Photo Courtesy of Burchick Construction

University of Pittsburgh
CHEVRON ANNEX

PITTSBURGH, PENNSYLVANIA

Technical Report 1

September 23
2011

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Advisor: Dr. Chimay Anumba

EXECUTIVE SUMMARY

The purpose of Technical Report 1 is to become acquainted with the University of Pittsburgh's Chevron Annex project. The project is located in Pittsburgh, Pennsylvania and is a two phase project consisting of a renovation and an addition to the University's Chevron Tower and Ashe Auditorium. The addition is a three story addition, consisting of two floors of laboratory space and one story for a mechanical penthouse. The addition will tie into the existing Chevron Tower, east of the addition, on each of the new floors.

The lab spaces will be occupied by the University's Chemistry Department. Since the project consists of state-of-the-art laboratory equipment, the MEP system is extremely complex. The complexity of these systems required extensive coordination of the trades to enable the project to finish on schedule. The majority of the MEP systems related to the lab space is located on the 4th floor of the addition.

The project was broken into eight packages and was competitively bid in September 2009, with the contracts being awarded in November 2009. Additionally, the University chose to hire Mascaro Construction as their CM Agent to overlook all of the work involved with the project. The first phase of the project was started in late November 2009 and completed the following December. The second phase of the project was sequenced in during the first phase and finished in September 2011. The schedule of the project was important because the addition needed to be completed before the students arrived for classes.

The vertical addition of the Ashe Auditorium presents a few difficulties for the project team. The existing structure of the Auditorium was not capable of supporting the addition; thus resulting in the need for new columns, each with a foundation system composed of pile caps and micropiles. Demolition of the existing slab was needed to drill the piles and form new foundations to support the new columns. There was also minimal space around the project, which made it difficult to provide adequate space for materials, equipment and site trailers. In order to solve this problem, the site trailers were located roughly 200 yards northwest of the building and the material storage was located 100 yards north of the building. There was a small lot to the west of the building that was used to locate the heavy equipment.

The Chevron Annex is in pursuit of a LEED Gold rating. The checklist is currently under review with a number of the points in question. The project team is utilizing the entire LEED-NC checklist, with a majority of their points coming from the Sustainable Sites and Indoor Environmental Quality sections.

Research of this project will continue throughout the year, with a concentration on the costs and schedules involved. Important attributes of the schedule and key building system costs and how they affect the project's execution will also be analyzed. This information and research can be found in Technical Report 2.

TABLE OF CONTENTS

PROJECT SCHEDULE SUMMARY

The project schedule summary that can be found in Appendix A illustrates the major phases of construction for the Chevron Annex. The key milestone and phasing relationships are also indicated. The schedule is divided into three main sections:

- Preconstruction
- Construction
- Turnover/Commissioning

In addition to these three sections; the foundation, structural, building enclosure/shell and finish sections were also considered.

FOUNDATION

The foundation for the Chevron Annex is composed of pile caps and stepped grade beams. The pile caps are to support the new columns and are located inside the existing Ashe auditoriums. In order to accommodate these pile caps, the existing floor and stepped slabs in the auditorium needed to be demolished. Additionally, the grade beams are located in the northwest corner of the building and support a 1'-2" thick cast-in-place concrete wall. The foundation work also includes the soil nailing and temporary shoring involved with the excavation for the grade beams and foundation walls.

STRUCTURAL

The structural system for the addition includes steel beams and columns, as well as composite steel deck. The structural activities of the schedule also include the installation of the steel deck and slabs, as well as the detailing and fireproofing involved with the steel. A milestone activity is also included in the schedule for the completion of the steel erection. This milestone portrays a significant event involved with the construction of this building.

BUILDING ENCLOSURE/SHELL

The building's façade is a combination of terra cotta, metal panels, louvers and glazing. All of these systems are included under the "Building Enclosure/Shell" task in the summary schedule. Also included in this task is the exterior sheathing and vapor barrier for the exterior of the building. This task is a long activity on the schedule because of the complexity of the exterior façade systems and the amount of work needed to be done.

FINISH

The finishes involved in the in the construction of the Chevron Annex are summarized under the "Interiors" task in the summary schedule. Some of the items included in the interiors task are activities such as drywall, ceiling finishes, flooring, architectural millwork, etc. This task is another one of the longer activities included in the schedule due to the time and care needed for these activities.

Overall, the total project duration is 486 days. This duration is split into two phases that consisted of the auditorium renovation and a vertical addition above the auditorium. The renovation and work involved with the auditorium was completed on December 31, 2010 and the vertical addition is expected to be finished October 14, 2011.

For the complete Gantt Chart Summary Schedule, please refer to Appendix A.

BUILDING SYSTEMS SUMMARY

YES	NO	Work Scope
X		Demolition
X		Structural Steel Frame
X		Cast-In-Place Concrete
	X	Precast Concrete
X		Mechanical System
X		Electrical System
X		Masonry
X		Curtain Wall
X		Support of Excavation

DEMOLITION

The first phase of the Annex consists of renovating the existing Ashe Auditorium, as well as the Chevron Tower's lobby. In order to do this, there was selective demolition that had to be performed. Some of the major demolition that was necessary includes demolishing holes in block walls and the roof deck to make room for beam and column penetrations, removing the floor and stepped slabs, and demolishing portions of walls for new openings to tie into to the existing Chevron Tower.

STRUCTURAL STEEL FRAME

The majority of the Annex's structure consists of structural steel. A combination of W and HSS sections are used throughout the new addition. The W shaped steel is ASTM A992, with a yield strength of 50ksi. A composite deck is placed on the steel to distribute the loads from the building. The deck is continuous over 3 or more spans and ranges from 1-1/2" to 2" in thickness. Normal weight concrete is placed over the deck and is to have a strength of 4,000 psi after 28 days. Additionally, a braced frame consisting of W shaped beams and columns, as well as HSS cross braces are used to help resist the lateral loads imposed on the building. Shear loads ranging from 50 K to 100K are experienced at the bases of the braced frames and are absorbed by large footings. A portion of one of the braced frames used on this project is shown below:

Figure 1 Structural Steel Braced Frame

CAST-IN-PLACE CONCRETE

Cast-in-place concrete was also used throughout the construction of the Chevron Annex. Footers, pile caps, grade beams, slab on grades, slab on decks all required the use of cast-in-place concrete. All of the concrete used on the project is to be in accordance with ACI 318. Pile caps were placed in the existing slab on grades and stepped slabs, with the thickness of these pile caps ranging from 24" to 60" in depth. Stepping grade beams and mat slabs were also used to support concrete walls for the generator room.

Figure 2 Rebar & Formwork for Concrete Wall at Generator Room

MECHANICAL SYSTEM

Three new air handling units will supply the new addition and are located on the new penthouse level. Two of the units (AHU-1, 2) will serve the chemical lab and administration areas, which are located on two of the new floors. The third unit (AHU-3) will service the Ashe Lobby infill area located on the ground floor. All three of these units are designed as heating-cooling, single duct, variable volume reheat systems.

Additionally, three laboratory exhaust fans are used to remove any fumes from the lab areas. Each fan is sized to provide 50% of the design flow rate. Two of the fans operate in parallel under normal operation, while the other fan is in standby mode. These fans are located in the southeast corner of the penthouse level and are enclosed by louvers. Two of the three exhaust fans are shown below:

Figure 3 Laboratory Exhaust Fans

ELECTRICAL SYSTEM

The electrical system for the Chevron Annex consists of transformers, switchboards and an emergency generator. The distribution transformer for this project has a maximum rating of 300kVA with a primary voltage of 400 volts through three phases and three wires. The secondary voltage for the transformer is 208Y/120 volts through three phases and four wires. Additionally, the main switchboard consists of 1600 amps, 480/277 volts through three phases and four wires plus a ground. The emergency generator that is specified for this job is located at the northwest corner of the building and delivers 1500 kW of power at 480Y/277 V. Additionally, multiple panelboards of different ratings and sizes are located on each of the floors throughout the project.

MASONRY

The Chevron Annex did not include any traditional masonry work; however, it did use a clay tile veneer system as one of the façade systems. This system is a total of 6 inches, which consists of an aluminum framing girt system, rigid insulation and clay tiles. The clay tiles used are a combination of six and twelve inch high tiles of various lengths to help break up the look of the façade.

