Technical Report II

900 16th Street

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Construction Management | Leicht

EXECUTIVE SUMMARY

Technical Report II provides an in depth analysis of the façade used on the 900 16th Street office building. While there are a variety of façade types used on this structure the main focus of this report is to analyze the precast and curtainwall façade system. The analysis's preformed focus on the means and methods, project schedule, system costs, and site logistics associated with this process. This report also includes an interview with DAVIS superintendent Brad Dugan. The content of said interview covers causes of schedule delays, possible schedule acceleration scenarios, constructability challenges and logistical issues.

The façade of 900 16th Street is comprised of four major systems including precast panels, curtainwall, EIFS, and a 3D structural curtainwall. Of the four systems present three of the systems were held to a 22 week duration between the middle of May 2015 and the beginning of October 2015. The final system to be installed was the 3D curtainwall which began in late September of 2015 and is expected to be completely finished in early February of 2016. Several areas could have had a great impact on the schedule durations. To shorten the overall installation time there could have been an additional assist crane to help with precast panels. Also it would have been helpful if there was more attention to detail in trade coordination and delivery schedules.

Upon completion of a detail estimate of the façade, using Timberline estimation software, a value of $9,303,905 was reached. This value was roughly $1.2 million greater than the actual cost of the system. The variations in the final system cost came from differences between subcontractor values and the values provided by the Timberline software. The site logistics plans included in the appendices clearly show the location of all major equipment located on site and the explanations in the following report tell of the areas of focus in each.

Throughout the project the entire team was consistently faced with issues that threatened the schedule. Some of these were completely unavoidable (i.e. the Secret Service denying material deliveries). An interview with the DAVIS site superintendent shed light on some of the major constructability and logistics concerns and issues. During said interview possible solutions to the problems that had arisen throughout construction were discussed and came be found in the following report.

TABLE OF CONTENTS

| PRODUCTION PLAN |

System Construction Means and Methods:

Each panel was picked into place by one of the two cranes on site during this period of the construction. All panels on the South and the West were picked into place by the tower crane that was utilized during the construction of the structure of 900 16th Street. To install the panels on the East face of the façade were picked into place using a separate crawler crane brought in specifically with this process. With a consistently flow of deliveries, each panel was picked directly from the flatbed truck in which it was brought to site on. Although various connection methods are used the main method involves steel plate embeds in both the precast panels and structure. Once in place, a piece of steel angle is bolted to the panel and tack welded in place. While panels in a sequence are being lifted into place a crew of welders use a process referred to as back welding to permanently secure each of the panels in the previous sequence to the building. Following the start of the façade installation the installation of the aluminum punched window units was able to begin. The curtain wall systems located on the Northeast and Southeast corners of the main structure were constructed with a two man crew and the use of a JLG lift. So that flying in the precast panels did not damage the curtainwall system, its construction did not begin until the completion of the panels. The final part of the façade to begin construction is the 3D feature curtainwall system. This highly complex system designed in Germany is being delivered to site on flat beds and is being lifted into place with a truck crane. All the connections are being completed by hand by tradesmen on a JLG lift. The West façade features an Exterior Insulated Finishing (EIFS) system. This system is connected to exterior sheathing fastened to 6" metal studs. All of the EIFS system was constructed using a swing stage scaffolding system.

LEGEND
Yellow – Limestone Precast
Red – Marble Precast
Green – Curtainwall/Storefront
Orange – Structural Curtainwall
White – Window Units

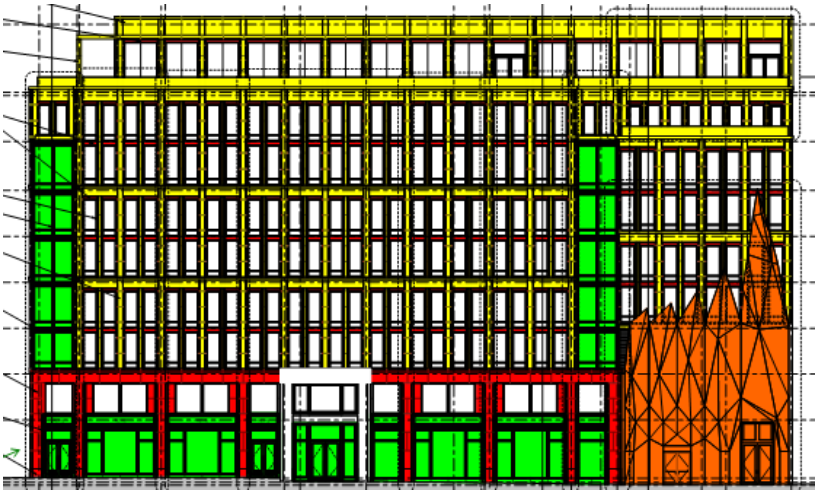


Figure 1: Various Façade Types on East Face

Production Schedule:

Refer to Appendix A for Detailed Project Schedule of the façade

The construction of the façade is key to the completion of all interior work because without the enclosure the building is open to the elements. Prior to beginning the façade it is necessary that the entire structure be complete so that all of the precast panels can be received. Timely completion of the façade is key to getting the building dried in. When the façade is nearing completion the interior trades can be released to close out the project.

Construction of the East façade began on the street level of the South portion and began to move northward. With the tower crane just of the East façade precaution needed to be taken when pieces of precast were being erected in that area. Once those panels were in place the crawler crane was relocated to the North end of the site, switching places with the laydown areas. The erectors of the precast panels, EE Marr, typically ran a crew of 1 Superintendent, 1 Foreman, 6 Certified Welders, and 1 Rigger. The number in the crew varied occasionally depending to the amount of work that needed or could be completed on any given day. Using this crew set up the subcontractor was able to install all of the precast panels in 44 days. The curtainwall system located in the Northeast and Southeast corners of the building were constructed by a crew of 3 using a JLG lift to assist them. A crew of 5 tradesmen was tasked to construct the 3D curtainwall system.

Detailed Cost Estimate:

Refer to Appendix B for the entire Detailed Cost Estimate

A detailed cost estimate of the 900 16th Street façade was compiled using Timberline estimation software. This estimate includes the curtainwall, 3D curtainwall, precast panels, and EIFS systems. Also included in this estimate was the equipment cost for both the tower crane and the crawler crane used to set the precast panels. The material, labor and equipment costs shown in the estimate come from the databases that are within the Timberline program. After completion of the estimate a value of $9,303,905 was reached for the total cost of the entire façade.

