Technical Report I

900 16th Street

Douglas W. Watson | 16 September 2015
Construction Management | Leicht

EXECUTIVE SUMMARY

900 16th Street is a feature office building under construction on the corner of 16th Street NW and I Street NW in Washington DC. This building was chosen to be studied as a part of the Penn State Architectural Engineering Senior Thesis course. The purpose of the AE Senior Thesis course is to analyze the construction of a structure in every aspect from preconstruction to completion.

Technical Report One will provide information concerning the scope of work and conditions that the project is being executed under. The forthcoming pages of this analysis will provide information including, but not limited to, a summary of the construction schedule, evaluation of the project costs, existing site conditions and surroundings, site logistics, project delivery system, the general contractors staffing plan, and client information.

The building is comprised of nine above grade stories and three below grade stories. While the majority of the space within the structure is slated to be office space, a portion of the ground level will be retail space. Along with the retail space a portion of the North most area of the building will be a replacement space for the church that had existed on the site prior to construction. The structure of the building is mainly cast-in-place concrete with a mixture of two-way slabs and post-tensioned slabs. Precast concrete panels with inlayed limestone and marble are used as the main component of the façade. Along with the precast façade a system of aluminum punched windows and a feature 3D curtainwall make this structure stand from the sea of buildings surrounding it.

TABLE OF CONTENTS

CLIENT INFORMATION

NOTE: This building is Base Building project with a separate contractor for Interiors.

As per request of the owner, the specific name of the owners of 900 16th Street is not to be released. However, the owner of this building is one of the largest real estate developers in the DC area. The purpose behind this new office building is to provide showcase space to clients in a historic district of Washington DC. Located only a few blocks away from Lafayette Square, the space has already attracted several high value clients including the law firm of Miller & Chevalier, who will occupy over half of the available office space.

There are several expectations for the schedule of this project. Due the fact that a majority of the space already has planned occupants it is key that the project be completed by the time the leases of the respective parties are set to begin. If there is a schedule delay preventing this then the Owner and the general contractor, DAVIS, will be responsible for the costs associated for the future tenants to remain in their current spaces.

PROJECT DELIVERY SYSTEM

**Reference Appendix A for an organizational chart of the involved parties of the project.*

The delivery method that this project utilizes is a Construction Manager at Risk with a GMP. The general contractor for 900 16th Street is James G. Davis Construction Corporation (DAVIS) and they hold a Cost + Fee with a Guaranteed Maximum Price with the owner. Although this project was intended to go out for bidding, DAVIS was able negotiate a contract with the owner before the bid process occurred. All subcontractors on the job are contracted to DAVIS and were selected by method low-bid.

STAFFING PLAN

**Reference Appendix B for the staffing plan and task distribution.*

To complete this project in the most efficient manner as possible the general contractor, DAVIS, utilizes a number of employees at all levels and all disciplines. The entire office and field staff is housed in a building adjacent to the site. DAVIS was allowed, with permission of the owner, to use the mezzanine level of the building North of the site as the field office for the project. The project team consists of multiple project managers and project engineers to ensure that all the complex systems have proper attention.

SITE LOGISTICS & EXISTING SITE CONDITIONS

**Reference Appendix C for the construction logistics plan*

The project site is located in the heart of Washington DC on the corner of 16th Street NW and I Street NW. In this case the site was occupied by a church and a monitor building that needed to be demolished before the new building could begin. Because the site is located on the

corner of two streets it is neighbored by buildings on both the North and West. 10' from the property line to the South is an active tunnel of the DC metro system.

During construction the site is commonly occupied by several pieces of equipment. The site plan, which can be seen in Appendix C, shows the typical layout for a concrete pour. At the end of each pour the pump truck was taken off site immediately to reopen the site access and laydown area. As soon as the building reached the second level overhead protection was put into place on the pedestrian walkway located on the South side of the site fence along I Street NW. The lack of available space on site eventually lead to moving the subcontractors trailer to above the pedestrian walkway on the South side of the site.

PROJECT COST EVALUATION

**Reference Appendix D supplementary project cost information.*

A square foot estimate was completed using the 2015 RS Means Square Foot Cost Data. After calculating the proper adjustment factors the estimated cost and cost per square foot of the total project.

Total Cost:	$201.15/SF	-	$40,528,189
Construction Cost:	$167.60/SF	-	$33,768,110
RS Means Estimate:	$140.93/SF	-	$28,394,779

The value obtained from the RS Means estimate are considerably lower than the actual costs reported by the job. There are many reasons why the numbers came out so low. This structure features a lot of high end façade types that RS Means does not take into account when compiling their estimation information. The project also requires a number of different excavation systems that require special attention in an estimate. RS Means provided an over estimate of the electrical system that is being installed on 900 16th Street because

**Reference Tables 1 and 2 in Appendix D for cost summaries.*

PROJECT SUMMARY SCHEDULE

**Reference Appendix E for project summary schedule*

The owner gave the notice to proceed with construction on February 7th of 2014. Immediately following the NTP site mobilization and installation of perimeter controls occurred. Construction began with the abatement and demolition of two existing buildings. The project experienced a 3 month delay due to the demolition of a firestop and structural component of 1600 K St. Existing condition drawings improperly depicted the function of a brick wall which separated the monitor building and 1600 K St. Following the completion of demolition and excavation the structure of 900 16th began with foundations on October 6th, 2014. After the structure reached grade, the construction of the floors one to nine began to fall into a three phase sequence. All sequences accounted for approximately one third of the floor area on each level. The sequences moved North to South and the formwork for the columns to the next level began

the day following each slab pour. The main structure was just over a month from being completed when the precast façade began being set on May 11th, 2015. In November of 2015 the process of constructing the core and shell of 900 16th Street is predicted to reach substantial completion after a 22 month duration.