The installation of this system takes time and consists of a few detailed steps. First, a horizontal angle is attached to the exterior face of the building. Next, rigid insulation is placed between the horizontal angles and then 8" long angles are attached to the horizontal angles at predetermined locations. After this, vertical profiles made of aluminum are fastened to the 8" angles and are spaced accordingly. Finally, the tiles are put in place and attached with clips to keep them held in place and uniformly spaced. A section view of the entire terra cotta system is shown below:

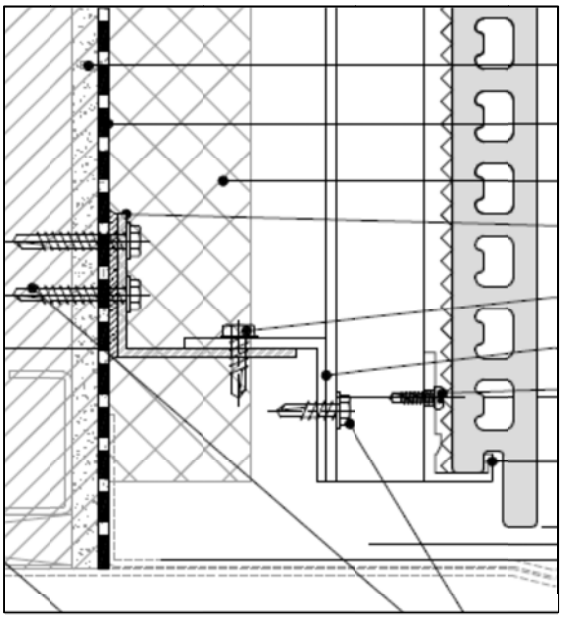


Figure 4 Section View of Terra Cotta System

CURTAIN WALL

A majority of the building's facade is covered with an aluminum curtain wall system. The overall system is 7-1/4" thick and is composed of three types of glazing that are each an inch thick. The glass types include clear insulating glass, translucent spandrel glass and opaque spandrel glass. In addition to the glass, 1" thick insulated metal panels and 8" extruded aluminum sunshades are used throughout the system to help accent to the curtain wall.

Figure 5 Curtain Wall System

SUPPORT OF EXCAVATION

Although the project did not require a large amount of excavation, the excavation that was performed needed to be supported. This was accomplished by using the method of soil nailing. Roughly 19 soil nails were drilled and installed, followed by Shotcrete to help support the excavation.

Figure 6 Soil Nail and Shotcrete

PROJECT COST EVALUATION

The figures below display cost estimate values produced by Burchick Construction, along with five other subcontractors' bids to construct the Chevron Annex. The values of each bid package were recorded at the time of the bid opening in September 2009 and may have fluctuated since then.

Bid Package	Contractor	Avg. Bid	% of Building	Cost/SF
A - Site/Structure	Burchick	$ 5,750,000	28.2%	$ 164.29
B - Roofing	Stringert	$ 250,000	1.2%	$ 7.14
D - Curtainwall	Southwest	$ 1,000,000	4.9%	$ 28.57
E - General Trades	Burchick	$ 4,750,000	23.3%	$ 135.71
F - Plumbing	SSM	$ 1,250,000	6.1%	$ 35.71
G - Fire Protection	Alliance	$ 375,000	1.8%	$ 10.71
H - HVAC	SSM	$ 4,500,000	22.1%	$ 128.57
J - Electrical	Lighthouse	$ 2,500,000	12.3%	$ 71.43
		$ 20,375,000		$ 582.14

Figure 7 Building Construction Estimate by Bid Package

Referring to figure 7, the site & structure, general trades and hvac all carry a significant amount of the overall construction cost. This is because the Annex is a vertical addition with state-of-the-art chemical laboratory spaces. A vertical addition's structure is more expensive to construct than a horizontal addition because there are more variables involved such as supporting the structure with new columns and foundations, without interrupting the spaces below. Additionally, the laboratory space includes lab areas with numerous mechanical connections to help keep the area as fume and dust free as possible. The large amount of connections and equipment increases the overall price of the hvac systems, as shown in the figure above. Finally, the interior finishes and exterior facades are unique and elegant, thus increasing the cost of the general construction involved with the project. (It is important to note that the renovation square footage was not included in the calculation for the cost per square foot.)

Furthermore, an analysis of the cost of construction for the Chevron Annex was performed using the *R.S. Means* Costworks references. Both, an assembly and square foot estimate were produced using this reference and are described in the sections below.

R.S. MEANS COSTWORKS SQUARE FOOT ESTIMATE

Due to the difficulty and complexity of this project, it is tough to produce an accurate estimate using the *R.S. Means Costworks* reference. With that said, the Chevron Annex is a university laboratory addition that included a renovation to the lower levels. Using the Costworks reference, the project was modeled as a college laboratory with face brick and a concrete brick back-up on a steel frame; which was the closest type of building description the reference provided.

Refer to Appendix B.1 for a more detailed breakdown of the *R.S. Means Costworks 2011* square foot estimate.

R.S. MEANS COSTWORKS ASSEMBLY ESTIMATE

Similar to the square foot estimate, the assembly estimate was also produced using the *R.S. Means Costworks* reference. A more accurate building estimate was able to be produced using this type of estimating method. The estimate was more accurate because this reference included numerous assemblies to choose from to best model the building of interest.

Refer to Appendix B.2 for a more detailed breakdown of the *R.S. Means Costworks 2011* assembly estimate.

COMPARISON OF COSTS

Each type of estimate was compared to one another, while evaluating the differences between the costs. The total costs varied greatly as shown in the figure below:

Type of Estimate	Total Building Cost	Cost/SF
Actual	$ 20,375,000.00	$ 582.14
Square Foot	$ 5,025,000.00	$ 143.59
Assembly	$ 10,867,586.00	$ 310.50

The square foot estimate produced using the *R.S. Means Costworks* resource was significantly lower than the cost of construction summarized in figure 7. When comparing these two values, a couple of key differences were noted. The first difference between the two estimates was that the Costworks building type was referenced as a college laboratory, but the reference only produces an estimated building cost for a one story laboratory space. This poses a problem because the Annex is a two story lab space, with

an additional level for mechanical equipment. Furthermore, the final estimate produced in Costworks did not factor in the extensive amount of work that went into the exterior of the building. The exterior of the building chosen in Costworks was faced with brick and a block brick / steel frame back-up. This is far from the actual exterior, but was the most comparable of the provided selections.

The assembly estimate produced is also significantly lower than the actual cost of construction. When comparing this estimate with the actual values of construction, it was noticed that the assembly estimate was more accurate than the square foot estimate, but was still a considerable amount off. The reason for the increase in accuracy of this type of estimate is that there is a wider range of systems to choose from, making it possible to model the building more accurately than the square foot method. However, using the assemblies estimate resource, it is still difficult to accurately estimate the construction cost of a project. Some major differences between the assembly estimate and actual costs include the limited choices of façade systems, the lab equipment and amount of special finishes involved with the project. These types of specialized products are expensive and are not listen in the selection of assemblies. Also, there is a large amount of demolition and MEP systems for this project, which was not estimated in detail when performing the assembly estimate.

After comparing the different methods and resources used to develop estimates, it is concluded that the R.S. Means resources do not always produce an accurate estimate. However, these tools may be effective at the early stages of a project when the scope of work is still vague. Finally, using historical data and internal information and resources may be the best way to produce an accurate estimate for a project.

EXISTING CONDITIONS

The project is located in Oakland, Pennsylvania; which is large neighborhood in Pittsburgh where the University of Pittsburgh's main campus is located. The site and surrounding buildings are shown in the aerial photograph below. The Chevron Annex is outlined in **RED**.

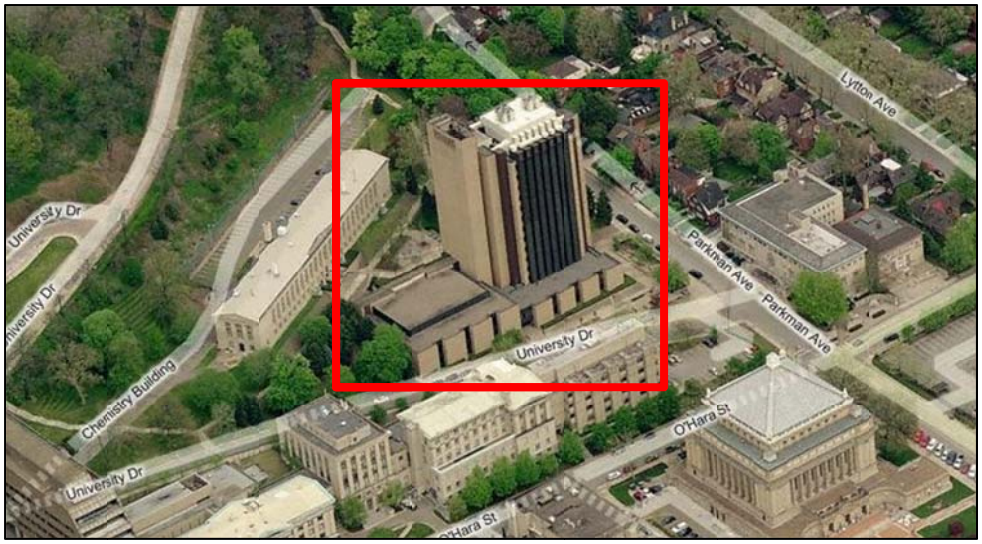


Figure 9 Bird's Eye View of the Chevron Annex and adjacent structures prior to construction

The new addition is placed on top the western section of building above the Ashe Auditorium and will be accessible from both the Chevron Tower and the Ashe Auditorium. The compacted site made it difficult for material storage and locating an on-site office. The overall site layout plan is included in Appendix C.