Site Plans and Logistics:

Refer to Appendix C for Site Logistics Plans for each phase of construction

The site logistics during this construction process experienced very little change throughout its duration because all three sides were being constructed at the same time. The precast of the West and the South were erected with the same tower crane that was used to build the structure. A swing stage scaffold was placed on the northern part of the West façade to install the EIFS system. Before the South and West sides began an 80 ton crawler crane was delivered to site to erect the East face. One main change in the site layout is the position of this crawler crane. Initially it had been located in the South portion of the site, shown in the first site plan in Appendix C, so that it could lift into place all of the precast panels in that section of the East

façade. Following the completion of South portion of the East façade it was relocated to the North, shown in the second site plan in Appendix C, to set the remainder of the panels. It was extremely important that the crane did not affect site access or egress throughout the entire process so the follow of deliveries would be able to continue.

Following the completion of the precast, EIFS, and curtainwall systems both cranes were dismantled and removed from site. At this point a truck crane was brought onto the site to be used for the erection of the 3D structural curtainwall system at the entrance of the church. The location of this system caused the site access to tighten significantly (shown in the third site plan in Appendix C). The positioning of the crane blocked the main access to the site making it more difficult to receive deliveries.

PRODUCTION ANALYSIS

Production Analysis:

Overall the schedule was structured in such a way that allowed for the system to be completed in the least amount of time. Instead of completing a single face at a time the team thought it would be best to work on all three faces at once. This was only possible due to careful planning which ensured the tower crane used for the structure could support the load of the largest precast panel, brought in a second crane, and set up a swing stage scaffold. These three pieces of equipment allow the plan of completing all three faces come to fruition. By doing so the overall project schedule was cut and the interior trades were able to be released at an earlier date then if they were done one after another. To feed the precast façade erection there were two flat beds of panels on site at all times but on many occasions that was not enough to keep work moving continually. The team could have implemented a laydown area in close proximity to the crane so that there could have been an excess of panels available on site. This way there would not be any down time because of a lack of material. At various points deliveries would be shut down because of events occurring at the White House, located only two blocks from the project site. Halting of material deliveries caused occasional delays in the production schedule. These delays could have been avoided if the project team took more time to plan the deliveries around significant events occurring in the area.

Cost Analysis:

Table 1 below shows that comparison between the actual cost of the façade and what the detailed estimate completed on Timberline yielded.

Table 1: Cost Comparison

Detailed Estimate	$9,303,905
Actual Cost	$8,098,768

The estimate I compiled came out to be $1,205,137 over the actual cost of the façade system. There are several reasons as to why the two numbers are different. The main reason comes from the limitations of the estimation software used. This building has a unique façade that was not specifically available in any of the databases so the closest system had to be chosen as an alternative. In some cases a more expensive system was the only alternative and certain would have drove up the costs. For instance the system did not include the specific type of precast façade panels that were used on the job. To attain a similar cost, separate line items for the concrete and the limestone/marble had to be used. The additional labor costs created from the having three activities instead of one added to the overall system cost. Along with that all prices for the material, labor and equipment costs used in this estimate came directly from the Timberline software so it is very possible that any of the three costs was a several over estimate of the actual costs per unit.

Logistical Analysis:

When looking at the utilization of space on site and the various systems that were used to complete this process I believe that it was very efficient. The South, East, and West facades were all being worked on at the same point in time and were completed on nearly the same dates. While there were many aspects of the positioning of material and equipment that allowed for a good flow of work, there is still room for improvement. The most important thing with a site located in the heart of a city is unimpeded site access and egress. Throughout the entire process the crawler crane never became an issue, but the flat beds occasionally did (as seen in Figure 2). While it can be argued that the weight of the panels does not allow the flat beds to be further from the crane, it was possible to remove the panels from the flat bed and place them in a staging area. In doing so site access and egress could have been cleared so that deliveries for other trades could be more easily received. During the installation of this system the primary entrance to the site is cut off by the crane (shown in Figure 3). At this stage in the construction process the only deliveries that the crane location poses a threat to is curtainwall deliveries. Almost all other deliveries are coming in on box trucks and have the capacity to enter an exit through a single gate. It may have been possible to set the crane up parallel

Figure 2: Site Congestion

Figure 3: 3D Curtainwall Crane Location

to the structure so that the primary entrance could have remained open.

FIELD SUPERVISOR INTERVIEW

Refer to Appendix D for a Transcript of the interview conducted

Schedule Acceleration Scenarios:

The façade of a structure plays perhaps one of the most important roles in the critical path of any construction project. This is true because in order for the building to be dried in the façade must be completed. Without dry in it is almost impossible to release the interior trades. By releasing them early the project runs the risk of huge delays if the interior materials are damaged by inclement weather. Since this process is one of the final tasks on the building it can make or break the schedule. If it does not finish according to the schedule then the interior trades will be delayed and furthermore the entire project.

At the end of the day the precast façade system that is utilized on 900 16th Street is fairly simple for a contractor that is used to this type of construction. However there are a few key elements that could have helped to accelerate the schedule of a project that was already 3 months behind. One issue that was brought up during the interview was the lack of laydown area and occasional work stoppages that came when there were no more panels to be lifted on site. It was suggested that perhaps the erector could have built a device that allowed for the panels to be stored on site so that a steady flow of deliveries could have been established. This way there would never be a time when they ran out of panels to erect on site.

To assist with the process of unloading all of the panels that were being delivered, a third crane could have been on site with the sole purpose of unloading panels and placing them in the designated storage area. This additional crane could also be used to double the productivity by using it to lift panels into place. With two cranes, each working from a different direction, the duration to erect the East façade the overall duration could have been drastically reduced.

Constructability and Logistical Challenges:

As stated earlier most of the façade is a fairly simple system but what did provide challenges were the number of various connections and the added weight of the precast panels from the limestone and marble. While a majority of the connections between the panels and the structure were quite typical there were many that required special attention due to their complexity. These welded connections took a considerable amount of time to complete compared to their typical counterparts.

Besides the varying variety and complexity of the connections the marble and limestone cast into the concrete created a whole new challenge. This challenge was the added weight to the panels from these dense stones. The increase in weight required larger cranes and extra care in

maneuvering each panel into place. To best take these challenges out of the picture the DAVIS team held many preconstruction meetings with all parties involved to choose the cranes to be delivered to site. This ensured that the entire process would run as smoothly as possible.