BUILDING SYSTEMS SUMMARY

Demolition:

To create the new office building at 900 16th Street NW two existing buildings needed to first be demolished. On site there existed both a church and the churches monitor building. Initial demolition of these structures first being with abatement to remove all hazardous materials from them. Following abatement a Brokk was used to take down the monitor building, which had shared a wall with the building North of the site, and an excavator with a jack hammer attachment was used to demo the main church building.

Support of Excavation:

With the variety of obstacles that this project provides there were three main support of excavation systems that were used during the excavation for the sublevel parking garage. Figure 1 shows a real time image of the excavation of 900 16th Street. Extra care needed to be taken place on the South said of the excavation due to the underground metro line being located at little over 10' from the edge of the property line. The South and West edges of excavation (highlighted in orange in the above figure) used a system of walers, rakers, and heel blocks as the support of excavation. The East edge of the excavation (highlighted in blue) was able to receive the standard piles and lagging with tie-back system because there was nothing located underneath 16th street that would impede them from being used. The North edge of the excavation, along the 1600 K Street building, was supposed to use underpinning but after further investigation of the neighboring buildings foundations a bracket pile system was implemented.

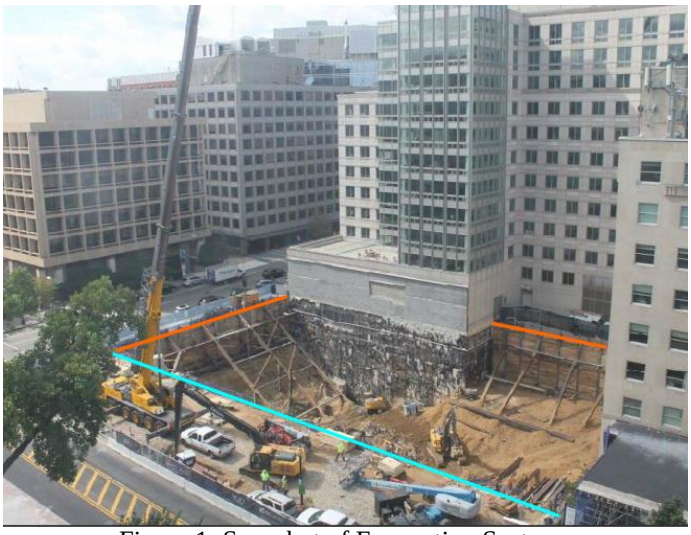


Figure 1: Snapshot of Excavation Systems

Cast-in-Place Concrete:

The main structural system of 900 16th Street is cast in place concrete and implements a mixture of both two-way normal weight concrete slabs with drop panels and post-tensioned concrete slabs with drop panels. Levels P2 through the ground level utilize two-way flat slab systems with drop panels while levels 2 to the penthouse are constructed with post-tensioned slabs with drop panels. The typical slab dimension for the upper levels is 7" thick with 8" drop panels at the columns.

There were two methods of concrete placement used in the construction of the cast-in-place structure. Once the tower crane was erected a crane and bucket method was utilized for smaller pours. As the slabs began to be poured a pump truck was the main method of concrete placement. After the 9th floor slab was poured, the crane and bucket method was used to complete the concrete pour on the roof. The main form work used was job built lumber forms and metal shoring to support uncured concrete.

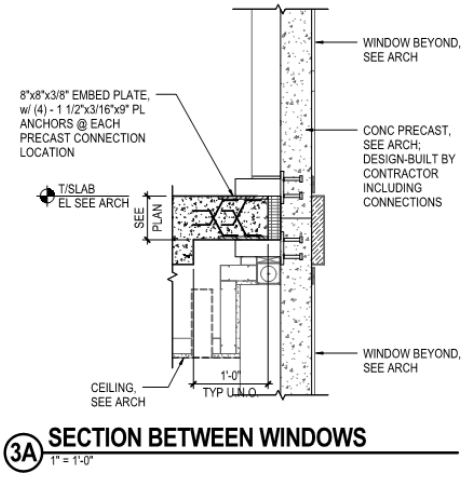


Figure 2: Pre-Cast Connection Detail

Building Façade:

The façade of this structure is unique because a majority of it is precast concrete panels that have limestone or marble cast within them. Each panel was cast off site and picked into place off directly off the flat beds they were delivered on. The typical connection detail is shown in Figure 2 to the left. Embed panels are cast into each floor slab and precast panels as shown in detail 3A. Once each panel is set into place by the track crane on site they are secured to the floor slab with steel angle and a welded connection. The north most entrance on 16th street features a 3D structural curtainwall system that was fabricated in Germany.

Mechanical System:

The main building mechanical system is a chilled water system with a central plant. The central plant is located on the first parking level and is home to 2 water chilling units and their respective pumps. Both of the cooling towers are located in the Northwest corner of the penthouse level.

Electrical System:

The primary electrical system of the building is run from 2 separate 2000 amp, three phase, 4 wire switchgears running at 265/460 V. Power is transported to the rest of the building using two bus ducts, one which supplies floors one to four while the other supplies floors five to nine.