LOCAL CONDITIONS

The Chevron Annex is located at 219 Parkman Avenue in Oakland, Pennsylvania. The building is located on a site located in the corner of The University of Pittsburgh's main campus at the intersection of Parkman Avenue and University Drive.

Due to the fact that the project site was located in a densely populated area, parking and other areas of need were hard to come by. A site office was needed for the multiple primes involved with the project and was located approximately a quarter mile west of the site. The site office complex consisted of two small trailers and one larger double-wide trailer. The two smaller trailers were occupied by the General Contractor and the Lighting Contractor. The larger double-wide trailer was for the Construction Manager of the project.

Limited parking was available at this site-office.

The following figure displays the locations of the site, office, and lay-down areas.

RED: Project Site

BLUE: Field Offices & Limited Parking

GREEN: Lay-down/Storage Areas

Figure 10 Overhead View of Project Area

CLIENT INFORMATION

The University of Pittsburgh, commonly referred to as Pitt, is the owner of the project. The University of Pittsburgh is a public institution that is highly recognized in a number of academic areas ranging from philosophy to dentistry. The University is comprised of five campuses. The main campus is located in Oakland, with the other campuses located around western Pennsylvania. The Oakland campus has over one hundred academic, research and administrative buildings located on it. The most notable of all the buildings is the Cathedral of Learning. This building is one of the tallest academic buildings in the world, at an astonishing 42-stories and 535 feet tall.

Enrollment at the University is more than 35,000 students, which accounts for roughly five percent of all students enrolled in institutions of higher education in the state of Pennsylvania. Over 13,500 faculty and staff members assist and support the needs of the University.

Although The University of Pittsburgh is the outright owner of the project, the University's Chemistry Department is the main tenant of the space. The department is led by Dr. Peter Wipf, who is an extremely notable professor with multiple awards and publications involved with the chemistry of natural products. The space will be fitted for the department's synthetic chemistry research program. The research interests of the tenant include the total synthesis of natural products, organometallic and heterocyclic chemistry, combinatorial, medicinal and computational chemistry.

In addition to the University and their Chemistry Department, The University of Pittsburgh's Facilities Management Department is another party involved in the project. The Facilities Management Department is the main representative for the University and is led by Chris Niemann along with David Klimchock as two main representatives for the department.

PROJECT DELIVERY SYSTEM

The University of Pittsburgh used a Design-Bid-Build with CM Agency project delivery method for the Chevron Annex project. The University broke the project into eight bid packages. Each package was competitively bid and was each awarded as a lump sum contract. Contracts held between each of the primes and their subcontractors were also lump sum contracts. Due to the project's complexity, the University chose to hire a CM Agent. Mascaro Construction was the CM Agent that Pitt hired and they held a cost plus a fee contract with the owner. The organizational chart for the Chevron Annex is shown below.

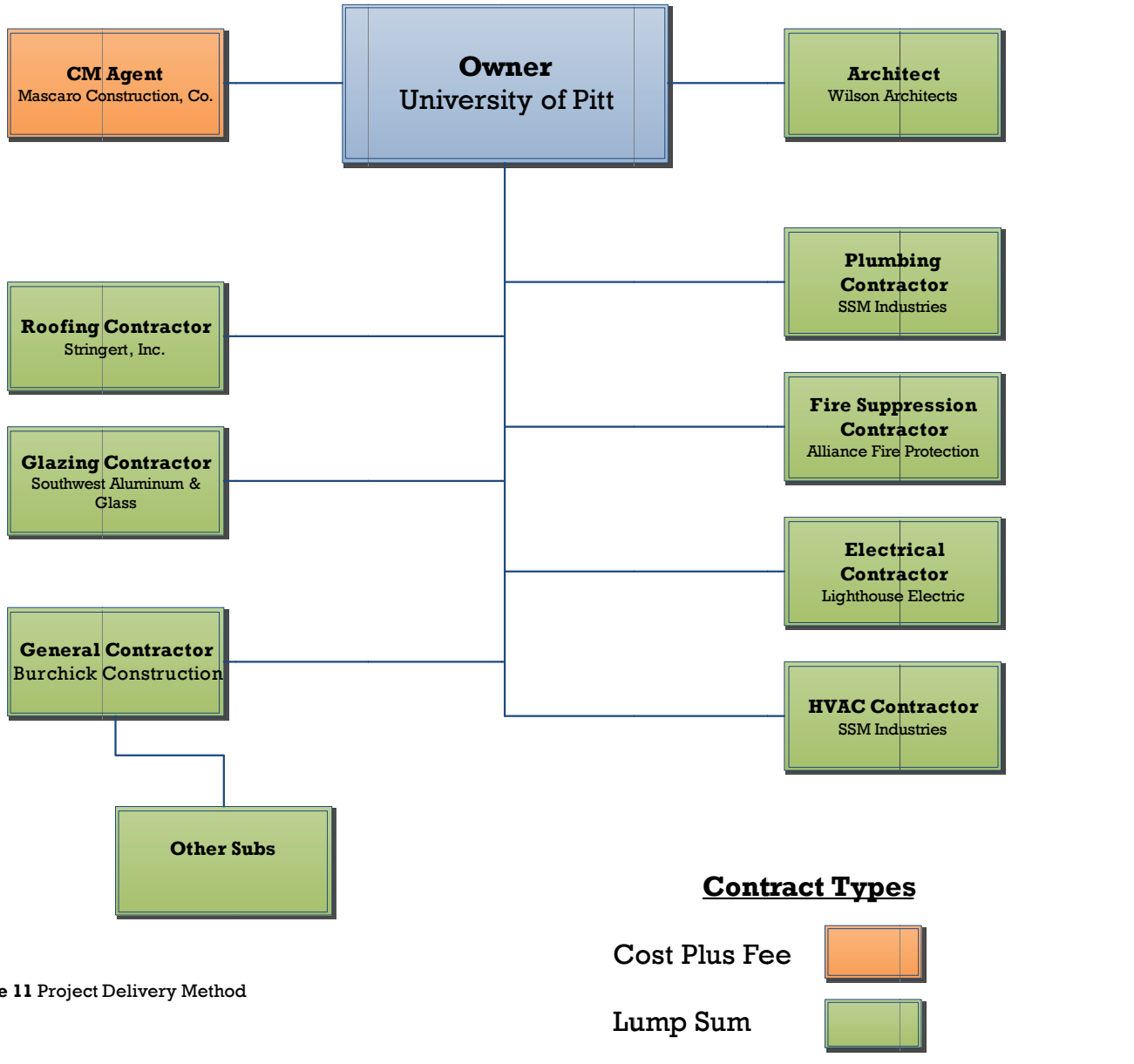


Figure 11 Project Delivery Method

STAFFING PLAN

Burchick organized their staff for this project similar to most of their other projects. However, since this job was complex, Burchick assigned more foreman than usual to this project.

Typically, for most of Burchick's projects, Joe Burchick overlooks the entire process of the project. He does this by staying in constant contact with the project manager that is assigned to the respective project. For the Chevron Annex, Burchick assigned Dave Meuschke to take on the responsibilities of project manager. Dave spent most of his time in the office; while the on-site superintendent, Keith Konesky, kept him updated on the daily tasks that were being performed. Dave also referred to Burchick's chief estimator, Joe Scaramuzzo, for any questions regarding change order costs and any information that pertained to the bidding of the project.

On-site, Keith Konesky is in charge of coordinating all of the contractors involved in the project. He is also in charge of four foremen that help him keep track of the daily activities that are performed by the various tradesmen that Burchick employs. Both, Burchick's accountant and administrative assistant also keep in touch with Dave and Keith to keep track of any accounting or administrative duties that need to be completed. The diagram below outlines the staffing plan that Burchick optimized for the Chevron Annex.