Another large constructability concern was the 3D structural curtain wall that serves as the entrance to the church. Each connection within this system is different than the last, which slows down the construction process significantly. Also due to the complex shapes of glass panes and framing system the shop drawings were impossible to submit in 2D. For this reason a 3D shop drawing model was submitted to the architect for approval. Attempting to complete and approve 2D drawing of this system pushed the fabrication dates a considerable amount. The shear complexity of the system lead to many delays throughout the design phases and is proving to be difficult to construct in the field now that that process has begun.

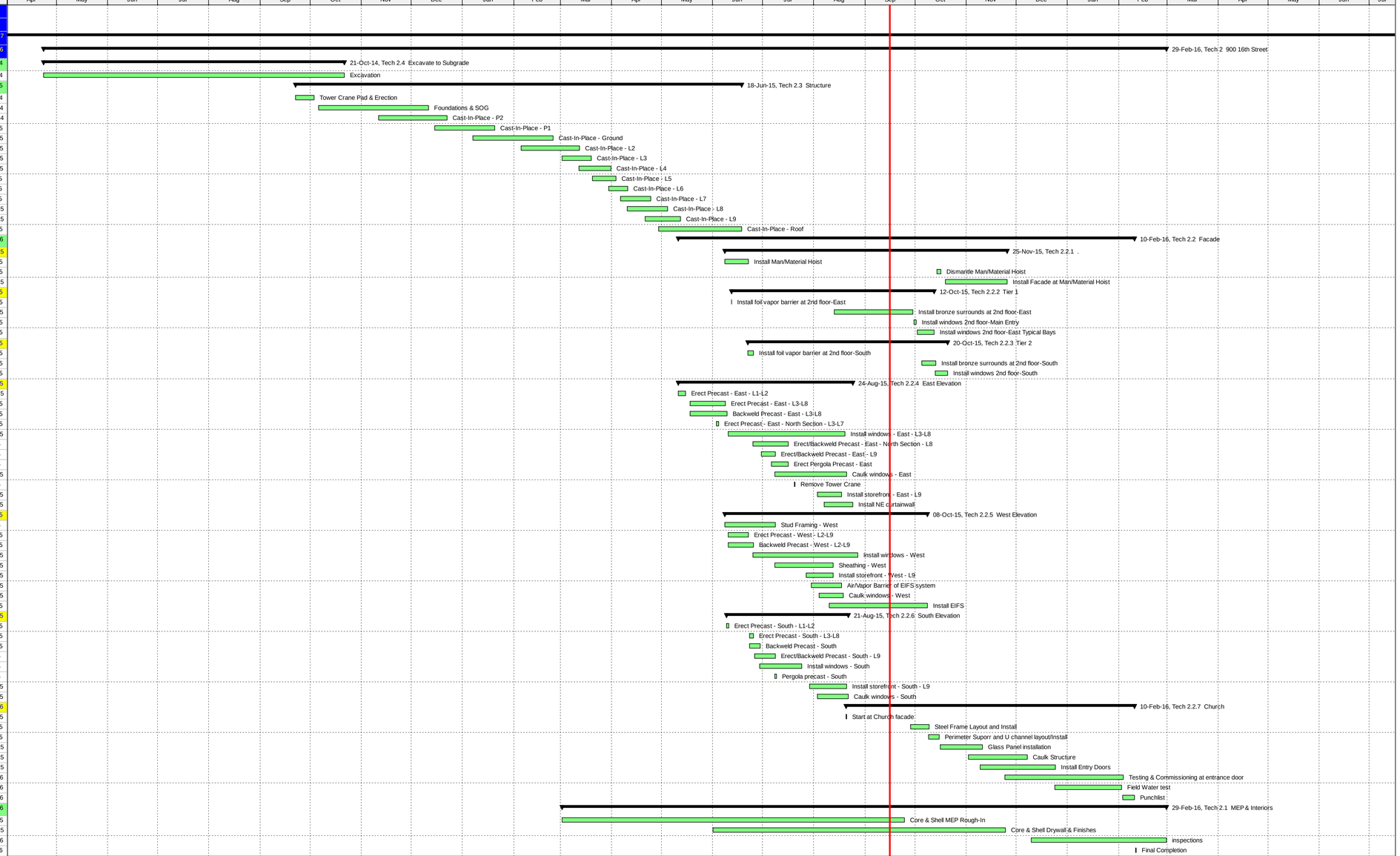
One final general issue throughout all of construction, that was sometimes unavoidable, was the delay of material deliveries to the site. Due to the project sites proximity to the White House and the National Mall there were several circumstances in which deliveries would have to be canceled or delayed by order of the Secret Service. Also the traffic congestion of the always busy streets of DC contributed to delays throughout the entire installation of the façade. More careful planning around big events in the area and heavy traffic hours could have prevented these delays.

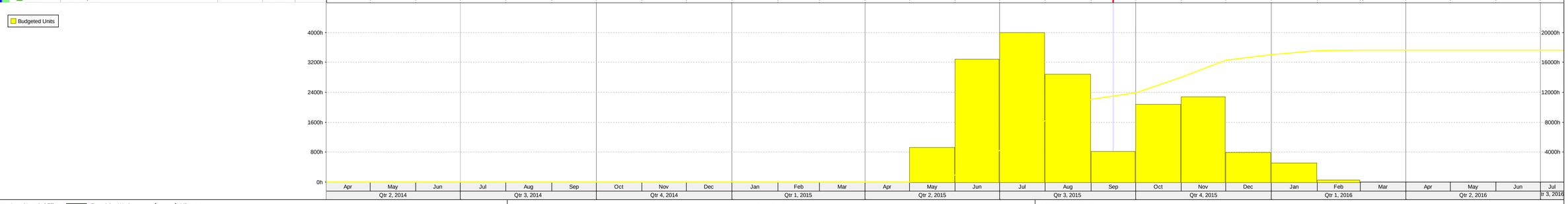
If presented with the same system on another project it would be helpful to go over thoroughly with the welders on site to ensure they fully understand all connections no matter the complexity. In doing so it is possible that the time lost at complex connections could have been avoided. It would have been helpful to begin the design of the 3D curtainwall at an earlier date so the fabrication could have begun at an earlier date Also it would be extremely beneficial to the process if additional storage on site was available.

