00	-	2,853.00	211,122.00
Office Manager	74	WKS	-	1,727.00	-	1,727.00	127,798.00
Asst. Office Manager	74	WKS	-	1,250.00	-	1,250.00	92,500.00
Payroll Accountant	74	WKS	-	1,250.00	-	1,250.00	92,500.00
Civil/Site Project Manager	74	WKS	-	3,759.00	-	3,759.00	278,166.00
Civil/Site APM	74	WKS	-	2,418.00	-	2,418.00	178,932.00
Civil/Site APM	74	WKS	-	2,418.00	-	2,418.00	178,932.00
Concrete/Int. Project Manager	74	WKS	-	3,759.00	-	3,759.00	278,166.00
Concrete/Int. APM	74	WKS	-	2,418.00	-	2,418.00	178,932.00
Façade Project Manager	74	WKS	-	3,759.00	-	3,759.00	278,166.00
Façade APM	74	WKS	-	2,418.00	-	2,418.00	178,932.00
Façade APM	74	WKS	-	2,418.00	-	2,418.00	178,932.00
MEP Project Manager	74	WKS	-	3,759.00	-	3,759.00	278,166.00
MEP Coordinator	37	WKS	-	3,759.00	-	3,759.00	139,083.00
MEP APM	74	WKS	-	2,418.00	-	2,418.00	178,932.00
MEP APM	74	WKS	-	2,418.00	-	2,418.00	178,932.00
						SUBTOTAL OFFICE MANAGEMENT	4,510,115.00
FIELD OPERATIONS							
Description	Quantity	Unit	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total
General Superintendent VP	80	WKS	-	6,368.00	-	6,368.00	509,440.00
Superintendent	80	WKS	-	3,399.00	-	3,399.00	271,920.00
Assistant Superintendent	74	WKS	-	2,983.00	-	2,983.00	220,742.00
Assistant Superintendent	74	WKS	-	2,983.00	-	2,983.00	220,742.00
Assistant Superintendent	74	WKS	-	2,983.00	-	2,983.00	220,742.00
Façade Superintendent	40	WKS	-	3,399.00	-	3,399.00	135,960.00
Interiors Superintendent	58	WKS	-	3,399.00	-	3,399.00	197,142.00
Field Engineering Manager	80	WKS	-	2,983.00	-	2,983.00	238,640.00
Field Engineer	80	WKS	-	2,191.00	-	2,191.00	175,280.00
Asst. Field Engineer	80	WKS	-	1,572.00	-	1,572.00	125,760.00
Asst. Field Engineer	80	WKS	-	1,572.00	-	1,572.00	125,760.00
Safety Director	80	WKS	-	2,527.00	-	2,527.00	202,160.00
Safety Engineer	74	WKS	-	2,191.00	-	2,191.00	162,134.00
Safety Engineer	74	WKS	-	2,191.00	-	2,191.00	162,134.00
						SUBTOTAL FIELD MANAGEMENT	2,747,814.00
ADMISTRATIVE FACILITIES & SUPPLIES							
Description	Quantity	Unit	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total
Office Trailers	14	Each	27,600.00	1,250.00	-	28,850.00	403,900.00
Office Furniture	18.5	Month	1,200.00	-	-	1,200.00	22,200.00
Temporary Fencing	3000	LF/12 Mo.	1.79	1.21	-	3.00	13,875.00
Vehicular Parking	2500	SF	4.73	2.14	0.40	7.27	18,175.00
Trailer Cleaning	74	WKS	22.50	1,050.00	-	1,072.50	79,365.00
Postage & Shipping	19	Month	1,500.00	-	-	1,500.00	28,500.00
Office Equipment	19	Month	-	-	-	150.00	2,850.00
Office Supplies	19	Month	-	-	-	95.00	1,805.00
Personal Computers	19	Month	-	-	-	3,500.00	66,500.00
Local Area Network	19	Month	-	-	-	892.00	16,948.00
Computer Software	34	Per Person	750.00	-	-	750.00	25,500.00
Scheduling Software	1	Per Person	4,500.00	-	-	4,500.00	4,500.00
Telephone Bills	19	Month	210.00	-	-	210.00	3,990.00
Cell Phone Bills	19	Month	3,800.00	-	-	3,800.00	72,200.00
Jobsite Shed	19	Month	97.50	-	-	97.50	1,852.50
Printing/Copying Services	19	Month	4,722.00	-	-	4,722.00	89,718.00
Automobile - Project Executive	19	Month	650.00	-	-	650.00	12,350.00
Automobile - Senior Project Manager	19	Month	650.00	-	-	650.00	12,350.00
Truck - Senior Superintendent	19	Month	550.00	-	-	550.00	10,450.00
Truck - Superintendent	19	Month	550.00	-	-	550.00	10,450.00
Motor Vehicle Expenses (Gas/Maint.)	76	Month	400.00	-	-	400.00	30,400.00
Travel Expenses	1	Allowance	25,000.00	-	-	25,000.00	25,000.00
Moving/Relocation Expenses	1	Allowance	20,000.00	-	-	20,000.00	20,000.00
As-Built Drawings	1	Allowance	25,000.00	-	-	25,000.00	25,000.00
						SUBTOTAL ADMINISTRATIVE FACILITIES & SUPPLIES	997,878.50
JOBSITE WORK REQUIREMENTS							
Description	Quantity	Unit	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total
Temporary Lighting	390000	CSF Floor	2.63	10.70	0.00	13.33	51,987.00
Power For Temporary Lighting	390000	CSF Floor/Month	2.85	-	-	2.85	205,627.50
Temporary Water	18.5	Month	1,250.00	250.00	600.00	2,100.00	38,850.00
Construction Power for Job Duration	390000	CSF Floor	110.00	-	-	110.00	429,000.00
Jobsite Signs (10"x10" Aluminum)	100	Each	48.00	16.95	-	64.95	6,495.00
Pest Control	14	Per Building	18.65	10.10	-	28.75	402.50
Temporary Toilets	60	Job	0.11	18.65	56.00	168.00	10,080.00
						SUBTOTAL JOBSITE WORK REQUIREMENTS	742,442.00
SAFETY							
Description	Quantity	Unit	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total
Safety Signage (10"x10" Aluminum)	250	Each	48.00	16.95	-	64.95	16,237.50
						SUBTOTAL SAFETY	16,237.50
MISCELLANEOUS							
Description	Quantity	Unit	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total
Preliminary Schedule	1	Each	-	20,000.00	-	20,000.00	20,000.00
Monthly Schedule Updates	19	Per Month	-	455.00	-	455.00	8,645.00
Security Badges & Supplies	1	Allowance	15,000.00	-	-	15,000.00	15,000.00
Photography (8"x10" Prints) Set	19	Per Month	-	-	-	415.00	7,885.00
						SUBTOTAL MISCELLANEOUS	51,530.00
						SUBTOTAL OFFICE MANAGEMENT	4,510,115.00
						SUBTOTAL FIELD MANAGEMENT	2,747,814.00
						SUBTOTAL ADMINISTRATIVE FACILITIES & SUPPLIES	997,878.50
						SUBTOTAL JOBSITE WORK REQUIREMENTS	742,442.00
						SUBTOTAL SAFETY	16,237.50
						TOTAL	9,066,017.00
						PERMITS	1.00%
						FEE	3.00%
						LOCATION FACTOR	0.979
						GRAND TOTAL	9,230,655.87

