Stanton Elementary School, ***Washington, D.C.***

Technical Assignment 2:
Production Analysis

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Executive Summary

The following report serves to inform about the key logistical elements of the foundation installation of the Stanton Elementary School building addition that occurs in phase two of the project. The foundation system utilizes a helical pile and pile cap system that also features continuous footings around the perimeter of the building.

The foundation system construction should last approximately 77 days and span from June 3, 2015 to September 18, 2015. The most important task to monitor to ensure that the construction of this system falls within the expected timeline is the installation of the helical piles. This phase in construction also overlaps with the superstructure phase, and coordinating the construction of these two major systems will be very important, especially given the limited space on the project site.

The overall phase two project cost is $16,000,000. The estimate provided will show that approximately $389,000 of that $16,000,000 will be dedicated to the construction of the foundation system. The foundation cost was covered by two different subcontractors, a concrete subcontractor and a helical piles subcontractor operated under a $295,000 contract for its portion of the work. The concrete subcontractor was responsible for almost $94,000 of work for the installation of the concrete and masonry foundations.

Logistically, the site has the potential to be very cluttered and difficult to manage given the limited amount of space that is provided for construction. Two site logistics plans were developed for this phase in construction to attempt to adapt to site to the needs of the project. The initial site logistics plan is identified as the most efficient solution for the project during the initial stages of the foundation construction. The second site logistics plan provides a more sensible approach to site utilization as the project begins to transition from the foundation phase to the superstructure phase of construction.

Since the schedule is fairly long and the construction team struggled to maintain the proper work pace to meet this schedule, scheduling acceleration scenarios and constructability and logistical challenges are identified at the conclusion of the report. A lot of focus needs to be placed on understanding the method of installation for the helical piles in order to stay on schedule. Additionally, battling site utilization issues during the transition from the foundation phase to the superstructure phase will prove to have a major impact on whether or not the construction team can stay on schedule and maintain a safe project.

System Construction Means and Methods

The addition occurring during phase two of the Stanton Elementary School construction project will utilize a pile and pile cap foundation system. A total of 262 helical piles will be drilled into the ground and capped by a variety of eleven different pile caps. In addition to the pile and pile cap system, the building foundation will also utilize continuous footings around the perimeter of the building addition.

The original building plan design called for spread footings. However, due to worries about the stability of the soil, a more structurally sound system was required. In addition to poor soil conditions, Tompkins Builders was looking for a more efficient way of constructing the foundations. Utilizing pile and pile cap foundations would limit the amount of excavation and subsequent backfill required. Less excavation would allow for construction to take place during poor weather more often than if there was a large excavated hole on site. This would also result in minimal soil disturbance and would put much less stress on E&S (erosion and sediment) controls during construction. Because less excavation would take place, a much smaller stockpile would be on site, allowing for a less cluttered site in general. The project cost could also be more easily identified with a pile and pile cap system. The cost for this type of system could easily be determined whereas the cost for the original system could be variable due to the possibility of unforeseen conditions within the excavated soil. All of these factors invoked the switch to a pile and pile cap system. The helical piles extend anywhere from five feet to thirty feet into the ground.

Few spread footings do still exist for smaller building elements at a southern entrance of the building between column lines 13 and 14 and along column line A.4. This system uses a shallow foundation with a 5’-0” x 5’-0” footer that is 1’-4” in depth. In addition to the minimal spread footings that will still take part in the foundation design, a continuous footer supporting a short concrete masonry foundation wall outlines the perimeter of the building. In general, the footer has dimensions of 2’-6” wide by 1’-6” deep and is reinforced concrete.

The phase two addition also includes an elevator. The elevator pit foundation uses continuous footing foundation with a five-inch slab at a depth below that of the rest of the building’s foundation. Elevator foundation walls are cast-in-place concrete walls that are twelve inches thick. Number five reinforcing bars are used for horizontal support, and number 7 reinforcing bars are used for vertical support. The elevator pit was excavated by hand and created difficulties for the crew. Following excavation, the pit could be formed and cast in place.

Production Schedule and Analysis

The full detailed production schedule is outlined in Appendix A at the end of the report. The schedule indicates that with construction of the foundation systems beginning on June 3, 2015, the building foundation system can be completed by September 18, 2015. This is a duration of 107 days, or 77 construction days. The assumption was made that each construction day will consist of eight labor hours. See the summary schedule below for a brief overview of the key dates of construction for the foundation system.

Table 1: Summary Schedule of Foundation System

ID	Activity Name	Duration (Days)	Start	Finish
A1170	Purchase & Release Concrete	5	11/17/14	11/21/14
A1180	Purchase & Release Masonry	5	11/17/14	11/21/14
A1220	Foundation to Grade Permit	60	12/11/14	3/4/15
A1190	Purchase & Release Helical Piles	1	3/18/15	3/18/15
A1200	Purchase & Release Waterproofing	1	3/23/15	3/23/15
A1210	Fabrication & Delivery Helical Piles	10	5/1/15	5/14/15
A1000	Helical Piles – Drill	15	6/3/15	6/23/15
A1010	Formwork: Pile Caps, Spread Footings, Strip Footing	16	6/23/15	7/14/15
A1020	Rebar Placement: Pile Caps, Spread Footings, Strip Footing	3	7/14/15	7/16/15
A1030	Place Concrete: Pile Caps and Footings	2	7/17/15	7/20/15
A1080	Below Slab MEP, Pre-K	10	7/21/15	8/3/15
A1040	Remove Formwork: Pile Caps, Footers	2	7/27/15	7/28/15
A1050	Foundation Walls: Place CMUs	4	7/27/15	7/30/15
A1060	Foundation Walls: Place Rebar	4	7/31/15	8/5/15
A1070	Foundation Wall; Place Grout	2	8/5/15	8/6/15
A1090	Excavation, FRP Deep Footings, Walls	15	8/11/15	8/31/15
A1100	Waterproofing	5	8/31/15	9/4/15
A1110	Slab on Grade Forms	2	9/7/15	9/8/15
A1120	Slab On Grade Wiremesh	2	9/9/15	9/10/15
A1130	Slab on Grade Placement	1	9/11/15	9/11/15
A1140	Slab On Grade Finishing	5	9/11/15	9/17/15
A1150	Foundations Complete	0	9/18/15	9/18/15