Appendix A:

Detailed Production Schedule

#	Activity ID	Activity Name	Original Duration	Start	Finish
1		001 Whitmore Lab Renovatoin	0		
2		Performing Arts Performing Arts Facade	0		
3		PCA The Performing Arts Center	1091	01-Oct-13	07-Dec-17
4		Tech 2 900 16th Street	484	23-Apr-14	29-Feb-16
5		Tech 2.4 Excavate to Subgrade	130	23-Apr-14	21-Oct-14
6	A1000	Excavation	130	23-Apr-14	21-Oct-14
7		Tech 2.3 Structure	194	22-Sep-14	18-Jun-15
8	A1010	Tower Crane Pad & Erection	10	22-Sep-14	03-Oct-14
9	A1020	Foundations & SOG	49	06-Oct-14	11-Dec-14
10	A1030	Cast-In-Place - P2	30	11-Nov-14	22-Dec-14
11	A1040	Cast-In-Place - P1	27	15-Dec-14	20-Jan-15
12	A1050	Cast-In-Place - Ground	35	07-Jan-15	24-Feb-15
13	A1060	Cast-In-Place - L2	26	05-Feb-15	12-Mar-15
14	A1070	Cast-In-Place - L3	14	02-Mar-15	19-Mar-15
15	A1080	Cast-In-Place - L4	14	12-Mar-15	31-Mar-15
16	A1090	Cast-In-Place - L5	11	20-Mar-15	03-Apr-15
17	A1100	Cast-In-Place - L6	10	30-Mar-15	10-Apr-15
18	A1110	Cast-In-Place - L7	15	06-Apr-15	24-Apr-15
19	A1120	Cast-In-Place - L8	17	10-Apr-15	04-May-15
20	A1130	Cast-In-Place - L9	16	21-Apr-15	12-May-15
21	A1140	Cast-In-Place - Roof	37	29-Apr-15	18-Jun-15
22		Tech 2.2 Facade	198	11-May-15	10-Feb-16
23		Tech 2.2.1 .	123	09-Jun-15	25-Nov-15
24	A1150	Install Man/Material Hoist	11	08-Jun-15	22-Jun-15
25	A1160	Dismantle Man/Material Hoist	3	14-Oct-15	16-Oct-15
26	A1170	Install Facade at Man/Material Hoist	28	19-Oct-15	25-Nov-15
27		Tech 2.2.2 Tier 1	87	12-Jun-15	12-Oct-15
28	A1180	Install foil vapor barrier at 2nd floor-East	0	12-Jun-15	12-Jun-15
29	A1190	Install bronze surrounds at 2nd floor-East	34	13-Aug-15	29-Sep-15
30	A1220	Install windows 2nd floor-Main Entry	2	30-Sep-15	01-Oct-15
31	A1230	Install windows 2nd floor-East Typical Bays	7	02-Oct-15	12-Oct-15
32		Tech 2.2.3 Tier 2	87	22-Jun-15	20-Oct-15
33	A1240	Install foil vapor barrier at 2nd floor-South	4	22-Jun-15	25-Jun-15
34	A1250	Install bronze surrounds at 2nd floor-South	7	05-Oct-15	13-Oct-15
35	A1260	Install windows 2nd floor-South	6	13-Oct-15	20-Oct-15
36		Tech 2.2.4 East Elevation	76	11-May-15	24-Aug-15
37	A1270	Erect Precast - East - L1-L2	5	11-May-15	15-May-15
38	A1280	Erect Precast - East - L3-L8	16	18-May-15	08-Jun-15
39	A1290	Backweld Precast - East - L3-L8	17	18-May-15	09-Jun-15
40	A1300	Erect Precast - East - North Section - L3-L7	2	03-Jun-15	04-Jun-15
41	A1310	Install windows - East - L3-L8	51	10-Jun-15	19-Aug-15
42	A1320	Erect/Backweld Precast - East - North Section - L8	16	25-Jun-15	16-Jul-15
43	A1330	Erect/Backweld Precast - East - L9	7	30-Jun-15	08-Jul-15
44	A1340	Erect Pergola Precast - East	9	06-Jul-15	16-Jul-15
45	A1350	Caulk windows - East	32	08-Jul-15	20-Aug-15
46	A1360	Remove Tower Crane	1	20-Jul-15	20-Jul-15
47	A1370	Install storefront - East - L9	11	03-Aug-15	17-Aug-15
48	A1380	Install NE curtainwall	12	07-Aug-15	24-Aug-15
49		Tech 2.2.5 West Elevation	89	08-Jun-15	08-Oct-15
50	A1390	Stud Framing - West	23	08-Jun-15	09-Jul-15
51	A1400	Erect Precast - West - L2-L9	9	10-Jun-15	22-Jun-15
52	A1410	Backweld Precast - West - L2-L9	12	10-Jun-15	25-Jun-15
53	A1420	Install windows - West	46	25-Jun-15	27-Aug-15
54	A1430	Sheathing - West	26	08-Jul-15	12-Aug-15
55	A1440	Install storefront - West - L9	13	27-Jul-15	12-Aug-15
56	A1450	Air/Vapor Barrier of EIFS system	13	30-Jul-15	17-Aug-15
57	A1460	Caulk windows - West	11	04-Aug-15	18-Aug-15
58	A1470	Install EIFS	44	10-Aug-15	08-Oct-15
59		Tech 2.2.6 South Elevation	54	09-Jun-15	21-Aug-15
60	A1480	Erect Precast - South - L1-L2	2	09-Jun-15	10-Jun-15
61	A1490	Erect Precast - South - L3-L8	3	23-Jun-15	25-Jun-15
62	A1500	Backweld Precast - South	5	23-Jun-15	29-Jun-15
63	A1510	Erect/Backweld Precast - South - L9	9	26-Jun-15	08-Jul-15
64	A1520	Install windows - South	20	29-Jun-15	24-Jul-15
65	A1530	Pergola precast - South	2	08-Jul-15	09-Jul-15
66	A1540	Install storefront - South - L9	17	29-Jul-15	20-Aug-15
67	A1550	Caulk windows - South	15	03-Aug-15	21-Aug-15
68		Tech 2.2.7 Church	125	20-Aug-15	10-Feb-16
69	A1560	Start at Church facade	1	20-Aug-15	20-Aug-15
70	A1570	Steel Frame Layout and Install	10	28-Sep-15	09-Oct-15
71	A1580	Perimeter Suporr and U channel layout/Install	5	09-Oct-15*	15-Oct-15
72	A1590	Glass Panel installation	18	16-Oct-15*	10-Nov-15
73	A1600	Caulk Structure	26	02-Nov-15*	07-Dec-15
74	A1610	Install Entry Doors	34	09-Nov-15*	24-Dec-15
75	A1620	Testing & Commissioning at entrance door	52	24-Nov-15*	03-Feb-16
76	A1630	Field Water test	29	24-Dec-15*	02-Feb-16
77	A1640	Punchlist	6	03-Feb-16*	10-Feb-16
78		Tech 2.1 MEP & Interiors	261	02-Mar-15	29-Feb-16
79	A1650	Core & Shell MEP Rough-In	149	02-Mar-15	24-Sep-15
80	A1660	Core & Shell Drywall & Finishes	127	01-Jun-15	24-Nov-15
81	A1670	inspections	58	10-Dec-15*	29-Feb-16
82	A1680	Final Completion	1	11-Feb-16*	11-Feb-16