APPENDIX D – LEED PROJECT CHECKLIST

LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

Office Building
Northeast, United States

Yes	?	No			
10	**2**	**2**	**Sustainable Sites**		**14** Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
		1	Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density & Community Connectivity**	1
1			Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation - Public Transportation Access**	1
	?		Credit 4.2	**Alternative Transportation - Bicycle Storage & Changing Rooms**	1
1			Credit 4.3	**Alternative Transportation - Low Emitting & Fuel Efficient Vehicles**	1
1			Credit 4.4	**Alternative Transportation - Parking Capacity**	1
1			Credit 5.1	**Site Development - Protect or Restore Habitat**	1
1			Credit 5.2	**Site Development - Maximize Open Space**	1
1			Credit 6.1	**Stormwater Design - Quantity Control**	1
1			Credit 6.2	**Stormwater Design - Quality Control**	1
1			Credit 7.1	**Heat Island Effect - Non-Roof**	1
1			Credit 7.2	**Heat Island Effect - Roof**	1
	?		Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
3	**1**	**1**	**Water Efficiency**		**5** Points
1			Credit 1.1	**Water Efficient Landscaping - Reduce by 50%**	1
	?		Credit 1.2	**Water Efficient Landscaping - No Potable Use or No Irrigation**	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction - 20% Reduction**	1
1			Credit 3.2	**Water Use Reduction - 30% Reduction**	1

Yes	?	No			
6	**2**	**9**	**Energy & Atmosphere**		**17** Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
4		6	Credit 1	**Optimize Energy Performance**	1 to 10
		3	Credit 2.1	**On-Site Renewable Energy**	1 to 3
1			Credit 3	**Enhanced Commissioning**	1
1			Credit 4	**Enhanced Refrigerant Management**	1
	?		Credit 5	**Measurement & Verification**	1
	?		Credit 6	**Green Power**	1

continued…

Yes	?	No			
7	**0**	**6**	**Materials & Resources**		**13** Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse - Maintain 75% of Existing Walls, Floors & Roof**	1
		1	Credit 1.2	**Building Reuse - Maintain 100% of Existing Walls, Floors & Roof**	1
		1	Credit 1.3	**Building Reuse - Maintain 50% of Interior Non-Structural Elements**	1
1			Credit 2.1	**Construction Waste Management - Divert 50% from Disposal**	1
1			Credit 2.2	**Construction Waste Management - Divert 75% from Disposal**	1
		1	Credit 3.1	**Materials Reuse - 5%**	1
		1	Credit 3.2	**Materials Reuse - 10%**	1
1			Credit 4.1	**Recycled Content - 10% (post-consumer + ½ pre-consumer)**	1
1			Credit 4.2	**Recycled Content - 20% (post-consumer + ½ pre-consumer)**	1
1			Credit 5.1	**Regional Materials - 10% Extracted, Processed & Manufactured Regionally**	1
1			Credit 5.2	**Regional Materials - 20% Extracted, Processed & Manufactured Regionally**	1
		1	Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1