Burchick Staffing Plan

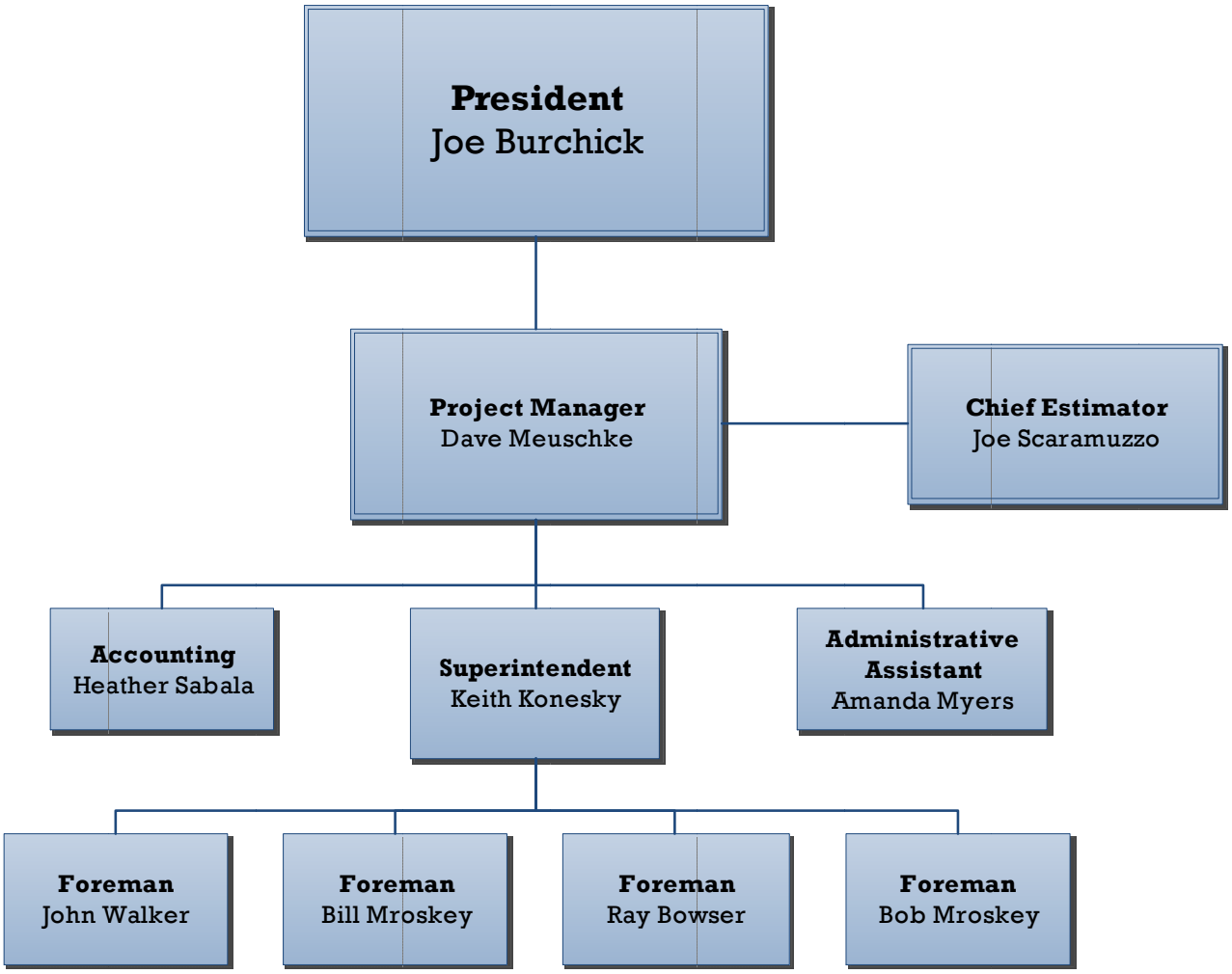


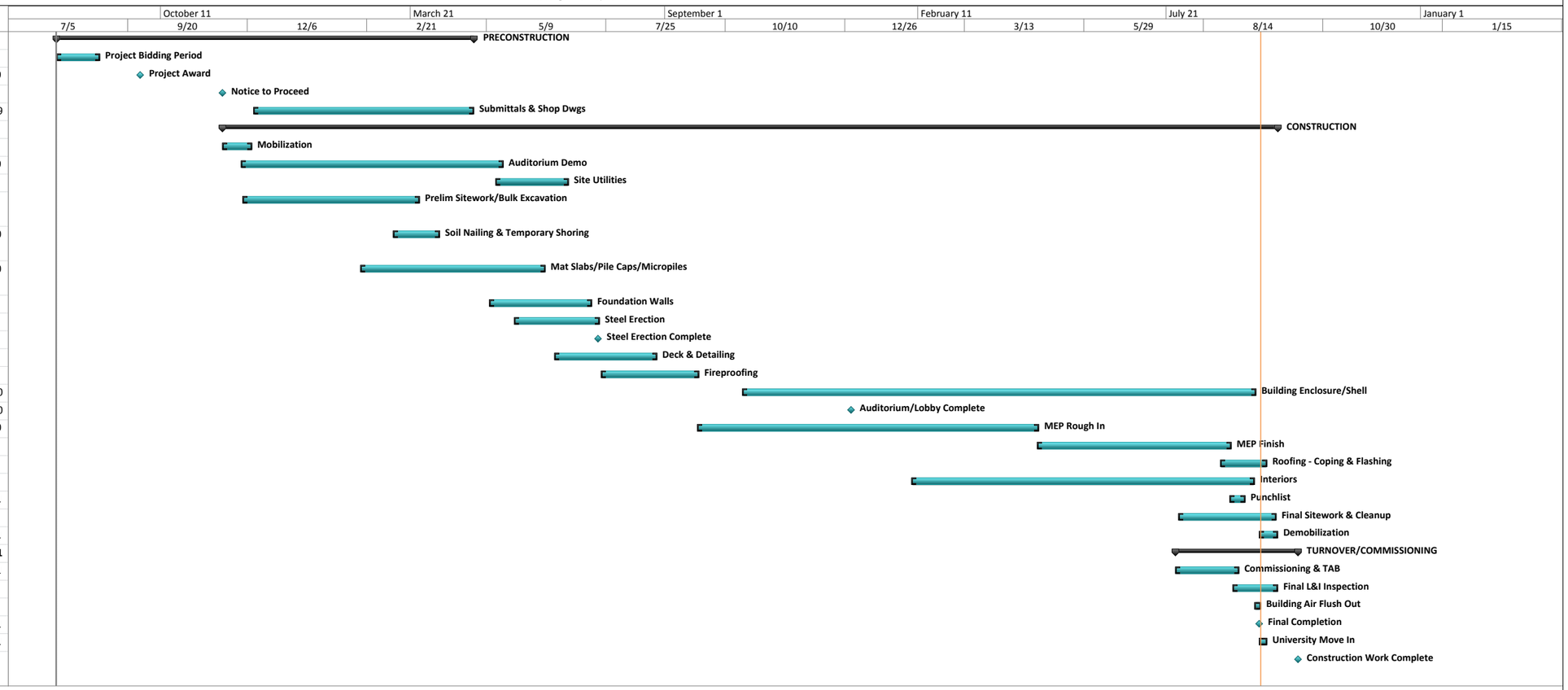
Figure 12 Burchick Staffing Plan

APPENDIX A – PROJECT SCHEDULE SUMMARY

See figure below

University of Pittsburgh Chevron Annex
Pittsburgh, Pennsylvania

ID	Task Mode	Task Name	Duration	Start
1		**PRECONSTRUCTION**	**193 days**	**Wed 8/5/09**
2		Project Bidding Period	20 days	Wed 8/5/09
3		Project Award	0 days	Mon 9/28/09
4		Notice to Proceed	0 days	Fri 11/20/09
5		Submittals & Shop Dwgs	102 days	Thu 12/10/09
6		**CONSTRUCTION**	**486 days**	**Fri 11/20/09**
7		Mobilization	13 days	Fri 11/20/09
8		Auditorium Demo	121 days	Wed 12/2/09
9		Site Utilities	34 days	Sat 5/15/10
10		Prelim Sitework/Bulk Excavation	82 days	Thu 12/3/09
11		Soil Nailing & Temporary Shoring	22 days	Wed 3/10/10
12		Mat Slabs/Pile Caps/Micropiles	85 days	Wed 2/17/10
13		Foundation Walls	48 days	Tue 5/11/10
14		Steel Erection	39 days	Thu 5/27/10
15		Steel Erection Complete	0 days	Tue 7/20/10
16		Deck & Detailing	48 days	Tue 6/22/10
17		Fireproofing	45 days	Thu 7/22/10
18		Building Enclosure/Shell	237 days	Thu 10/21/10
19		Auditorium/Lobby Complete	0 days	Thu 12/30/10
20		MEP Rough In	158 days	Wed 9/22/10
21		MEP Finish	89 days	Fri 4/29/11
22		Roofing - Coping & Flashing	22 days	Thu 8/25/11
23		Interiors	159 days	Mon 2/7/11
24		Punchlist	8 days	Wed 8/31/11
25		Final Sitework & Cleanup	45 days	Fri 7/29/11
26		Demobilization	10 days	Mon 9/19/11
27		**TURNOVER/COMMISSIONING**	**57 days**	**Wed 7/27/11**
28		Commissioning & TAB	29 days	Wed 7/27/11
29		Final L&I Inspection	21 days	Fri 9/2/11
30		Building Air Flush Out	2 days	Fri 9/16/11
31		Final Completion	0 days	Mon 9/19/11
32		University Move In	5 days	Mon 9/19/11
33		Construction Work Complete	0 days	Fri 10/14/11