Actual Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | summary

TASK filter: All Activities
Resource Profile Filter:Current Project's Resources

Appendix B:

Detailed Cost Estimate

Project name	900 16th Street Facade
Report format	Sorted by 'Group phase/Phase' 'Detail' summary

Spreadsheet Level	Takeoff Quantity	Labor Cost/Unit	Labor Price	Labor Amount	Labor Currency	Labor Foreign Cnv Factor
4000.000 MASONRY						
4410.100 Stone Marble						
Marble Facing Panel 3"	4,226.10 sf	12.50 /sf	40.00 /hr	52,826		
4410.110 Stone Limestone						
Panel Limestone Smooth Fin 3"	12,678.30 sf	12.50 /sf	40.00 /hr	158,479		
7000.000 THERMAL & MOISTURE PROT						
7111.010 Dampproofing: VaprBarrier						
Poly Vapor Barrier 6 mil	16,904.40 sf	0.13 /sf	40.00 /hr	2,254		
9110.000 EXTERIOR FRAMING						
9111.010 Exterior Frame: C Studs						
Cold-Formed Metal Stud Framing	6,648.00 sf	-	-	-		
03-48-43.00 Precast Concrete Trim						
03-48-43.40 Precast Lintels						
Precast lintel, 10" thick	16,904.40 sf	112.55 /sf	70.34 /mh	1,902,597		
06-16-36.00 Wood Panel Product Sheathing						
06-16-36.10 Sheathing						
Sheathing, plywood, 5/8" thick	6,648.00 sf	1.10 /sf	72.32 /mh	7,327		
07-21-13.00 Board Insulation						
07-21-13.10 Rigid Insulation						
Wall insulation, semi-rigid, foil faced, 3" thick	16,904.40 sf	0.72 /sf	72.20 /mh	12,205		
07-21-16.00 Blanket Insulation						
07-21-16.20 Blanket Insulation For Walls						
Blanket insulation, for walls or ceilings, foil faced fiberglass, 6" thick	6,648.00 sf	0.50 /sf	71.88 /mh	3,326		
07-24-00.00 Exterior Insulation And Finish Systems						
07-24-13.10 Exterior Insulation And Finish Systems						
2 1/4" EPS insulation	6,648.00 sf	6.33 /sf	61.70 /mh	42,067		
07-27-00.00 Air Barriers						
07-27-26.10 Fluid Applied Membrane Air Barrier						
Fluid applied membrane air barrier, 25 S.F./Gallon, spray	6,648.00 sf	0.36 /sf	61.70 /mh	2,387		
07-91-23.00 Backer Rods						
07-91-23.10 Backer Rods						
Pre-formed joint seals, backer rod, polyethylene, 3/4" dia	11,198.67 clf	122.90 /clf	70.67 /mh	1,376,268		
08-43-13.00 Aluminum-Framed Storefronts						
08-43-13.20 Storefront Systems						
Storefront systems, aluminum frame, monumental grade, clear 3/8". plate glass, doors with hardware	883.00 sf	9.45 /sf	67.92 /mh	8,344		
08-44-00.00 Curtain Wall And Glazed Assemblies						
08-44-13.10 Glazed Curtain Walls						
3D Structural Curtain wall	1,000.00 sf	0.00 /sf	0.00 /mh	0		

Labor Foreign Currency Price	Labor Foreign Currency Amount	Material Price	Material Amount	Vendor Name	Material Currency	Material Foreign Cnv Factor	Material Foreign Currency Price
/hr		36.00 /sf	159,747				/sf
/hr		26.00 /sf	346,171				/sf
/hr		0.04 /sf	627				/sf
-	-	0.44 /lnft	35,421				/lnft
/mh		160.60 /sf	2,714,847				/sf
/mh		0.86 /sf	5,704				/sf
/mh		2.40 /sf	40,537				/sf
/mh		0.66 /sf	4,388				/sf
/mh		2.38 /sf	15,796				/sf
/mh		0.01 /sf	73				/sf
/mh		6.11 /clf	68,368				/clf
/mh		44.55 /sf	39,338				/sf
0.00 /mh	0	1,770.48 /sf	1,770,475				/sf

Material Foreign Currency Amount	Sub Amount	Sub Name	Sub Currency	Sub Foreign Cnv Factor	Sub Foreign Currency Price	Sub Foreign Currency Amount	Equip Price	Equip Amount
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	64.63 /mh	436,979
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	19.31 /mh	2,632
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	-	-

Eqp Currency	Eqp Foreign Cnv Factor	Eqp Foreign Currency Price	Eqp Foreign Currency Amount	Other Price	Other Amount	Other Currency	Other Foreign Cnv Factor
		-	-	-	-		
		-	-	-	-		
		-	-	-	-		
		-	-	-	-		
		/mh		-	-		
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		/mh		-	-		
		-	-	-	-		
		-	-	-	-		
		-	-	-	-		
		-	-	-	-		

Other Foreign Currency Price	Other Foreign Currency Amount	Total Cost/Unit	Total Amount
-	-	50.30 /sf	212,573
-	-	39.80 /sf	504,650
-	-	0.17 /sf	2,881
-	-	5.33 /sf	35,421
-	-	299.00 /sf	5,054,422
-	-	1.96 /sf	13,031
-	-	3.12 /sf	52,742
-	-	1.16 /sf	7,713
-	-	9.10 /sf	60,495
-	-	0.37 /sf	2,461
-	-	129.00 /clf	1,444,635
-	-	54.00 /sf	47,682
-	-	1,770.48 /sf	1,770,475