From *Table 1* above, it is evident that even though the actual construction of the foundation system is not scheduled to begin until June 3, 2015, planning for this system much begin well in advance. This is shown by the purchase and release of concrete and masonry back in November of 2014. In addition, purchase and release of the helical piles and the waterproofing must occur prior to installation and occurs in March of 2015. The foundation to grade permit also must be obtained prior to installing the foundation system as well.

Construction of the foundation system is the first major phase in construction for phase two of the Stanton Elementary School project. It is essential that the schedule is followed and that the project does not start getting behind this early in phase two of the project. In the case of this project, the helical piles installation is essential. This should take approximately 15 days to complete. It is unknown what is in the critical path and what is not based on the schedule that was provided by Tompkins Builders. It is however fairly safe to assume that on-time installation of the helical piles, placement of the pile caps, footings, concrete masonry foundation walls, and slab on grade are all essential to maintaining the schedule for this project. The superstructure is reliant on the proper installation of each of these foundation elements. It will take proper attention to the schedule and proper site utilization of a smaller than normal site to have the superstructure phase of construction begin on August 18th (the date Tompkins anticipated to begin the superstructure construction) and to have the entire building finished by December 28th as required by the owner.

Detailed Costs Estimate and Analysis

The full detailed estimate can be viewed in Appendix B. This estimate defines costs for the pile caps, spread footings, continuous footings, concrete masonry unit foundation wall, the elevator pit shaft wall, and the slab on grade of the foundation system. Details regarding reinforcing bar and formwork are included within this estimate. Helical piles were left out of the estimate for this system could not be accurately be depicted by an estimate with the cost data provided by the Timberline estimating software and RS Means. In addition, the helical piles exact sizes are unknown as a piles schedule was not provided. *Table 2* below depicts a more realistic view of the foundation system estimate based on the estimate that is provided in Appendix B and the original estimated cost of the helical pile installation as provided by Tompkins Builders.

Table 2: Foundation System Estimated Cost

Estimate Item	Cost (Material + Labor)
Appendix B Estimate	
Formwork: Pile Caps	$13,143
Formwork: Footings	$3,967
Formwork: Slab On Grade	$521
Formwork: Elevator Walls	$2.085
Rebar: Pile Caps	$14,753
Rebar: Footings	$2,524
Rebar: Elevator Pit Walls/CMU Foundation Walls	$3,960
Rebar: Wiremesh	$3,583
Concrete: Pile Caps	$14,564
Concrete: Footings	$7,498
Concrete: Elevator Pit Walls	$906
Concrete: Slab On Grade	$19,038
Mortar: CMU Block Fill	$1,274
Concrete Block, 8”: Foundation Wall	$6,138
Tompkins Builders Helical Piles Contract	$295,000
Total	***$388,955***

Based solely on the cost estimate provided above, the overall cost of the foundation system should be about $389,000. All takeoffs were taken directly from the construction drawings provided by Tompkins Builders. All formwork, rebar, and concrete dimensions are accurate and no assumptions were made about the actual size or quantity of these elements. Most concrete was 4000 psi concrete. In cases when concrete type was not indicated in the construction drawings, the concrete was assumed to be 4000 psi. In addition, the wire mesh within the concrete slab on grade was not noted on the construction drawings. The wire mesh was assumed to be 6” x 6” wire mesh.

Some assumptions that had to be made had to do with the actual constructability of the system itself. One assumption that was made is that concrete was placed directly from the chute of the concrete truck into the form. This would be a method of cutting costs while not having a major effect on the project schedule. However, whether or not this method was performed during the actual project is not known to this point. Leaving out the cost of this equipment could cause the estimate to be a little lower than expected. Additionally, this estimate assumes that labor costs are $40 per hour, which may be lower than the industry standard. This could be another possible contributing factor to an estimate that is short of the actual construction cost. The estimate was generated by prices that were stored in the Timberline database as requested by the assignment. However, these prices conflicted heavily with those of RS Means. When compared, RS Means costs were much higher than those stored in the timberline database. Again, this inconsistency in cost data could be another indicating factor of a possible under-estimate.

The helical piles account for almost two thirds of the system cost. This price is higher than the original foundation cost estimate of $156,138.01 that was performed as a square foot estimate. This is a good sign because the original square foot estimate came in a little low. However, details provided by the Tompkins construction team would indicate that the estimate of $388,955 would be lower than the actual cost of the system. The overall cost of the concrete for the entire concrete system (including the metal decking that is part of the composite floor slabs on floors two and three) is just shy of $1 million. This is to say that the foundation, which was estimated to cost approximately $95,000 in concrete alone is approximately one tenth of that cost. It is highly unlikely that the foundation concrete only accounts for ten percent of the total concrete systems cost for this project. Unfortunately it is unclear how close or how far off the detailed estimate provided in this report actually is to the official detailed foundation estimate that Tompkins builder is using for this project. Until more information is obtained, the accuracy of this estimate cannot be determined. The conclusion can be drawn however that the estimate is an improvement from the previous square foot estimate provided in the technical assignment 1 report and gives a closer representation of the project costs.