Project: Chevron Schedule Summ
Date: Tue 9/20/11

Task	Milestone	Project Summary	External Milestone	Inactive Milestone	Manual Task	Manual Summary Rollup	Start-only	Deadline
Split	Summary	External Tasks	Inactive Task	Inactive Summary	Duration-only	Manual Summary	Finish-only	Progress

Robert Mroskey

APPENDIX B.1 – SQUARE FOOT ESTIMATE SUMMARY

Square Foot Cost Estimate Report

Estimate Name:	**Chevron Annex** 219 Parkman Ave , Pittsburgh , PA , 15260
Building Type:	**College, Laboratory with Face Brick with Concrete Brick Back-up / Steel Frame**
Location:	**National Average**
Story Count:	**1**
Story Height (L.F.):	**16**
Floor Area (S.F.):	**35000**
Labor Type:	**Union**
Basement Included:	**No**
Data Release:	**Year 2011 Quarter 3**
Cost Per Square Foot:	**$143.58**
Building Cost:	**$5,025,500**

Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

** Only 1 Floor

		% of Total	Cost Per S.F.	Cost
A Substructure		**8.00%**	**$11.20**	**$392,000**
A1010	**Standard Foundations**		**$2.26**	**$79,000**
	Strip footing, concrete, reinforced, load 5.1 KLF, soil bearing capacity 3 KSF, 12" deep x 24" wide spread footings, 3000 PSI concrete, load 50K, soil bearing capacity 3 KSF, 4' - 6" square x 12" deep			
A1030	**Slab on Grade**		**$4.96**	**$173,500**
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	**Basement Excavation**		**$0.17**	**$6,000**
	Excavate and fill, 30,000 SF, 4' deep, sand, gravel, or common earth, on site storage			
A2020	**Basement Walls**		**$3.81**	**$133,500**
	Foundation wall, CIP, 4' wall height, direct chute, .099 CY/LF, 4.8 PLF, 8" thick Foundation wall, CIP, 4' wall height, direct chute, .148 CY/LF, 7.2 PLF, 12" thick			
B Shell		**17.90%**	**$25.20**	**$882,000**
B1010	**Floor Construction**		**$3.93**	**$137,500**
	Floor, concrete, slab form, open web bar joist @ 2' OC, on W beam and column, 35'x35' bay, 41" deep, 125 PSF superimposed load, 173 PSF total load			

	Floor, concrete, slab form, open web bar joist @ 2' OC, on W beam and column, 35'x35' bay, 41" deep, 125 PSF superimposed load, 173 PSF total load, for columns add		
	Fireproofing, gypsum board, fire rated, 2 layers, 1" thick, 8" steel column, 3 hour rating, 14 PLF		
B1020	**Roof Construction**	**$7.09**	**$248,000**
	Floor, steel joists, beams, 1.5" 22 ga metal deck, on columns, 25'x30' bay, 25" deep, 40 PSF superimposed load, 60 PSF total load		
B2010	**Exterior Walls**	**$4.71**	**$165,000**
	Brick wall, composite double wythe, standard face/CMU back-up, 8" thick, perlite core fill		
B2020	**Exterior Windows**	**$1.99**	**$69,500**
	Aluminum flush tube frame, for 1/4"glass,1-3/4"x4", 5'x6' opening, no intermediate horizontals		
	Glazing panel, plate glass, 1/4" thick, clear		
B2030	**Exterior Doors**	**$2.09**	**$73,000**
	Door, aluminum & glass, with transom, narrow stile, double door, hardware, 6'-0" x 10'-0" opening		
	Door, aluminum & glass, with transom, non-standard, hardware, 3'-0" x 10'-0" opening		
B3010	**Roof Coverings**	**$4.99**	**$174,500**
	Roofing, asphalt flood coat, gravel, base sheet, 3 plies 15# asphalt felt, mopped		
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite		
	Roof edges, aluminum, duranodic, .050" thick, 6" face		
	Flashing, aluminum, no backing sides, .019"		
	Gravel stop, aluminum, extruded, 4", mill finish, .050" thick		
B3020	**Roof Openings**	**$0.41**	**$14,500**
	Skylight, plastic domes, insulated curbs, 30 SF to 65 SF, single glazing		
	Roof hatch, with curb, 1" fiberglass insulation, 2'-6" x 3'-0", galvanized steel, 165 lbs		
	Smoke hatch, unlabeled, galvanized, 2'-6" x 3', not incl hand winch operator		
C Interiors		**20.20%**	**$28.44**	**$995,500**
C1010	**Partitions**		**$9.31**	**$326,000**
	Concrere block (CMU) partition, light weight, hollow, 6" thick, no finish			
	Concrere block (CMU) partition, light weight, hollow, 8" thick, no finish			
C1020	**Interior Doors**		**$1.39**	**$48,500**
	Door, single leaf, kd steel frame, kalamein fire, commercial quality, 3'-0" x 7'-0" x 1-3/4"			
C1030	**Fittings**		**$0.04**	**$1,500**
	Lockers, steel, single tier, 5' to 6' high, per opening, minimum			
C3010	**Wall Finishes**		**$5.54**	**$194,000**

	2 coats paint on masonry with block filler			
	Painting, masonry or concrete, latex, brushwork, primer & 2 coats			
	Wall coatings, epoxy coatings, maximum			
C3020	**Floor Finishes**		**$5.59**	**$195,500**
	Carpet tile, nylon, fusion bonded, 18" x 18" or 24" x 24", 35 oz			
	Composition flooring, epoxy, minimum			
	Vinyl, composition tile, maximum			
C3030	**Ceiling Finishes**		**$6.57**	**$230,000**
	Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support			
D Services		**52.90%**	**$74.43**	**$2,605,000**
D2010	**Plumbing Fixtures**		**$31.89**	**$1,116,000**
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, wall hung, PE on CI, 18" x 15"			
	Lab sink w/trim, polyethylene, single bowl, double drainboard, 54" x 24" OD			
	Service sink w/trim, vitreous china, wall hung 22" x 20"			
	Shower, stall, fiberglass 1 piece, three walls, 36" square			
	Water cooler, electric, wall hung, wheelchair type, 7.5 GPH			
D2020	**Domestic Water Distribution**		**$3.21**	**$112,500**
	Gas fired water heater, commercial, 100< F rise, 600 MBH input, 576 GPH			
D2040	**Rain Water Drainage**		**$0.64**	**$22,500**
	Roof drain, CI, soil,single hub, 6" diam, 10' high			
	Roof drain, CI, soil,single hub, 6" diam, for each additional foot add			
D3050	**Terminal & Package Units**		**$19.00**	**$665,000**
	Rooftop, multizone, air conditioner, schools and colleges, 25,000 SF, 95.83 ton			
D4010	**Sprinklers**		**$2.80**	**$98,000**
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 50,000 SF			
D4020	**Standpipes**		**$0.27**	**$9,500**
	Wet standpipe risers, class III, steel, black, sch 40, 6" diam pipe, 1 floor			
D5010	**Electrical Service/Distribution**		**$2.54**	**$89,000**
	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 1000 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 1000 A			
	Switchgear installation, incl switchboard, panels & circuit breaker, 1200 A			
D5020	**Lighting and Branch Wiring**		**$10.47**	**$366,500**
	Receptacles incl plate, box, conduit, wire, 8 per 1000 SF, .9 W per SF, with transformer			