Yes	?	No			
11	1	3	**Indoor Environmental Quality**		**15** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke - (ETS) Control**	Required
1			Credit 1	**Outdoor Air Delivery Monitoring**	1
1			Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan - During Construction**	1
	?		Credit 3.2	**Construction IAQ Management Plan - Before Occupancy**	1
1			Credit 4.1	**Low-Emitting Materials - Adhesives & Sealants**	1
1			Credit 4.2	**Low-Emitting Materials - Paints & Coatings**	1
1			Credit 4.3	**Low-Emitting Materials - Carpet Systems**	1
1			Credit 4.4	**Low-Emitting Materials - Composite Wood & Agrifiber Products**	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems - Lighting**	1
		1	Credit 6.2	**Controllability of Systems - Thermal Comfort**	1
1			Credit 7.1	**Thermal Comfort - Design**	1
1			Credit 7.2	**Thermal Comfort - Verification**	1
		1	Credit 8.1	**Daylight & Views - Daylight 75% of Spaces**	1
		1	Credit 8.2	**Daylight & Views - Views for 90% of Spaces**	1

Yes	?	No			
5	0	0	**Innovation & Design Process**		**5** Points
1			Credit 1.1	**Innovation in Design - 100% Structured Parking/Pervious Paving**	1
1			Credit 1.2	**Innovation in Design - 40% Water Use Reduction**	1
1			Credit 1.3	**Innovation in Design - Green Housekeeping**	1
1			Credit 1.4	**Innovation in Design - Greenguard Certified Furniture Systems**	1
1			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
42	6	21	**Project Totals (pre-certification estimates)**	**69** Points

Certified 26-32 points Silver 33-38 points Gold 39-51 points Platinum 52-69 points

APPENDIX E – BIM EXECUTION PLANNING

BIM GOALS

Priority (1-3)	Goal Description	Potential BIM Uses
1- Most Important	**Value added objectives**	
3	Minimize In-Field Conflicts	3D Coordination, Subcontractor Design Review
3	Minimize Logistic Issues	3D Site Planning, 4D Modeling
1	Operations and Maintenance Information	O&M Compilation, As-Built Drawings
3	Capitalize on Sustainable Aspects	LEED Documentation, Engineering Analysis
2	Rapid Design Change Cost Evaluation	GC/Sub Cost Reviews
1	Educate Tradesmen	In-Field BIM Access

BIM USE ANALYSIS

BIM Use*	Value to Project	Responsible Party	Value to Resp Party	Capability Rating			Additional Resources / Competencies Required to Implement	Notes	Proceed with Use
	High / Med / Low		High / Med / Low	Scale 1-3 (1 = Low)					YES / NO / MAYBE
				Resources	Competency	Experience			
3D Coordination	HIGH	Clark Construction	MED	1	2	2	Establish Coordination Deadlines		**YES**
		A/E Team	MED	3	3	3	Increase Modeling Staff		
		Subcontractors	HIGH	3	3	2	Increase Modeling Staff/Training		
3D Site Planning	HIGH	Clark Construction	HIGH	3	3	3	Increase Modeling Staff	Will require superintedent input.	**YES**
		Subcontractors	MED	2	2	1	Training/GC Input	Need to provide scheduling specifics.	
4D Modeling	MED	Clark Construction	MED	2	2	2	Additional Modelers		**NO**
		Subcontractors	LOW	1	1	1	Training/Technology		
In-Field BIM Access	LOW	Clark Construction	MED	2	2	2	Superintendent Training		**NO**
		Subcontractors	HIGH	1	2	1	Intense Training/Technology Upgrades	Minimal experience/capabilities.	
Record Modeling/O&M Records	LOW	Clark Construction	MED	2	2	2	Need to hire O&M party	Not In RFP	**NO**
		WDG/HOK	LOW	1	1	1	Training/Technology		
		Tishman Aecom	MED	1	2	2	Training/Technology		
LEED Documentation	HIGH	Clark Construction	HIGH	3	3	3		LEED Gold Requirement	**YES**
		Tishman Aecom	HIGH	2	2	3	Additional LEED AP's	LEED Gold Requirement	
		WDG/HOK	MED	3	3	3		Company Reputation	
Cost Estimation	MED	Clark Construction	HIGH	3	3	3			**YES**
		Subcontractors	HIGH	2	2	3	Accurate Coordination Updates		
		A/E Team	MED	2	1	1	Accurate Cost Information		