Site Plan and Logistics and Analysis

The site utilization plan below in *Figure 1* outlines the site set up during the foundation installation phase of the project. *Figure 2* depicts the site utilization towards the end of the foundation phase of the project as construction begins to transition from the foundation phase to the superstructure phase. Larger representations of both figures are provided in Appendix C.

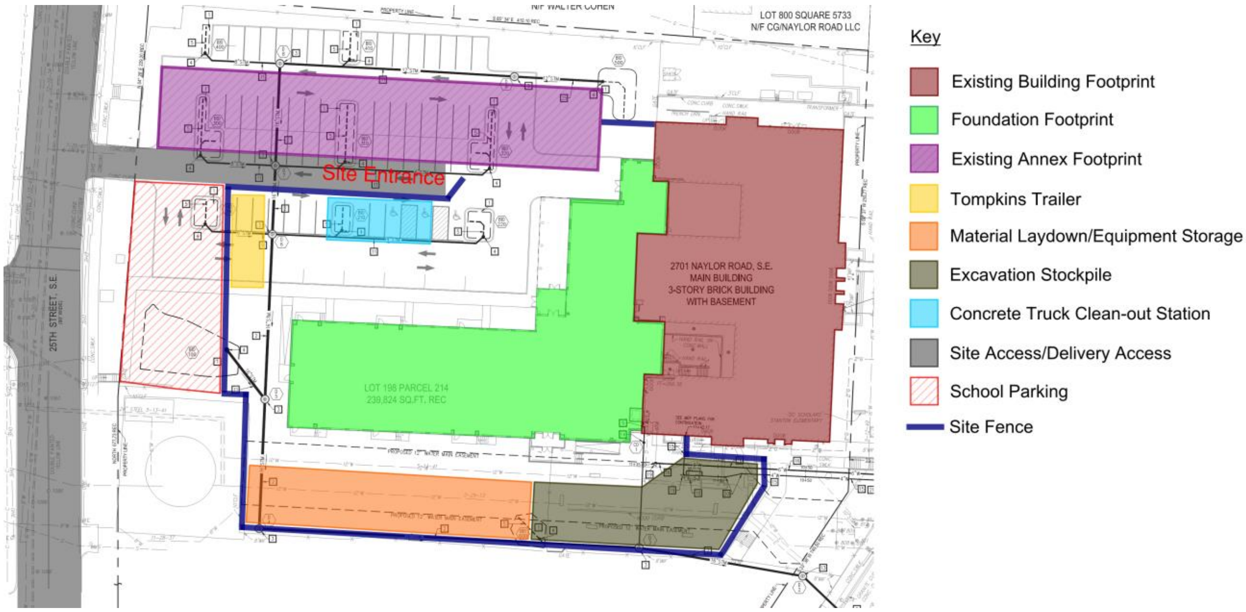


Figure 1: Foundation Phase Site Utilization Plan

Due to the change in the foundation structure from spread footings to helical piles and pile caps, the site became more flexible than originally expected. Very minimal excavation will be taking place during this stage in construction, and a very small portion of the site will need to be taken up for an excavated soils stockpile. The area that is designated for the stockpile is not located near the busy parts on the site so that it does not get in the way. Material staging should occur to the south of the building's footprint. This area will house rebar, wire mesh, helical piles, and possibly forms. The area labeled 'concrete truck clean-out station can also be utilized for staging, but should be left alone once pile installation is near conclusion.

The concrete cleanout station is near the site entrance/exit to allow for concrete trucks to be cleaned quickly and depart in an efficient manner. Additionally, there is a lot of space on the site in this area and this is one of the few locations on the site that seems appropriate for this activity. The white space on the site is all open space that should be utilized for concrete trucks to move around the site and place the concrete directly from its chute. This will eliminate any need for a concrete pump or any other alternative method of placing concrete that may be more expensive in the long run. Despite having a small footprint to work within, this method of site utilization minimizes congestion on the site.