Spreadsheet Level	Takeoff Quantity	Labor Cost/Unit	Labor Price	Labor Amount	Labor Currency	Labor Foreign Cnv Factor
08-44-13.10 Glazed Curtain Walls						
Curtain wall, aluminum, stock, double glazed, including glazing, average	560.00 sf	14.60 /sf	82.13 /mh	8,176		
08-51-13.00 Aluminum Windows						
08-51-13.20 Aluminum Windows						
Windows, aluminum, 3'-6" x 9'-0" opening, incl. frame and glazing	454.00 ea	57.50 /ea	57.50 /ea	26,105		
09-29-00.00 Gypsum Board						
09-29-10.30 Gypsum Board						
Gypsum 5/8" thick	6,648.00 sf	0.58 /sf	72.13 /mh	3,836		

Labor Foreign Currency Price	Labor Foreign Currency Amount	Material Price	Material Amount	Vendor Name	Material Currency	Material Foreign Cnv Factor	Material Foreign Currency Price
/mh		75.90 /sf	42,504				/sf
/ea		775.00 /ea	351,850				/ea
/mh		0.36 /sf	2,413				/sf

Material Foreign Currency Amount	Sub Amount	Sub Name	Sub Currency	Sub Foreign Cnv Factor	Sub Foreign Currency Price	Sub Foreign Currency Amount	Equip Price	Equip Amount
	-				-	-	-	-
	-				-	-	-	-
	-				-	-	-	-

Eqp Currency	Eqp Foreign Cnv Factor	Eqp Foreign Currency Price	Eqp Foreign Currency Amount	Other Price	Other Amount	Other Currency	Other Foreign Cnv Factor
		-	-	-	-		
		-	-	-	-		
		-	-	-	-		

Other Foreign Currency Price	Other Foreign Currency Amount	Total Cost/Unit	Total Amount
-	-	90.50 /sf	50,680
-	-	832.50 /ea	377,955
-	-	0.94 /sf	6,249

Appendix C:

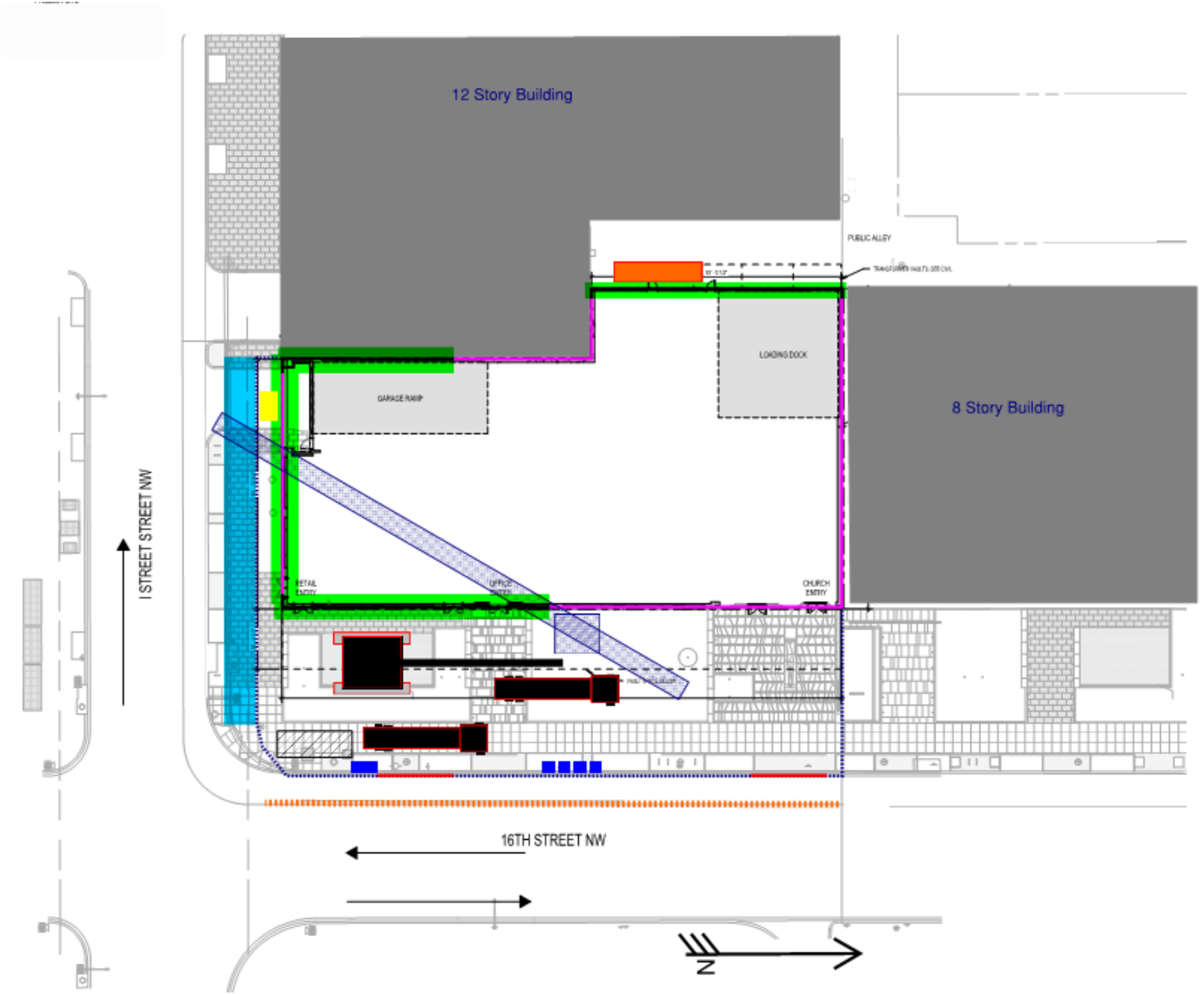
Site Logistics Plans

| SITE LOGISTICS |

Phase 1 Facade Installation

LEGEND

- Protected Pedestrian Walkway
- Work Being Completed
- Dumpster
- Entrance/Exit Gates
- Bathroom
- Tower Crane
- Building Perimeter
- Site Fence
- Construction Cones
- Adjacent Building
- Temporary Electrical Shed
- Flatbed Delivery Truck
- Mobile Crane
- Swing Stage Scaffold