	Wall switches, 2.0 per 1000 SF Miscellaneous power, 1 watt Central air conditioning power, 3 watts Fluorescent fixtures recess mounted in ceiling, 1.6 watt per SF, 40 FC, 10 fixtures @32watt per 1000 SF		
D5030	**Communications and Security**	**$3.36**	**$117,500**
	Communication and alarm systems, fire detection, addressable, 50 detectors, includes outlets, boxes, conduit and wire Fire alarm command center, addressable with voice, excl. wire & conduit Internet wiring, 8 data/voice outlets per 1000 S.F.		
D5090	**Other Electrical Systems**	**$0.24**	**$8,500**
	Generator sets, w/battery, charger, muffler and transfer switch, gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 11.5 kW Uninterruptible power supply with standard battery pack, 15 kVA/12.75 kW		
E Equipment & Furnishings		**1.10%**	**$1.50**	**$52,500**
E1020	**Institutional Equipment**		**$1.50**	**$52,500**
	Architectural equipment, laboratory equipment glassware washer, distilled water, deluxe Architectural equipment, laboratory equipment glove box, fiberglass, radio isotope Architectural equipment, laboratory equipment, cabinets, wall, open Architectural equipment, laboratory equipment, cabinets, base, drawer units Architectural equipment, laboratory equipment fume hoods, not including HVAC, deluxe including fixtures			
E1090	**Other Equipment**		**$0.00**	**$0**
F Special Construction		**0.00%**	**$0.00**	**$0**
G Building Sitework		**0.00%**	**$0.00**	**$0**

SubTotal	**100%**	**$140.77**	**$4,927,000**
Contractor Fees (General Conditions,Overhead,Profit)	**2.00%**	**$2.81**	**$98,500**
Architectural Fees	**0.00%**	**$0.00**	**$0**
User Fees	**0.00%**	**$0.00**	**$0**
Total Building Cost		**$143.58**	**$5,025,500**

APPENDIX B.2 – ASSEMBLY ESTIMATE SUMMARY

See Table Below

219 Parkman Ave
Pittsburgh,
PA, 15620
Year 2011 Quarter 3

Date: 22-Sep-11

Assembly Summary Report

Chevron Assembly

Cost Estimate Report
CostWorks
RSMeans

Prepared By:
Robert Mroskey
Penn State

Division Description		Total
A Substructure		$116,713.98
B Shell		$3,265,100.00
C Interiors		$1,388,040.27
D Services		$4,455,621.20
E Equipment & Furnishings		$823,970.00
G Building Sitework		$194,296.35
Subtotal		$10,243,741.80
General Contractor's Markup on Subs	3.00%	$0.00
Subtotal		$10,243,741.80
General Conditions	3.00%	$307,312.25
Subtotal		$10,551,054.05
General Contractor's Overhead and Profit	3.00%	$316,531.62
Grand Total		$10,867,585.68

Cost Estimate Report
CostWorks
RSMeans

Assembly Detail Report

219 Parkman Ave
Pittsburgh,
PA, 15620
Year 2011 Quarter 3

Date: 22-Sep-11

Chevron Assembly

Prepared By:
Robert Mroskey
Penn State

Assembly Number			Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
A Substructure							
A10102108250			Spread footings, 3000 PSI concrete, load 800K, soil bearing capacity 3 KSF, 18' - 0" square x 39" deep	4.00	Ea.	$10,002.08	$40,008.32
A10102506250			Pile caps, 10 piles, 11' - 6" x 7' - 9" x 49", 120 ton capacity, 31"column size, 2345 K column	17.00	Ea.	$3,723.98	$63,307.66
A20201202600			Concrete wall, CIP foundation wall, 12" thick, 3500 PSI concrete, 10' high	50.00	L.F.	$267.96	$13,398.00
A Substructure Subtotal							**$116,713.98**
B Shell							
B10102081500			Steel column, TS7x5, 25 K, 20' unsupported length, 14.53 PLF	10,000.00	V.L.F.	$29.16	$291,600.00
B10102412700			W beam and girder, 20'x20' bay, 40 PSF superimposed load, 14" deep, fireproofing .839 SF/SF, 90 PSF total load	35,000.00	S.F.	$10.55	$369,250.00
B10102431950			Floor - ceiling, structural steel, galvanized composite deck, 3" deep, 20 gauge	35,000.00	S.F.	$32.36	$1,132,600.00
B10102540720			Floor, composite metal deck, 5" slab, 20'x20' bay, 21" total depth, 75 PSF superimposed load, 126 PSF total load	35,000.00	S.F.	$21.11	$738,850.00
B10107100450			Fireproofing, concrete, 3000 PSI, 1.5" thick, 12" x 4" steel beam, 2 hour rating, 93 PLF	2,000.00	L.F.	$41.48	$82,960.00
B20101282100			Stone wall, ashlar veneer, 4" thick, 8' high, metal studs@16" back-up, low priced stone	5,000.00	S.F.	$34.81	$174,050.00
B20101465300			Metal siding panel, textured aluminum, 4' x 10' x 5/16", plywood backing, single face	11,000.00	S.F.	$7.78	$85,580.00
B20202201400			Glazing panel, insulating, 1" thick units, 2 lites, 1/4" float glass, clear	12,000.00	S.F.	$31.18	$374,160.00
B30101603800			Insulation, roof deck, polystyrene extruded, 2" thick	15,000.00	S.F.	$1.07	$16,050.00
B Shell Subtotal							**$3,265,100.00**
C Interiors							
C10101361200			Partitions, gypsum board, 5/8" thick, standard	75,000.00	S.F.	$7.93	$594,750.00
C10101382500			Partitions, load bearing metal stud, 16 ga, 16" OC, 6" wide	15,500.00	S.F.	$9.73	$150,815.00
C10201141000			Metal door/metal frame, flush-hollow core, 20 ga full panel, 3'-0" x 7'-0", KD drywall frame frame, 4-7/8"	170.00	Ea.	$1,079.37	$183,492.90
C10201142360			Metal door/metal frame, flush-hollow core, louver design, 6'-0" x 7'-0", KD drywall frame, 4-7/8"	10.00	Ea.	$2,502.46	$25,024.60
C10203100100			Hinges, full mortise, low frequency, steel base, 4-1/2" x 4-1/2", USP	500.00	Ea.	$6.92	$3,460.00
C10203100400			Locksets, heavy duty cylindrical, keyed, single cylinder function	40.00	Ea.	$158.37	$6,334.80
C10203100560			Closers, rack & pinion, adjustable backcheck, 3 way mount, all sizes, regular arm	80.00	Ea.	$293.21	$23,456.80
C10203100740			Push, push plate, aluminum	30.00	Ea.	$59.54	$1,786.20
C20101301700			Stairs, steel, cement fill pan tread, 24 risers	7.00	Flight	$14,205.20	$99,436.40

Assembly Number			Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
C20101301800			Stairs, steel, cement fill pan tread, add for intermediate landing	7.00	Flight	$1,275.51	$8,928.57
C30102300080			Painting, interior on plaster and drywall, brushwork, primer & 2 coats	60,000.00	S.F.	$1.17	$70,200.00
C30102300260			Painting, cabinets and casework, enamel, primer & 1 coat	35,000.00	S.F.	$1.27	$44,450.00
C30204101100			Terrazzo, minimum	3,500.00	S.F.	$18.51	$64,785.00
C30302101000			Suspended ceiling, 2' x 4' grid, fiberglass board, film faced, 5/8" thick	20,000.00	S.F.	$4.20	$84,000.00
C30302201400			Ceilings, suspended gypsum board, 4' x 8' x 5/8", gypsum drywall, 2 coats paint	6,000.00	S.F.	$4.52	$27,120.00
C Interiors Subtotal							**$1,388,040.27**
D Services							
D20101102080			Water closet, vitreous china, bowl only with flush valve, wall hung	12.00	Ea.	$2,586.92	$31,043.04
D20102102000			Urinal, vitreous china, wall hung	2.00	Ea.	$1,439.27	$2,878.54
D20103101600			Lavatory w/trim, vanity top, PE on CI, 19" x 16" oval	15.00	Ea.	$1,292.73	$19,390.95
D20104301960			Lab sink w/trim, polypropylene, cup sink, oval, 10" x 4-1/2" od	16.00	Ea.	$1,140.20	$18,243.20
D20908100920			Pipe cast iron, soil, B & S, service weight, 6" diameter	12,000.00	L.F.	$55.20	$662,400.00
D30105301920			Commercial building heating systems, terminal unit heaters, forced hot water, 10,000 SF bldg,100,000 CF, total, 2 floors	35,000.00	S.F.	$8.78	$307,300.00
D30201242600			Gas fired, heating and cooling, area to 3000 SF	35,000.00	S.F.	$6.15	$215,250.00
D30401061010			AHU, field fabricated, built up, cool/heat coils, filters, constant volume, 40,000 CFM	2.00	Ea.	$93,258.50	$186,517.00
D30401101020			AHU, central station, cool/heat coils, constant volume, filters, 5,000 CFM	1.00	Ea.	$32,160.38	$32,160.38
D30501501760			Rooftop, single zone, air conditioner, banks or libraries, 10,000 SF, 41.67 ton	35,000.00	S.F.	$11.23	$393,050.00
D30903101050			Fume hood exhaust system, 10 FT long, 8000 CFM	12.00	Ea.	$53,444.08	$641,328.96
D40104202500			Fire sprinkler system wet, ordinary hazard, one floor, area to 8000 SF/floor	35,000.00	S.F.	$5.89	$206,150.00
D40203100560			Wet standpipe risers, class I, steel, black, sch 40, 4" diam pipe, 1 floor	4.00	Floor	$7,761.58	$31,046.32
D50101200280			Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 200 A	50.00	Ea.	$3,823.40	$191,170.00
D50101200520			Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 1600 A	1.25	Ea.	$38,692.25	$48,365.31
D50102400360			Switchgear installation, incl switchboard, panels & circuit breaker, 1600 A	1.00	Ea.	$46,513.00	$46,513.00
D50201150280			Receptacle systems, underfloor duct, 7' on center, low density	35,000.00	S.F.	$8.44	$295,400.00
D50202481300			Lighting, fluorescent, surface mounted, 2' x 4', acryl prismatic diffuser	50.00	Ea.	$453.62	$22,681.00
D50202481400			Lighting, fluorescent, strip fixture, 8' long, two 8' lamps	75.00	Ea.	$392.82	$29,461.50
D50303100320			Telephone systems, underfloor duct, 7' on center, high density	35,000.00	S.F.	$11.75	$411,250.00
D50309100280			Communication and alarm systems, includes outlets, boxes, conduit and wire, sound systems, 100 outlets	2.00	Ea.	$131,851.00	$263,702.00
D50902101400			Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 1000 kW	1,500.00	kW	$266.88	$400,320.00
D Services Subtotal							**$4,455,621.20**
E Equipment & Furnishings							