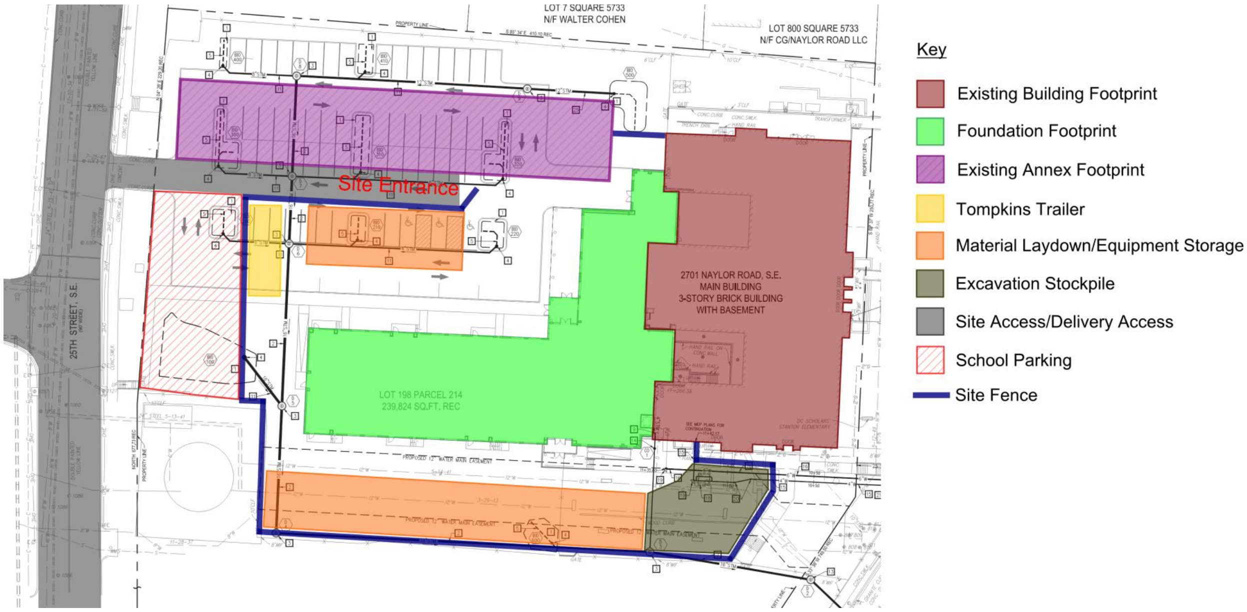


Figure 2: End of Foundation Phase Site Utilization Plan – Transition to Superstructure Site Utilization

Toward the end of the foundation phase, the expectation is that the area for the excavation stockpile may have diminished, (since backfilling during the foundation phase is required to bring the grade up to the appropriate level for placement of the first floor concrete slab). The area allocated for the stockpile has diminished and the material laydown area to the south of the building footprint has grown. At this point in the foundation phase, preparation should begin to occur for the next phase in construction so that no time is lost during the transition.

The superstructure phase is next, and steel delivery must occur to prepare. One complaint that was noted by the site superintendent on the project was that the site lacks space, and sometimes this makes the construction process much more difficult than it should be. This could especially be an in issue during the superstructure phase of construction. Steel W-shapes will take up a lot of space on the site, and it is especially important during this upcoming phase in construction to plan for the best possible layout for site utilization. To help limit site congestion, the material laydown and equipment storage designated locations on the site have grown in this site utilization plan. The area between the building foundation and the material staging area is about 30 to 35 feet wide, which should be plenty of space to continue to allow for deliveries and different machines on site to travel back into that area to gain access to the materials that occupy that space. The designated area for material staging behind the building footprint is approximately 200 feet by 30 feet. In addition, the area that was once designated as the concrete truck cleanout location will become available and should be used for material staging during the next phase in construction.

Schedule Acceleration Scenarios

The biggest risk that the project faces is falling behind on the helical piles installation. This is a system that was not in the original construction plan. Lack of planning can make this process a lot longer than it needs to be and could put the construction team behind schedule right away. The soils are known to be inconsistent in this area, therefore, this system is most likely to have issues over any other foundation system. Increasing the manpower will unfortunately not have an immediate effect on the schedule at this point in the foundation phase, due to the fact that this phase is highly reliant on proper installation by machine operators. It would not make sense to have multiple machines on the site either, as that would add to project cost. If anything, laborers should be expected to remain on-site until the required amount of piles are screwed into the ground to stay on pace to meet the schedule's expectations. Working longer hours seems to be the best method for accelerating the schedule in this scenario. An experienced crew should also be required for helical piles installation to help limit any potential delays in the schedule, even if they may not have provided the lowest bid on the project. The reason why this is important will be explained in the following section.

Another method that may prove successful would be to utilize a larger crew following the helical pile installation. These larger crews could install pile cap and spread footing forms quicker than a smaller crew. This work can also overlap with the pile installation to cut down on the project schedule as well.

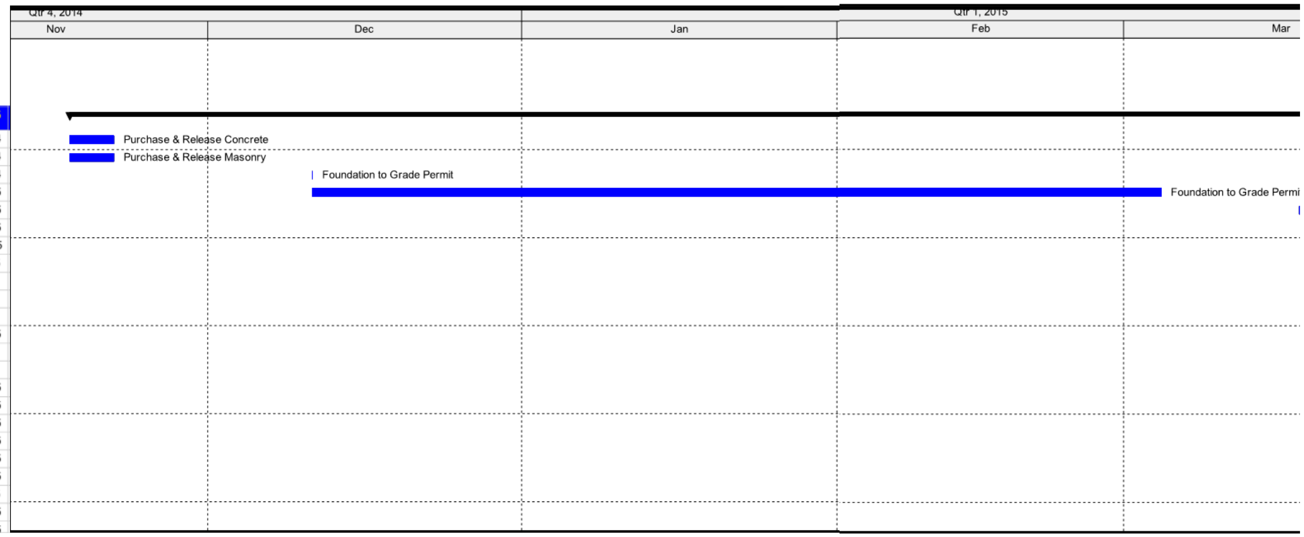
Constructability and Logistical Challenges