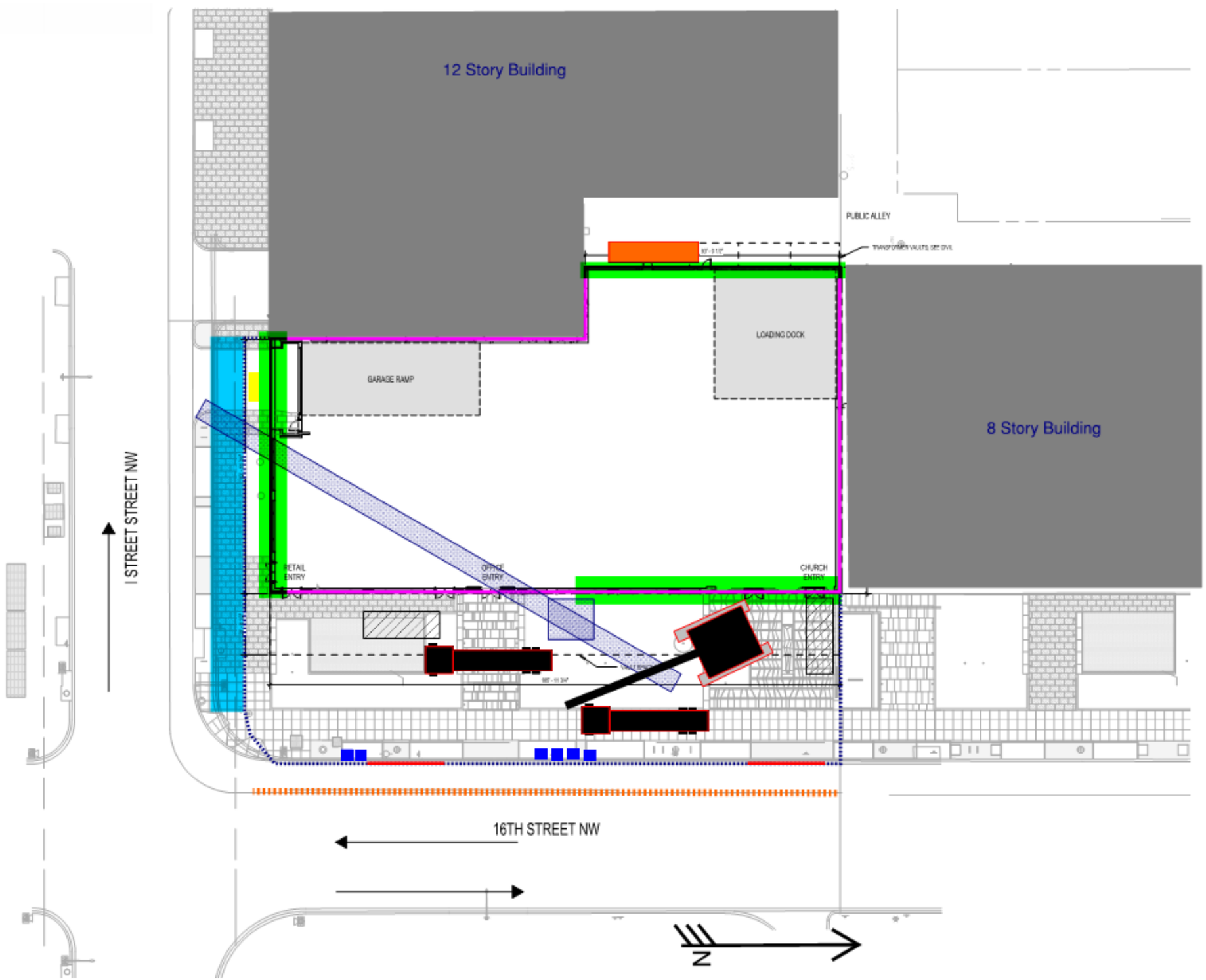


| SITE LOGISTICS |

Phase 2 Facade Installation

LEGEND

- Protected Pedestrian Walkway
- Work Being Completed
- Dumpster
- Entrance/Exit Gates
- Bathroom
- Tower Crane
- Building Perimeter
- Site Fence
- Construction Cones
- Adjacent Building
- Temporary Electrical Shed
- Flatbed Delivery Truck
- Mobile Crane
- Swing Stage Scaffold