Assembly Number			Description	Quantity	Unit	Total Incl. O&P	Ext. Total Incl. O&P
E10207300110			Architectural equipment, laboratory equipment, cabinets, wall, open	1,000.00	L.F.	$223.33	$223,330.00
E10207300120			Architectural equipment, laboratory equipment, cabinets, base, drawer units	1,000.00	L.F.	$600.64	$600,640.00
E Equipment & Furnishings Su							**$823,970.00**
G Building Sitework							
G20103052000			Concrete curb, 6" wide, 18" high, cast-in-place	140.00	L.F.	$9.42	$1,318.80
G20103053000			Granite curb, 4-1/2" wide, 12" high precast	100.00	L.F.	$23.29	$2,329.00
G20301201600			Concrete sidewalk, 4" thick, 4" gravel base, 4' wide	5,000.00	L.F.	$24.90	$124,500.00
G20301506100			Plaza, granite pavers, 3-1/2" x 3-1/2" x 3-1/2" thick, slab-on-grade, mortar bedding	500.00	S.F.	$40.25	$20,125.00
G20504201000			Lawn establishment, with loam, lime, fertilizer, seed, hay mulch	1,500.00	S.Y.	$12.01	$18,015.00
G30603201010			Storage tank, fuel, underground, double wall steel, 500 gallon	1.00	Ea.	$28,008.55	$28,008.55
G Building Sitework Subtotal							**$194,296.35**

APPENDIX C – OVERALL SITE LAYOUT PLAN

See figure below

PORTA-JOHN

MATERIAL STORAGE

CONEX TRAILER STORAGE

MOCK UP

TRASH CHUTE

ROADS/PARKING LOTS

SIDEWALKS

DUMPSTER

HEAVY EQUIPMENT

NORTH

TO SITE TRAILERS

EBERLY HALL PARKING LOT

EXISTING EBERLY HALL

LOADING DOCK

PROPOSED ANNEX BUILDING 110 FEET

EXISTING CHEVRON TOWER 15 STORIES

PARKMAN AVE.

UNIVERSITY DRIVE

MOCK UP

EXISTING ENGINEERING BUILDING

General Notes

No.	Revision/Issue	Date

Robert Mroskey

University of Pittsburgh Chevron Annex

219 Parkman Ave

Pittsburgh, PA 15260

Site Layout Plan

Date : 9/23/2011

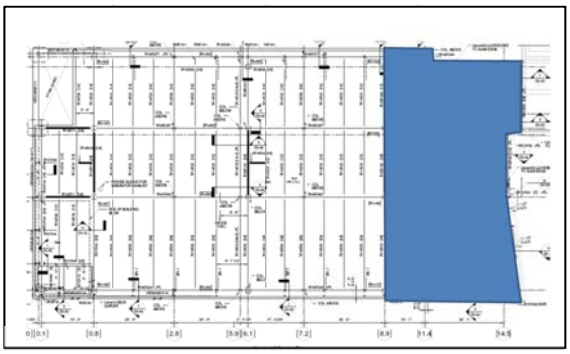
Scale : NTS

Sheet

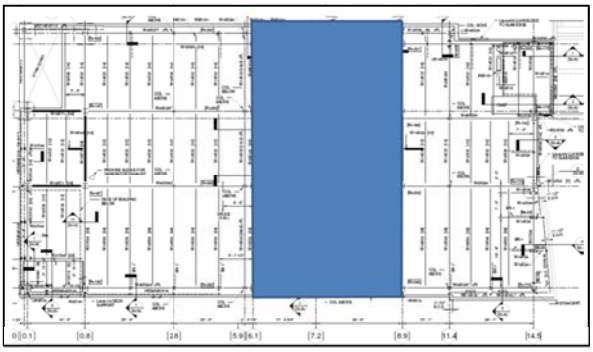
1 of 1

APPENDIX D – STEEL PHASE SEQUENCING

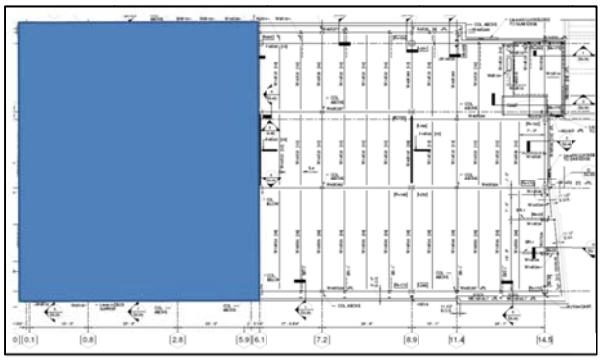
The figures below portray sequences 4-15 for the steel erection involved with the vertical addition of the Chevron Annex. The crane was placed at the southwest corner of the building on University Drive and the steel laydown area was also on University Drive.



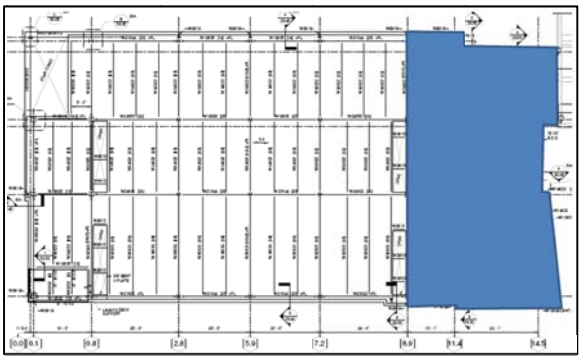
Sequence #4 Erect Steel CL 14.5-8.9 Floor 2



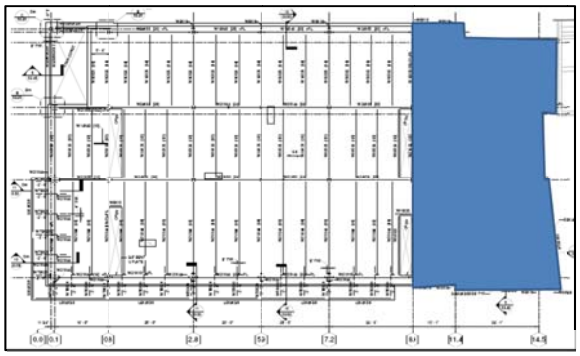
Sequence #5 Erect Steel CL 8.9-6.1 Floor 2



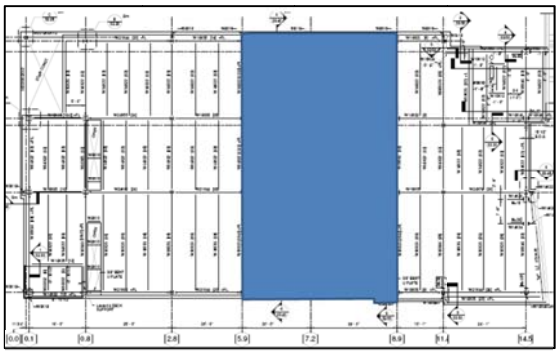
Sequence #6 Erect Steel CL 6.1-0.0 Floor 2