The main issue that was run into throughout the foundation installation was the installation of the helical piles. This occurred due to an inexperienced crew who had not had any experience performing this type of work before. Additionally, the crew was using new equipment and had not grown familiar with the equipment prior to operating this equipment on the project site. This was certainly a challenge for the inexperienced subcontractor. More importantly, it was a challenge for the site superintendent and project management. It became very difficult for the project management team to maintain the schedule after understanding how long the helical pile installation was going to last.

Possible constructability issues come with the limited space on the site. This could especially become a problem if the preferred method is to use a concrete pump or conveyor to place the concrete for the floor slab. Around the same time that the floor slab is being placed, steel erection for the building structure is scheduled to begin. Even without a pump or conveyer, it will be difficult to navigate through the site with concrete trucks and a crane at the same time. To allow for maximum flexibility on the site, mobile crane may be a better selection than a mobile crane. This will become especially important when a pump or conveyer is needed for concrete elevated slab pours on the second floor, the third floor, and the building roofs. A more cluttered site could also pose a threat to safety for the workers on the site. Attention to project safety will be crucial as the schedule gets pushed to its limit and activity on site really picks up towards the later stages in the foundation installation.

Appendix A: Production Schedule Data

NEWPROJ-4	Stanton Elementary	219	17-Nov-14	18-Sep-15
A1170	Purchase & Release Concrete	5	17-Nov-14	21-Nov-14
A1180	Purchase & Release Masonry	5	17-Nov-14	21-Nov-14
A0160	Foundation to Grade Permit	0	11-Dec-14	11-Dec-14
A1220	Foundation to Grade Permit	60	11-Dec-14	04-Mar-15
A1190	Purchase & Release Helical Piles	1	18-Mar-15	18-Mar-15
A1200	Purchase & Release Waterproofi	1	23-Mar-15	23-Mar-15
A1210	Fabrication & Delivery Helical Piles	10	01-May-15	14-May-15
A1000	Helical Piles - Drill	15	03-Jun-15	23-Jun-15
A1010	Formwork: Pile Caps, Spread Fo	16	23-Jun-15	14-Jul-15
A1020	Rebar Placement: Pile Caps, Spr	3	14-Jul-15	16-Jul-15
A1030	Place Concrete: Pile Caps and F	2	17-Jul-15	20-Jul-15
A1080	Below Slab MEP, Pre-K	10	21-Jul-15	03-Aug-15
A1040	Remove Formwork: Pile Caps, F	2	27-Jul-15	28-Jul-15
A1050	Foundation Walls: Place CMUs	4	27-Jul-15	30-Jul-15
A1060	Foundation Walls: Place Rebar	4	31-Jul-15*	05-Aug-15
A1070	Foundation Wall; Place Grout	2	05-Aug-15	06-Aug-15
A1090	Excavation, FRP Deep Footings,	15	11-Aug-15	31-Aug-15
A1100	Waterproofing	5	31-Aug-15	04-Sep-15
A1110	Slab on Grade Forms	2	07-Sep-15	08-Sep-15
A1120	Slab On Grade Wiremesh	2	09-Sep-15	10-Sep-15
A1130	Slab on Grade Placement	1	11-Sep-15	11-Sep-15
A1140	Slab On Grade Finishing	5	11-Sep-15	17-Sep-15
A1150	Foundations Complete	0	18-Sep-15	18-Sep-15