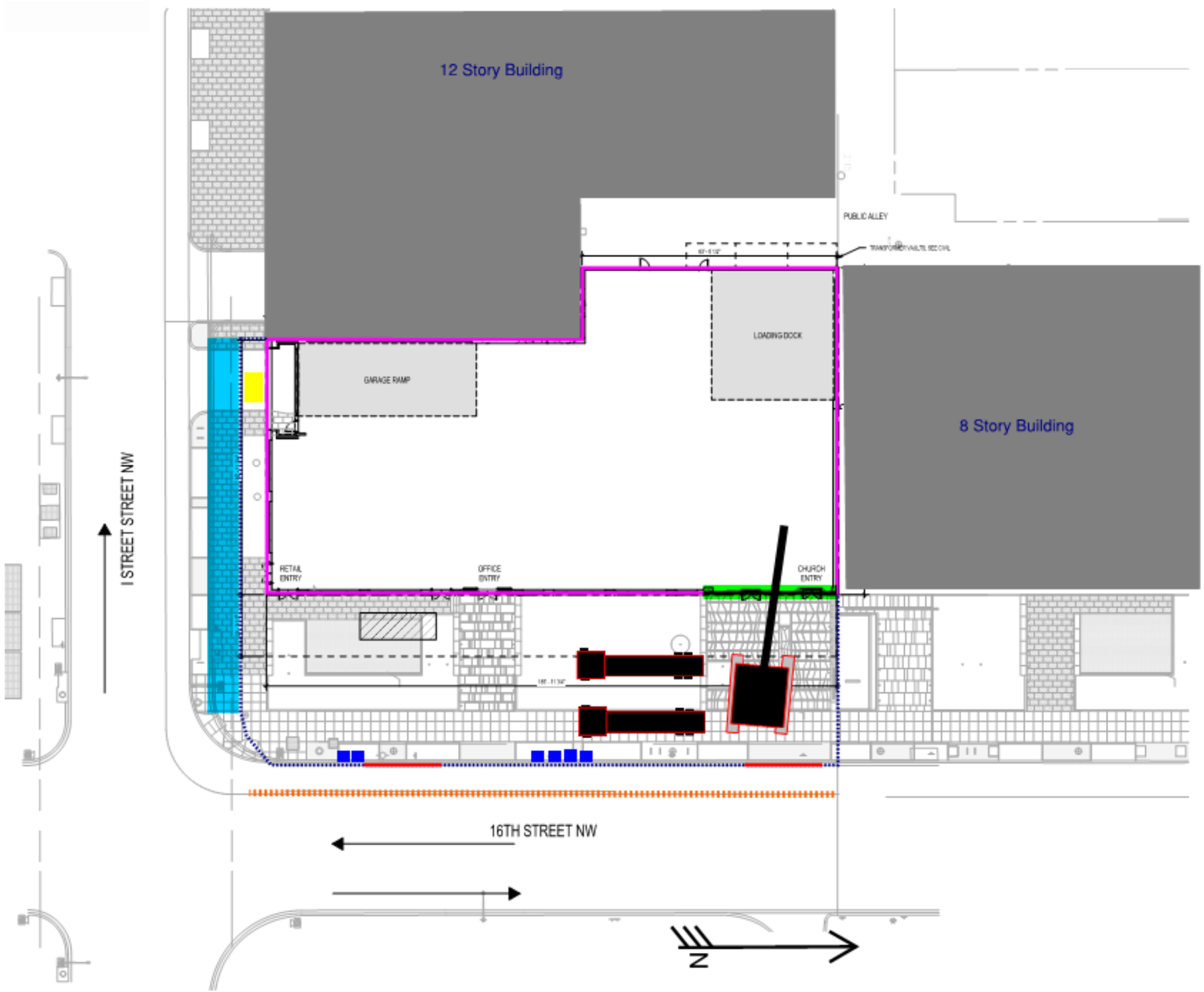


| SITE LOGISTICS |

3D Curtainwall System

LEGEND

- Protected Pedestrian Walkway
- Work Being Completed
- Dumpster
- Entrance/Exit Gates
- Bathroom
- Tower Crane
- Building Perimeter
- Site Fence
- Construction Cones
- Adjacent Building
- Temporary Electrical Shed
- Flatbed Delivery Truck
- Mobile Crane



Appendix D:

Field Supervisor Interview

1. What are the biggest risks to the project completion date associated with the construction of the façade?

   One of the main issues with any façade is that is comes into play at the end of nearly every project. So it has an enormous impact on the completion date. The completion of the façade is key for the release of all interior trades because the building needs to be dried in before they begin. Any delay at this stage in construction will could push back following trades and therefore the final completion date of the project. To keep to the façade on pace it is a must that there are enough materials available on site to keep construction moving without delays.

2. Excluding an increase in manpower or extra shifts, what are key areas that have potential to accelerate the construction of the façade?

   The contractors involved, A&C and EE Marr, are extremely good so in terms of improving the speed of their process there isn't much that could be changed. One area that could have led to increased productivity could have been if there was a possibility of increasing the laydown area. It is possible that the loading dock from the alley on the west could have been used to store an extra flat bed of precast if that side was finished at an earlier date. DAVIS had asked the subs to build a storage area that allowed the panels to be stored up right against the building. This way the flow of setting the panels could not be interrupted by the lack of panels on site.

3. Could the addition of a third crane accelerate the construction of the east façade especially after the 3 month delay caused on the north wall?

   It certainly could and you may be on to something with that idea. That crane could be used specifically to pick the panels from the flat beds and put them in the storage area while the main crane is used solely to set panels in place. This way the process of setting the panels could continue uninterrupted by the deliveries of new panels. It could also be used to set panels so that each crane starts on one end and they meet in the middle. All of this would of course would be pending a cost analysis to see if it would be a viable option.

4. What would be the required resources, costs and techniques to accomplish these alternative sequences or means and methods?

   The suggestions to increase the productivity and accelerate the schedule are all really dependent on costs associated and available manpower. Besides the cost of the extra crane, EE Marr would have to supply either additional riggers or both riggers and welders to accommodate it. While it could benefit the project it is not a guarantee that they have the available skilled tradesmen to be able to use that process.

5. What are unique constructability issues related to the façade of 900 16th Street?

   In general the process is not that difficult. Most of the connections are pretty standard with the exception of around 20 or 30 of them. Those connections certainly took longer because the welders needed to pay special attention to the shops before beginning the connections. I guess that the most difficult aspect was the limestone and marble that was cast with the concrete. The reason being is that it adds a significant amount of weight to each panel. Also, occasionally A&C were waiting for stone to arrive from the quarries so that panels could be cast. This lag cause some delays throughout the process.

6. How did the DAVIS team and the involved subcontractors overcome the constructability challenges presented by this project?

   Like any project there was a lot of planning that occurred before any subs involved arrived on site. To tackle these challenges we really just tried to micromanage the contractors involved to ensure everything was being done in a timely and safe manner. Also there was carefully planning when the cranes were being chosen for the job to ensure that they both had the capability of lifting the largest precast panel.

7. What were the main site logistics concerns with the faced construction process?

   The main concerns were that this process did not affect the other trades on site. The crane needed to be placed in positions that did not affect incoming and outgoing deliveries and site traffic. Also due to the limestone and marble in the precast careful attention was required not to damage them. If damaged they would have to be sent offsite and recast.

8. How would you change the façade materials or equipment to address the difficulties of the construction process?

   A possibility would be to change the entire façade to an EIFS system. The first part of that system is to apply water proofing so the building would be essentially dried in at an earlier point in time. This would benefit the interior trades by allowing them to begin work sooner than expected. However this system would never be approved by the owner because this project is supposed to be a showcase office building.

9. What safety precautions were put into place to help ensure the safety of the public and the site personnel during this process?

In terms of site safety everything for the job is pretty typical. On the South façade we took some extra precautions due to the proximity to the pedestrian sidewalk and adjacent buildings. To protect pedestrians below a specially designed overhead protection system was put into place that can support an impact force greater than the 200lbs required by OSHA. Also fire proof mats needed to be used to catch sparks from welding during the connection process. These mats kept sparks from falling on the adjacent building and pedestrians below.