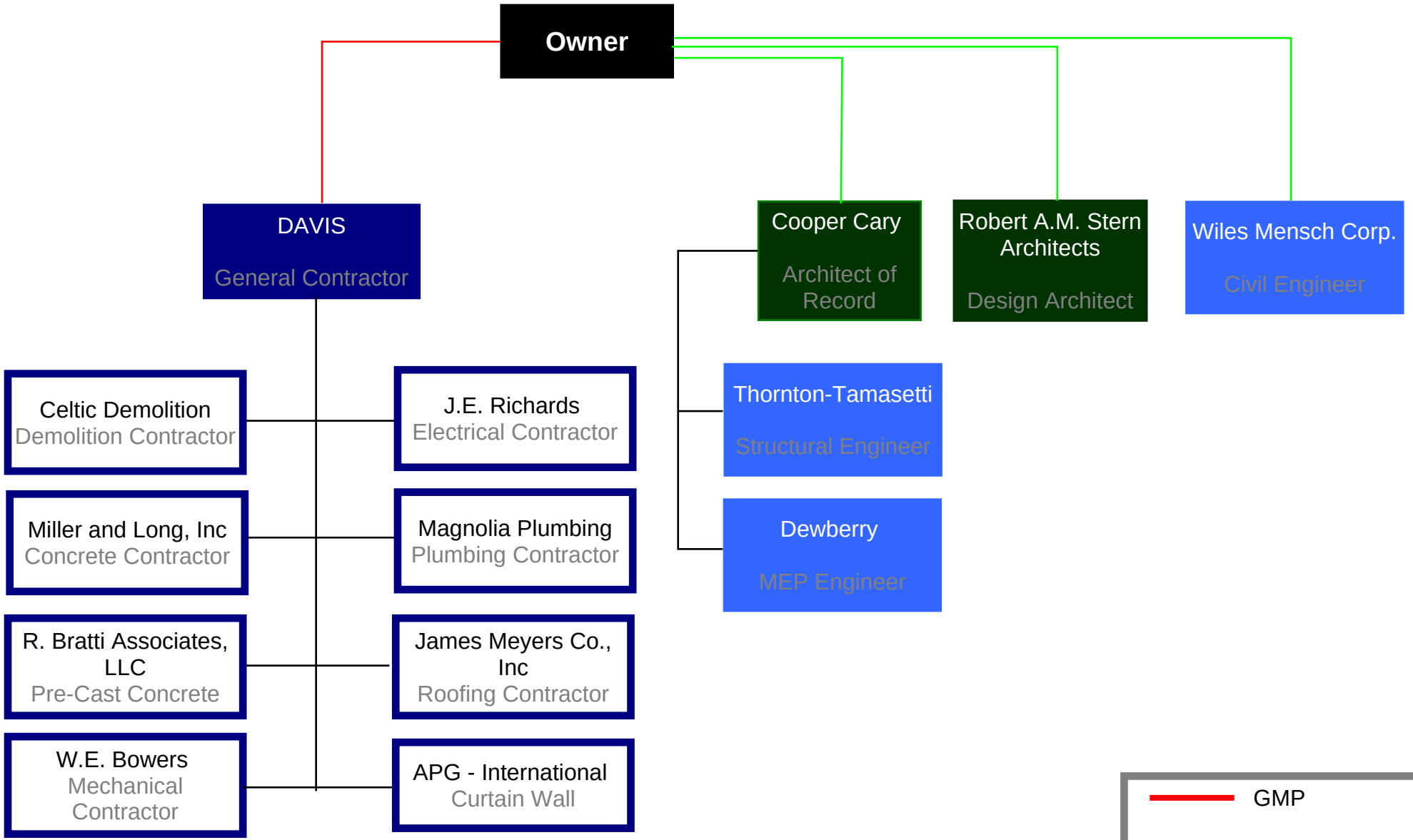
Sustainability Features:

900 16th Street was designed to receive a LEED Gold rating. The designers maximized the amount of green roof area by also incorporation green areas into the terrace space. Nearly the entire roof is a green roof while on the terrace there are two smaller green areas. Access and egress points to the terrace push occupants around the green areas and allow for the flow of foot traffic to be uninhibited. Many of the other LEED practices that are being utilized on this project involve waste management of construction materials, using materials with recycled content and utilizing regional suppliers and manufacturers to provide building materials.

Appendix A:

Project Delivery System

PROJECT DELIVERY SYSTEM



Appendix B:

Staffing Plan

STAFFING PLAN

Executive Level

JIM DUGAN
Senior VP
Operations Planing + Support, Weekly Review with the Project Team

JOEL MILLER
Project Executive
Preconstruction + Construction Coordination, Manage Schedule, Procurement + Closeout

DOMINIC ARGENTIERI
VP
Conceptual Estimating, Value Engineering, Constructibility Reviews

Office Supervision

STEPHEN GHENT
Project Manager
Facade + Finishes
Maintenance of Project Schedule + Budget, Partner with Field Team

TYLER MOYER
Project Manager
Structure + MEP Systems
Maintenance of Project Schedule + Budget, Partner with Field Team

JOE McGINNIS
Senior Superintendent
Primary Responsibility for Field Operations, Foreman Management, Safety + Quality Control Program Compliance

DAVE MASTERS
Construction Operations Executive
Executive Oversight of Field Operations, Executive Support for Project Site, Scheduling + Trade Coordination

Field Supervision + Safety

BRIAN LaCHANCE
Project Engineer
Updating Schedules, RFI + Submittal Processing, Assist with Financial Requisitions + Subcontractor Payment Processing

ANDREW PINO
Assistant Project Manager
Updating Schedules, RFI + Submittal Processing, Assist with Financial Requisitions + Subcontractor Payment Processing

SHUAN BATES
Senior Layout Engineer
Verify Field Documents, Assist with Trade Coordination, Provide Computer-Aided Design Assistance

JULIAN MEEDER
Layout Engineer
Verify Field Documents, Assist with Trade Coordination, Provide Computer-Aided Design Assistance

BRAD DUGAN
Project Engineer
Subcontractor Management, Daily Jobsite Reports, Weekly Subcontractor Coordination Meetings, Safety Reporting + Enforcement

JASON ELLIS
Project Engineer
Updating Schedules, RFI + Submittal Processing, Assist with Financial Requisitions + Subcontractor Payment Processing

Appendix C:

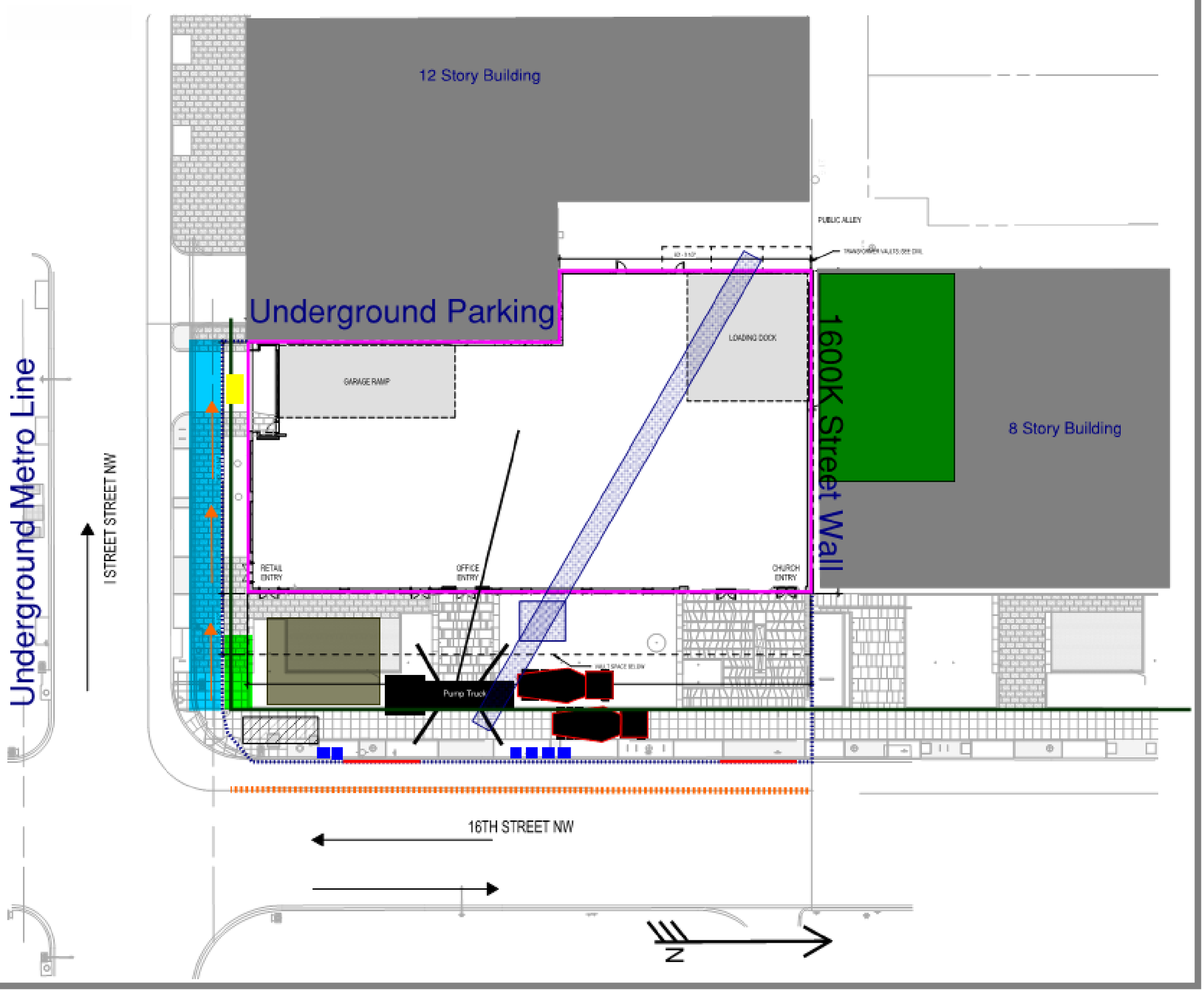
Site Logistics Plan

| SITE LOGISTICS |

Typical Cast-In-Place Pour Layout

LEGEND

- Protected Pedestrian Walkway
- Material Lay down
- GC/Sub Office
- Dumpster
- Entrance/Exit Gates
- Bathroom
- Tower Crane
- Building Perimeter
- Site Fence
- Construction Cones
- Adjacent Building
- Pedestrian Traffic
- Temporary Electrical Shed
- Existing Sanitary Line



Appendix D:

Project Cost Evaluation

COMMERCIAL/INDUSTRIAL/INSTITUTIONAL **M.470** **Office, 5-10 Story**

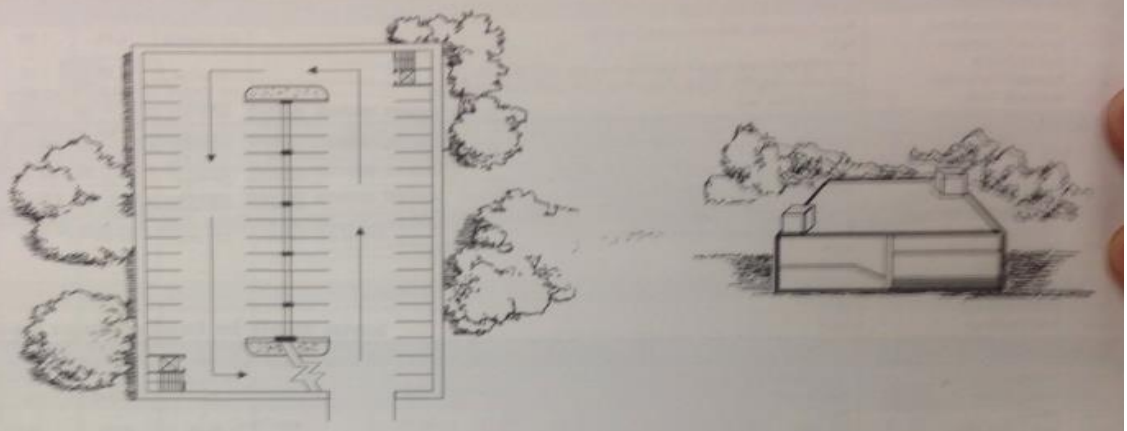
Costs per square foot of floor area

Exterior Wall	S.F. Area	20000	40000	60000	80000	100000	150000	200000	250000	300000
	L.F. Perimeter	260	360	400	420	460	520	650	720	800
Precast Concrete Panel	Steel Frame	233.60	202.70	186.10	**176.10**	171.40	163.45	161.65	159.10	157.65
	R/Conc. Frame	231.20	200.10	183.40	173.40	168.65	160.70	158.85	156.30	154.85
Face Brick with Concrete Block Back-up	Steel Frame	219.35	191.90	177.80	169.45	165.40	158.65	157.05	154.90	153.65
	R/Conc. Frame	214.30	188.40	174.70	166.60	162.70	156.15	154.65	152.55	151.35
Limestone Panel Concrete Block Back-up	Steel Frame	248.00	212.55	193.40	181.90	176.45	167.25	165.20	162.20	160.50
	R/Conc. Frame	245.15	209.75	190.55	179.05	173.60	164.40	162.35	159.40	157.70
Perimeter Adj., Add or Deduct	Per 100 L.F.	32.05	16.05	10.65	8.00	6.45	4.30	3.20	2.55	2.10
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	6.70	4.60	3.45	2.75	2.40	1.75	1.70	1.50	1.30

For Basement, add $40.60 per square foot of basement area

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, vary from

COMMERCIAL/INDUSTRIAL/INSTITUTIONAL **M.280** **Garage, Underground Parking**



Costs per square foot of floor area

Exterior Wall	S.F. Area	20000	30000	40000	50000	75000	100000	125000	150000	175000
	L.F. Perimeter	400	500	600	650	775	900	1000	1100	1185
Reinforced Concrete	R/Conc. Frame	99.55	92.85	89.50	86.40	82.10	80.05	78.55	77.55	76.75
Perimeter Adj., Add or Deduct	Per 100 L.F.	5.75	3.90	2.90	2.30	1.60	1.15	0.90	0.75	0.65
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	2.15	1.85	1.70	1.45	1.15	1.00	0.90	0.80	0.75

Basement—Not Applicable

B. SHELL							
	B10 Superstructure						
1010	Floor Construction	Concrete slab with metal deck and beams		S.F. Floor	24.93	21.81	17.1%
1020	Roof Construction	Metal deck, open web steel joists, interior columns		S.F. Roof	7.20	.90	
	B20 Exterior Enclosure						
	D20 Plumbing						
2010	Plumbing Fixtures	Toilet and service fixtures, supply and drainage	*1 Fixture/1370 S.F. Floor*	Each	3644	2.66	2.7%
2020	Domestic Water Distribution	Gas fired water heater		S.F. Floor	.57	.57	
2040	Rain Water Drainage	Roof drains		S.F. Roof	2.48	.31	
	D30 HVAC						
3010	Energy Supply	N/A		–	–	–	13.3 %
3020	Heat Generating Systems	Included in D3050		–	–	–	
3030	Cooling Generating Systems	N/A		–	–	–	
3050	Terminal & Package Units	Multizone unit gas heating, electric cooling		S.F. Floor	17.65	17.65	
3090	Other HVAC Sys. & Equipment	N/A		–	–	–	
	D50 Electrical						
5010	Electrical Service/Distribution	1600 ampere service, panel board and feeders		S.F. Floor	1.39	1.39	14.3%
5020	Lighting & Branch Wiring	High efficiency fluorescent fixtures, receptacles, switches, A.C. and misc. power		S.F. Floor	11.99	11.99	
5030	Communications & Security	Addressable alarm systems, internet and phone wiring, emergency lighting		S.F. Floor	4.59	4.59	
5090	Other Electrical Systems	Emergency generator, 100 kW, uninterruptible power supply		S.F. Floor	1.05	1.05	

Table 1

Building System Cost Evaluation					
System	**Actual Cost**	**Total Cost / SF**	**Percent of Total Cost**	**RS Means Estimated Cost**	**Estimated Cost / SF**
Structural	$ 6,904,903.00	$ 34.27	17.00%	$4,855,507.00	$ 24.10
Mechanical/Plumbing	$ 5,400,930.00	$ 26.81	13.30%	$4,543,164.00	$ 22.55
Electrical	$ 2,664,582.00	$ 13.22	6.57%	$4,060,453.00	$ 20.15