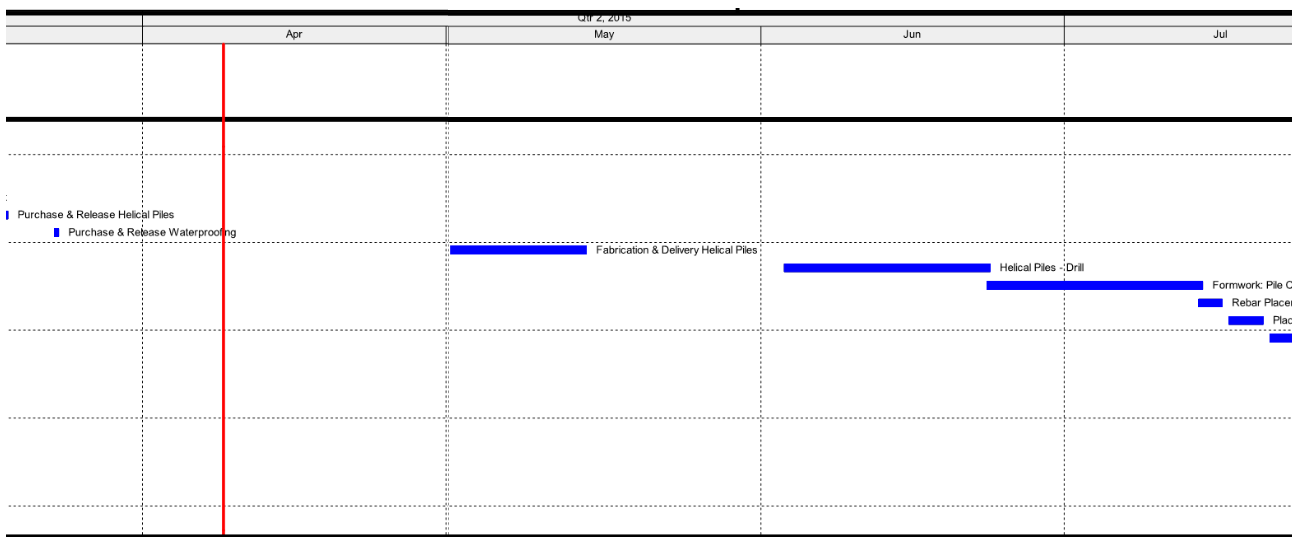


Figure 3: Production Schedule

NEWPROJ-4	**Stanton Elementary**	219	17-Nov-14	18-Sep-15
A1170	Purchase & Release Concrete	5	17-Nov-14	21-Nov-14
A1180	Purchase & Release Masonry	5	17-Nov-14	21-Nov-14
A0160	Foundation to Grade Permit	0	11-Dec-14	11-Dec-14
A1220	Foundation to Grade Permit	60	11-Dec-14	04-Mar-15
A1190	Purchase & Release Helical Piles	1	18-Mar-15	18-Mar-15
A1200	Purchase & Release Waterproofi	1	23-Mar-15	23-Mar-15
A1210	Fabrication & Delivery Helical Piles	10	01-May-15	14-May-15
A1000	Helical Piles - Drill	15	03-Jun-15	23-Jun-15
A1010	Formwork: Pile Caps, Spread Fo	16	23-Jun-15	14-Jul-15
A1020	Rebar Placement: Pile Caps, Spr	3	14-Jul-15	16-Jul-15
A1030	Place Concrete: Pile Caps and F	2	17-Jul-15	20-Jul-15
A1080	Below Slab MEP, Pre-K	10	21-Jul-15	03-Aug-15
A1040	Remove Formwork: Pile Caps, F	2	27-Jul-15	28-Jul-15
A1050	Foundation Walls: Place CMUs	4	27-Jul-15	30-Jul-15
A1060	Foundation Walls: Place Rebar	4	31-Jul-15*	05-Aug-15
A1070	Foundation Wall; Place Grout	2	05-Aug-15	06-Aug-15
A1090	Excavation, FRP Deep Footings,	15	11-Aug-15	31-Aug-15
A1100	Waterproofing	5	31-Aug-15	04-Sep-15
A1110	Slab on Grade Forms	2	07-Sep-15	08-Sep-15
A1120	Slab On Grade Wiremesh	2	09-Sep-15	10-Sep-15
A1130	Slab on Grade Placement	1	11-Sep-15	11-Sep-15
A1140	Slab On Grade Finishing	5	11-Sep-15	17-Sep-15
A1150	Foundations Complete	0	18-Sep-15	18-Sep-15

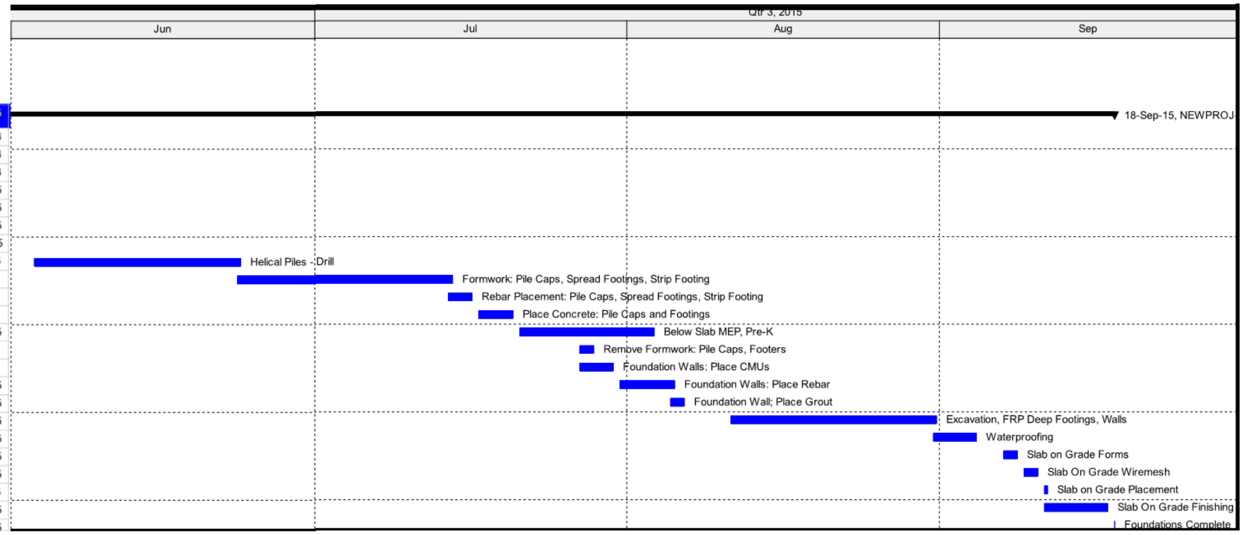


Figure 3: Production Schedule (Continued)