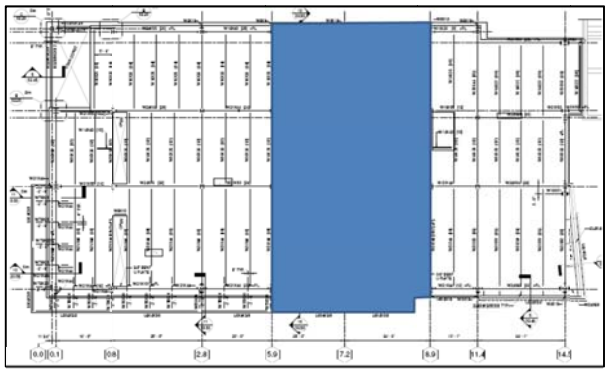
Sequence #7 Erect Steel CL 14.5-8.9 Floor 3



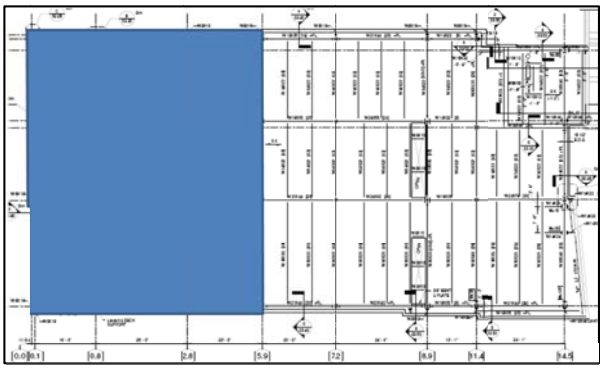
Sequence #8 Erect Steel CL 14.5-8.9 Floor 4



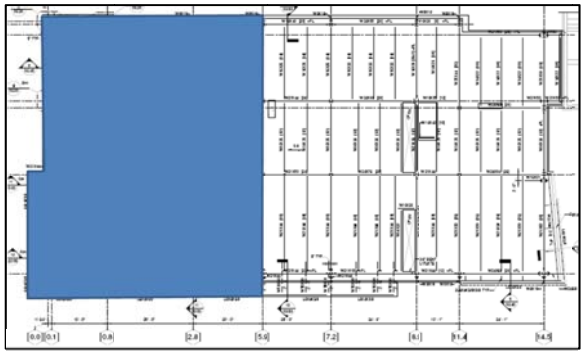
Sequence #9 Erect Steel CL 8.9-5.9 Floor 3



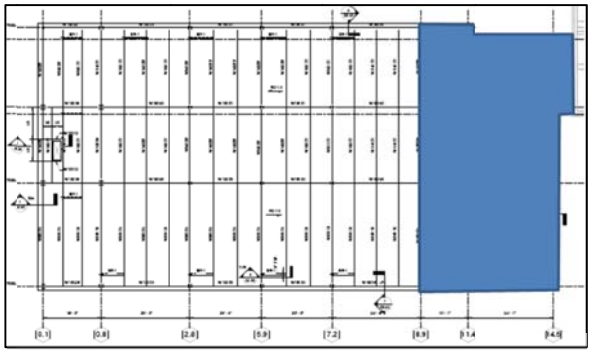
Sequence #10 Erect Steel CL 8.9-5.9 Floor 4



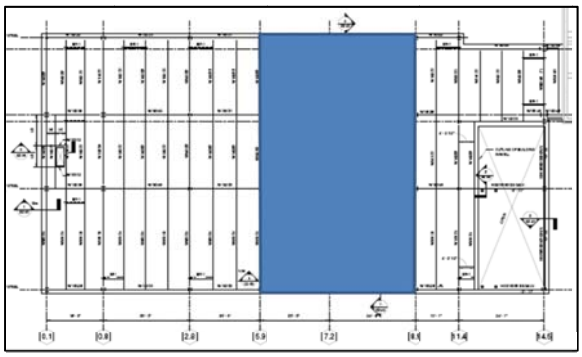
Sequence #11 Erect Steel CL 5.9-0.0 Floor 3



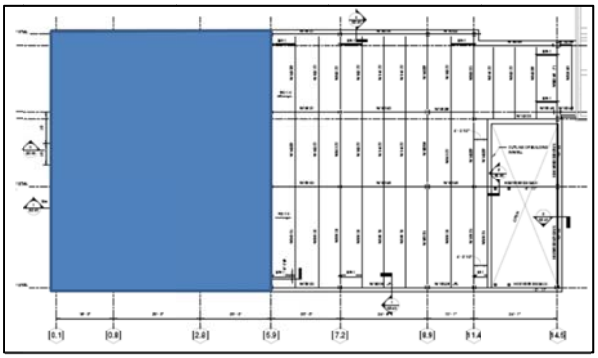
Sequence #12 Erect Steel CL 5.9-0.0 Floor 4



Sequence #13 Erect Steel CL 14.5-8.9 Floor Roof



Sequence #14 Erect Steel CL 8.9-5.9 Floor Roof



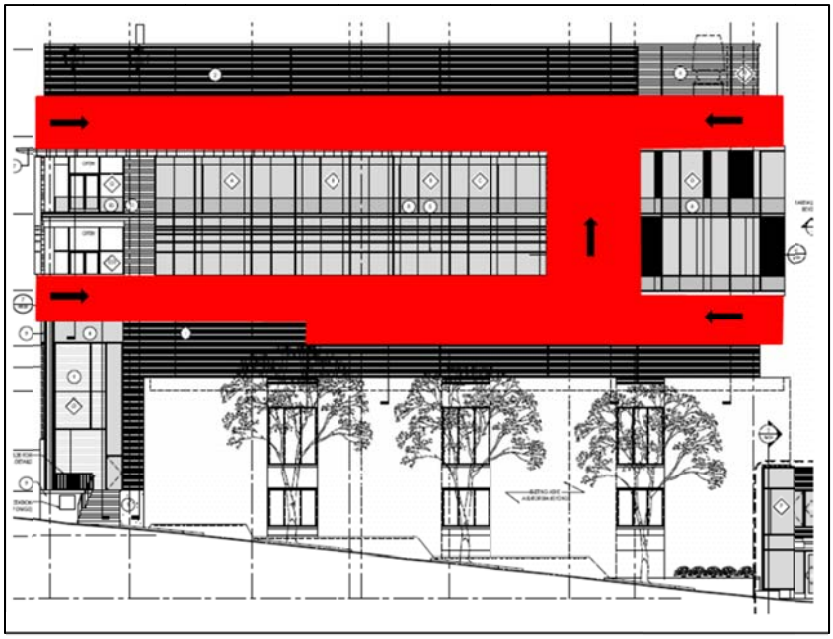
Sequence #15 Erect Steel CL 5.9-0.0 Floor Roof

APPENDIX E – TERRA COTTA FACADE PHASE SEQUENCING

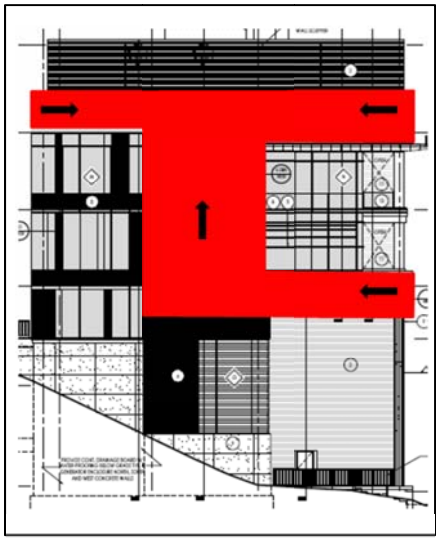
The figures below portray the phasing that was involved with installing the terra cotta façade system (shown in red) for the Chevron Annex. It is important to note that these figures that portray the phasing sequence plan of the terra cotta is a simplified version of the actual phasing used on site. In addition, the terra cotta system was installed using both swing scaffolds and JLG boom lifts. The determination of which pieces of equipment were to be used was a decision made on-site to best utilize the equipment and space provided at the time of installation. One major issue to note is that the tiles needed to be installed from the bottom up and the corner tiles of the system needed to be installed simultaneously, which were key roles in dictating the starting points of the installation procedure involved with the system.

The terra cotta first started on the east side of the building and was phased around the building in a clockwise manner. While the east elevation was being installed and the southeast corner was set, the south elevation's backup framing was able to be installed. This allowed the crews to specialize in one of the steps of the system, resulting in a better overall efficiency of the workers. As the south elevation was moving along to the center; the west elevation was being framed and insulated, keeping the installation process flowing smoothly. Finally, the terra cotta finished on the north elevation, completing the terra cotta façade. The figures below portray the sequencing of each face of the building shown by the arrows.

East Elevation



South Elevation



West Elevation

North Elevation