Table 2

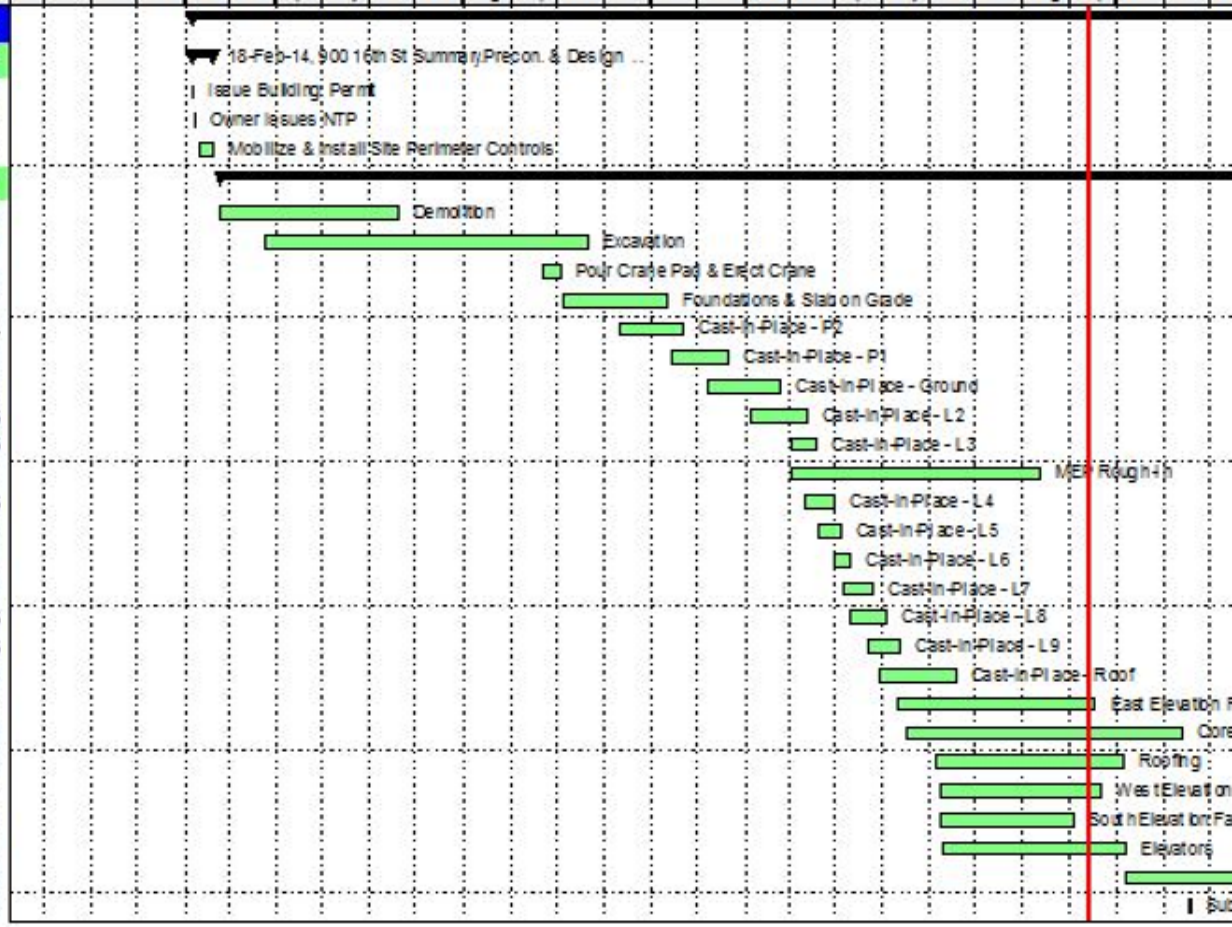
Total Cost Evaluation		
Construction Costs	$33,768,110.00	$ 167.60
Total Project Costs	$40,528,189.00	$ 201.15
RS Means Estimate	$28,394,779.00	$ 140.93

Appendix E:

Project Summary Schedule

Classic Schedule Layout

Activity Name	Original Duration	Start	Finish
t Summary 90016th St Summary Schedule	508	06-Feb-14	18-Jan-16
St Summary.Precon. & Design ..	9	06-Feb-14	18-Feb-14
Issue Building Permit	1	06-Feb-14	06-Feb-14
Owner Issues NTP	1	07-Feb-14	07-Feb-14
Mobilize & Install Site Perimeter Controls	7	10-Feb-14	18-Feb-14
St Summary.Base Building .	496	24-Feb-14	18-Jan-16
Demolition	83	24-Feb-14	18-Jun-14
Excavation	151	25-Mar-14	21-Oct-14
Pour Crane Pad & Erect Crane	10	22-Sep-14	03-Oct-14
Foundations & Slab on Grade	49	06-Oct-14	11-Dec-14
Cast-in-Place - P2	30	11-Nov-14	22-Dec-14
Cast-in-Place - P1	27	15-Dec-14	20-Jan-15
Cast-in-Place - Ground	35	07-Jan-15	24-Feb-15
Cast-in-Place - L2	26	05-Feb-15	12-Mar-15
Cast-in-Place - L3	14	02-Mar-15	19-Mar-15
MEP Rough-in	117	02-Mar-15	11-Aug-15
Cast-in-Place - L4	14	12-Mar-15	31-Mar-15
Cast-in-Place - L5	11	20-Mar-15	03-Apr-15
Cast-in-Place - L6	10	30-Mar-15	10-Apr-15
Cast-in-Place - L7	15	06-Apr-15	24-Apr-15
Cast-in-Place - L8	17	10-Apr-15	04-May-15
Cast-in-Place - L9	16	21-Apr-15	12-May-15
Cast-in-Place - Roof	37	29-Apr-15	18-Jun-15
East Elevation Facade	94	11-May-15	17-Sep-15
Core & Shell Finishes	129	18-May-15	12-Nov-15
Roofing	87	05-Jun-15	05-Oct-15
West Elevation Facade	76	08-Jun-15	21-Sep-15
South Elevation Facade	63	09-Jun-15	03-Sep-15
Elevators	85	10-Jun-15	06-Oct-15
Punchlist	74	07-Oct-15*	18-Jan-16
Substaintial Compeletion	1	18-Nov-15*	18-Nov-15