Schedule Supporting Takeoffs

Construction Task	RS Means Code	Description	Quantiy	Units	Daily Output	Total Days	Crew
Helical Piles Installation		Use data from Tompkins Buildiers - 15 days to install					
Form Pile Caps and Footings							
Pile Caps Formwork	03 11 1345 5000	P2	208	SFCA	305	0.68	C-1
Pile Caps Formwork	03 11 1345 5000	P3	257	SFCA	305	0.84	C-1
Pile Caps Formwork	03 11 1345 5000	P3E	53	SFCA	305	0.17	C-1
Pile Caps Formwork	03 11 1345 5000	P4	48	SFCA	305	0.16	C-1
Pile Caps Formwork	03 11 1345 5000	P5	878	SFCA	305	2.88	C-1
Pile Caps Formwork	03 11 1345 5000	P6	728	SFCA	305	2.39	C-1
Pile Caps Formwork	03 11 1345 5000	P7	229	SFCA	305	0.75	C-1
Pile Caps Formwork	03 11 1345 5000	P7E	76	SFCA	305	0.25	C-1
Pile Caps Formwork	03 11 1345 5000	P10	113	SFCA	305	0.37	C-1
Pile Caps Formwork	03 11 1345 5000	P12	480	SFCA	305	1.57	C-1
Pile Caps Formwork	03 11 1345 5000	P14	225	SFCA	305	0.74	C-1
Spread footing Formwork	03 11 1345 5000	F5	80	SFCA	305	0.26	C-1
Continuous Footings Formwork	03 11 1345 0200		1866	SFCA	375	4.98	C-1
Total						**16.04**	
Place Rebar							
Pile Caps	03 21 1160 0550	#8 Bar	9.63603	TON	4	2.41	4 rodman
Spread Footings	03 21 1160 0500	#5 Bar	0.0234	TON	3	0.01	4 rodman
Continuous Footings	03 21 1160 0500	#5 Bar	1.61148	TON	3	0.54	4 rodman
Total						**2.95**	
Place Concrete							
Pile Caps	03 31 1370 2600		175	CY	120	1.46	C-6
Spread Footings	03 31 1370 2600		4	CY	120	0.03	C-6
Continuous Footings	03 31 1370 1900		87	CY	120	0.73	C-6
Total						**2.22**	
Remove Formwork							
Pile Caps							
Spread Footings			Unknown				
Continous Footings							
CMU Foundation Walls							
Place Walls	04 22 1026 0250		1400	SF	425	3.29	D-8
Place Rebar	04 05 1926 0060		2722.72	LB	650	4.19	1 Bric
Fill with Grout	04 05 1630 0250		1400	SF	680	2.06	D-4
Total						**9.54**	
Slab on Grade							
Forms	03 11 1365 1410		1100	LF	622	1.77	C-1
Wire mesh	03 22 1110 0100		168	CSF	35	4.80	
Place Concrete	03 31 1370 1400		260	CY	140	1.86	C-20
Total						**8.43**	

Appendix B: Foundations Estimate

Item	Description	Takeoff Qty	Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
3000.000	***CONCRETE***										
3110.050	**Forms: Pile Caps**										
10	Pile Cap: Forms	3,295.00 sf	3.00 /sf	9,885	0.99 /sf	3,258	-		-	-	13,143
	Forms: Pile Caps			**9,885**		**3,258**					**13,143**
	247.13 Labor hours										
3110.100	**Forms: Footings**										
10	Continuos Footing: Forms	1,900.00 sf	1.20 /sf	2,280	0.803 /sf	1,526	-		-	-	3,806
10	Spread Footing: Forms	80.00 sf	1.20 /sf	96	0.803 /sf	64	-		-	-	160
	Forms: Footings			**2,376**		**1,591**					**3,967**
	59.400 Labor hours										
3110.150	**Forms: Walls**										
10	Elevator Pit: Wall Forms	630.00 sf	3.00 /sf	1,890	0.31 /sf	195	-		-	-	2,085
	Forms: Walls			**1,890**		**195**					**2,085**
	47.250 Labor hours										
3210.100	**Rebar: Pile Caps**										
86	Pile Cap: Rebar #8	7,218.00 lf	1.34 /lf	9,672	0.704 /lf	5,081	-		-	-	14,753
	Rebar: Pile Caps			**9,672**		**5,081**					**14,753**
	241.803 Labor hours										
3210.150	**Rebar: Footings**										
56	Spread Footing: Rebar #5	45.00 lf	0.52 /lf	23	0.283 /lf	13	-		-	-	36
56	Contiuous Footing: Rebar #5	3,099.00 lf	0.52 /lf	1,611	0.283 /lf	876	-		-	-	2,488
	Rebar: Footings			**1,635**		**889**					**2,524**
	40.872 Labor hours										
3210.300	**Rebar: Walls**										
56	Elevator Shaft Wall: Rebar #5	594.00 lf	0.52 /lf	309	0.283 /lf	168	-		-	-	477
56	Foundation CMU Wall Rebar #5	2,617.00 lf	0.52 /lf	1,361	0.283 /lf	740	-		-	-	2,101
66	Elevator Shaft Wall: Rebar #6	182.00 lf	0.752 /lf	137	0.41 /lf	74	-		-	-	211
76	Elevator Shaft Wall: Rebar #7	744.00 lf	1.02 /lf	759	0.56 /lf	413	-		-	-	1,172
	Rebar: Walls			**2,565**		**1,395**					**3,960**
	64.14 Labor hours										
3220.050	**Rebar: Wiremesh**										
w 20	Slab On Grade: Wiremesh - Walks 6x6 6/6	16,846.00 sf	0.12 /sf	2,022	0.093 /sf	1,562	-		-	-	3,583
	Rebar: Wiremesh			**2,022**		**1,562**					**3,583**
	50.54 Labor hours										
3310.120	**Conc: Pile Caps**										
c 40	Pile Cap: Conc 4000 psi	175.00 cy	20.00 /cy	3,500	63.221 /cy	11,064	-		-	-	14,564
	Conc: Pile Caps			**3,500**		**11,064**					**14,564**
	87.50 Labor hours										
3310.140	**Conc: Footings**										
c 40	Continuous Footing: Conc 4000 psi	86.40 cy	20.00 /cy	1,728	63.221 /cy	5,462	-		-	-	7,190
c 40	Spread Footing: Conc 4000 psi	3.70 cy	20.00 /cy	74	63.222 /cy	234	-		-	-	308
	Conc: Footings			**1,802**		**5,696**					**7,498**
	45.05 Labor hours										
3310.160	**Conc: Walls**										
c 40	Elevator Shaft Wall: Conc 4000 psi	9.722 cy	30.00 /cy	292	63.224 /cy	615	-		-	-	906
	Conc: Walls			**292**		**615**					**906**
	7.292 Labor hours										
3310.210	**Conc: Slabs On Grade**										
c 40	S.O.G. Conc 4000 psi	260.00 cy	10.00 /cy	2,600	63.221 /cy	16,438	-		-	-	19,038
	Conc: Slabs On Grade			**2,600**		**16,438**					**19,038**
	65.00 Labor hours										
	CONCRETE			***38,239***		***47,782***	***0***		***0***	***0***	***86,021***
	955.97 Labor hours										