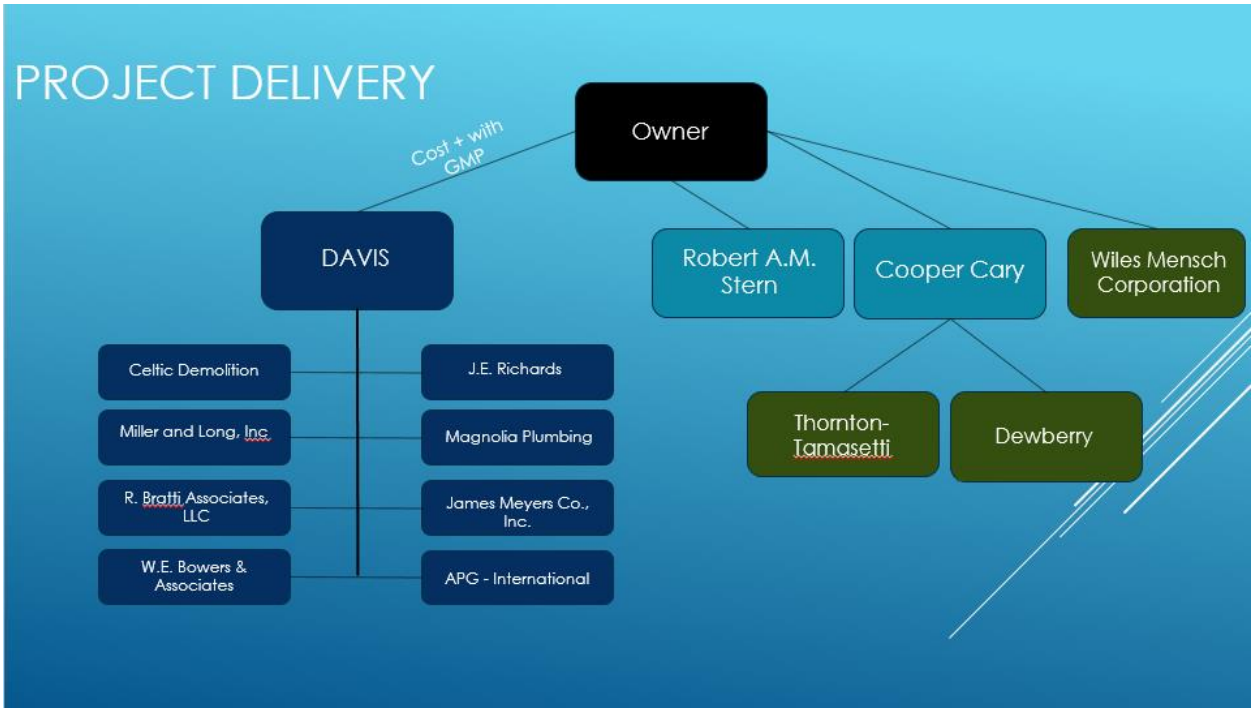
el of Effort Remaining Work Milestone
rk Critical Remaining Work summary

Project: Project Summary Schedule
Date: 9/16/2015

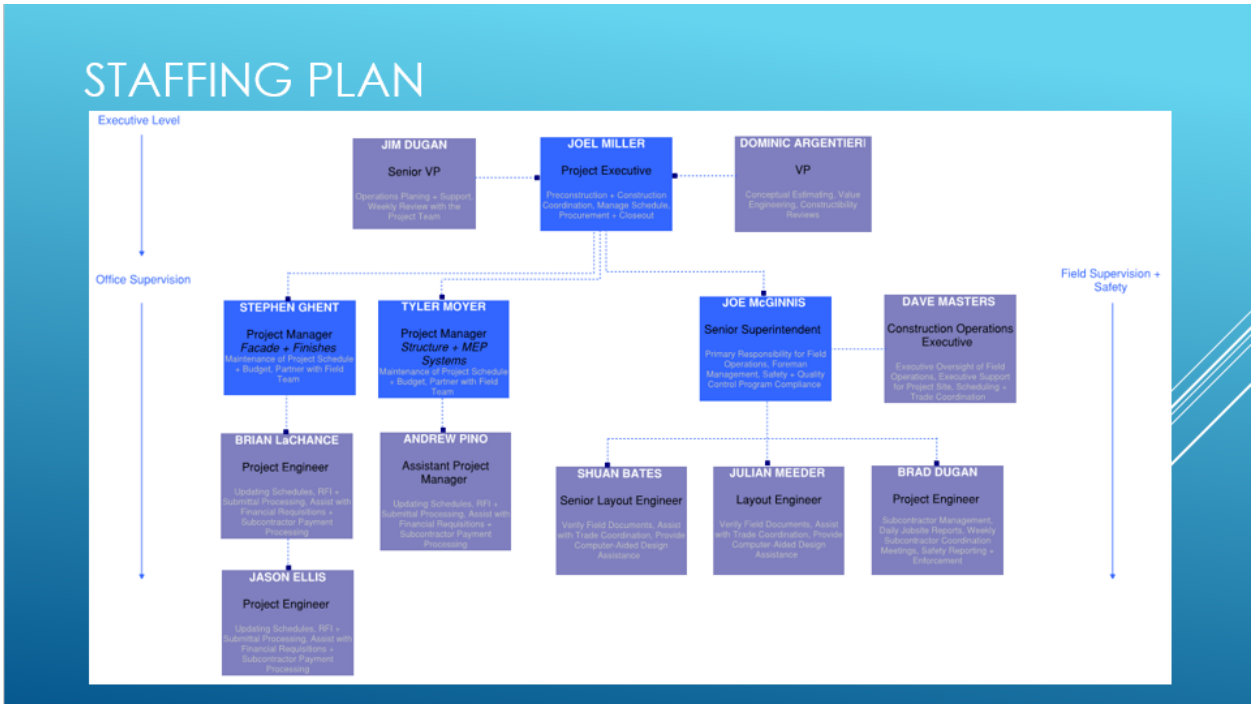
Appendix F:

Technical Report 1 Presentation Slides


CLIENT INFORMATION
Owner:
Large real estate owner, manger, and developer
Invests in mostly retail, office
Main Concerns
Leasable Space
Overall quality of final product
Schedule
The Third Church of Christ Scientist
Miller & Chevalier



[Refer to Appendix A for further information]



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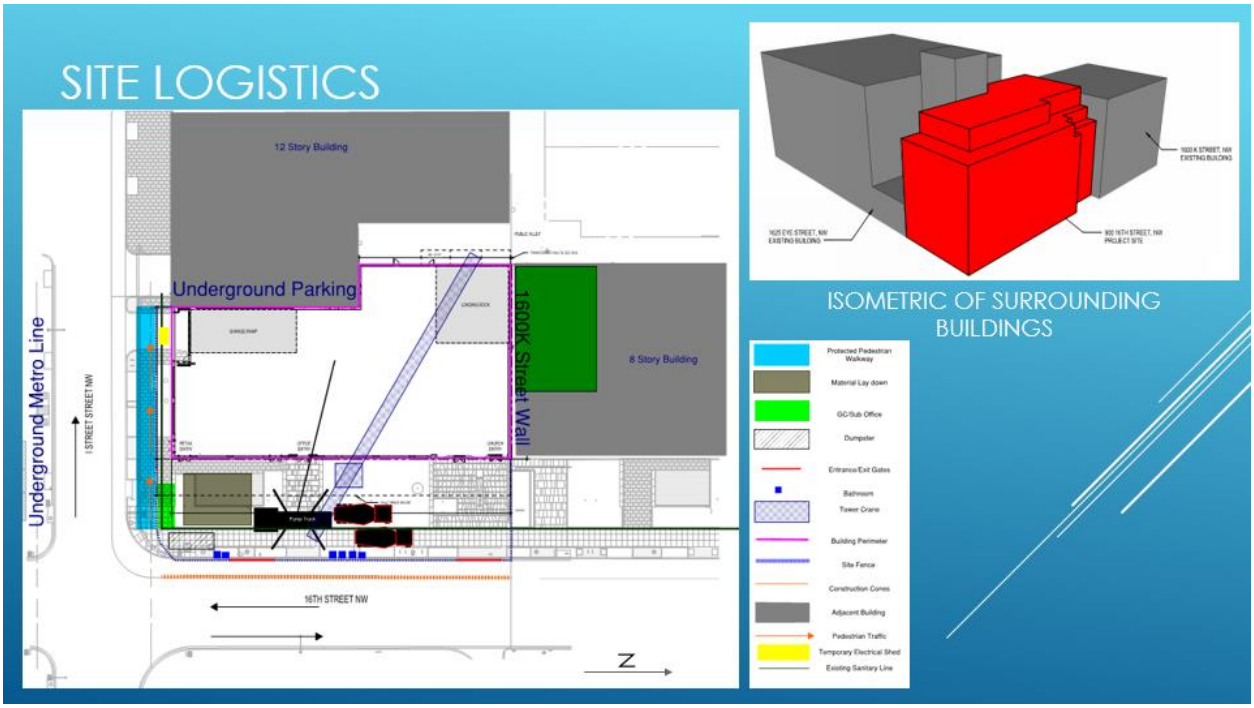


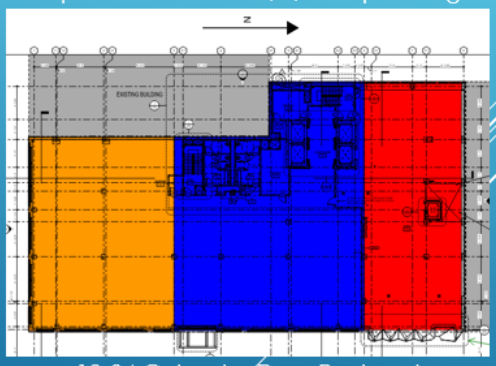
[Refer to Appendix C for further information]

PROJECT SUMMARY SCHEDULE

MILESTONE ACTIVITIES

Activity	Start Date	Finish Date
Mobilize & Site Fence Install	10-Feb-2014	18-Feb-2014
Excavate to Subgrade	25-Mar-2014	18-Oct-2014
Foundation/SOG	06-Oct-2014	11-Dec-2014
CIP Structure	11-Nov-2014	18-Jun-2015
Façade	11-May-2015	21-Sep-2015
Roofing	05-Jun-2015	05-Oct-2015
Core & Shell MEP	02-Mar-2015	12-Nov-2015
Elevators	10-Jun-2015	12-Nov-2015
Substantial Completion	Nov-2015	Nov-2015

Superstructure Slab F/R/P Sequencing



13-24 Calendar Days Per Level

[Refer to Appendix E for further information]

PROJECT COST EVALUATION

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  - Total Cost: $ 40,528,189 - $201.15/SF
- Actual System Costs
  - Structural: $ 6,904,906 - $34.27/SF
  - Mech/Plumb: $ 5,400,930 - $26.81/SF
  - Electrical: $ 2,664,582 - $13.22/SF
- Estimated Project Costs
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- Estimated System Costs
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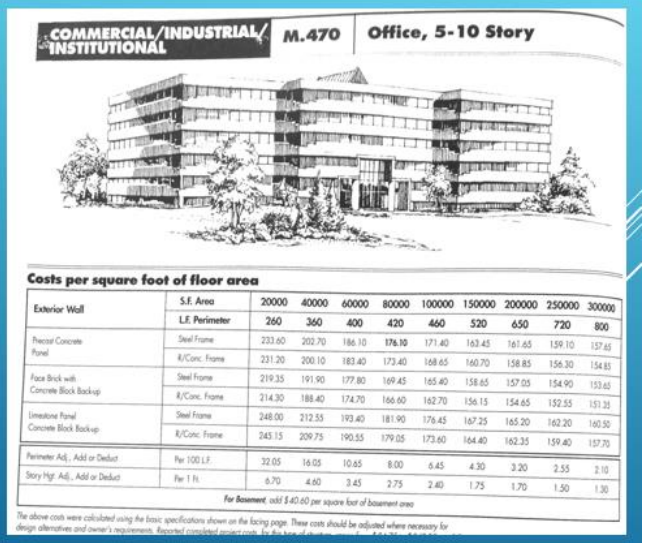

COMMERCIAL/INDUSTRIAL/INSTITUTIONAL M.470 Office, 5-10 Story

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For Basement, add $40.60 per square foot of basement area

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[Refer to Appendix D for further information]

Table 3: Incorporated Work Scopes

Yes	No	Work Scope
X		Demolition
	X	Structural Steel
X		Cast-In-Place
X		Precast Concrete
X		Mechanical System
X		Electrical System
X		Curtain Wall
X		Support of Excavation

BUILDING SYSTEMS

- Mechanical System
  - Central Plant chilled water system
- Electrical System
  - 2000A, 3 Phase, 265/460 V
- Structural System
  - Cast-in-place concrete
    - Two-way slabs
    - Post Tensioned Slabs

- Precast Façade
  - Concrete with limestone and marble topping
- Curtain Wall
  - Structural 3D curtain wall system