Figure 4: Foundation Concrete Detailed Estimate

Appendix C: Site Utilization

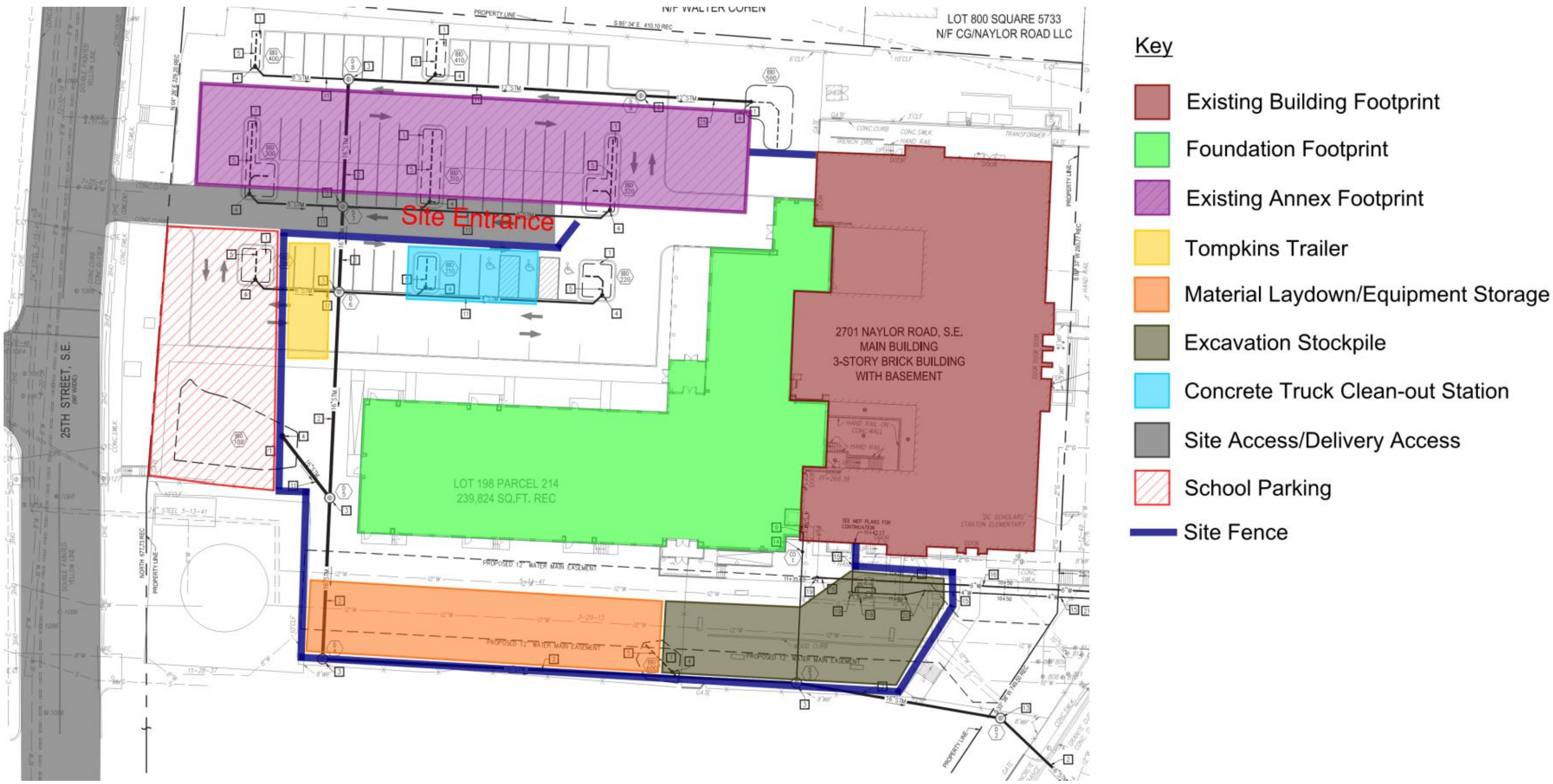


Figure 2: End of Foundation Phase Site Utilization Plan

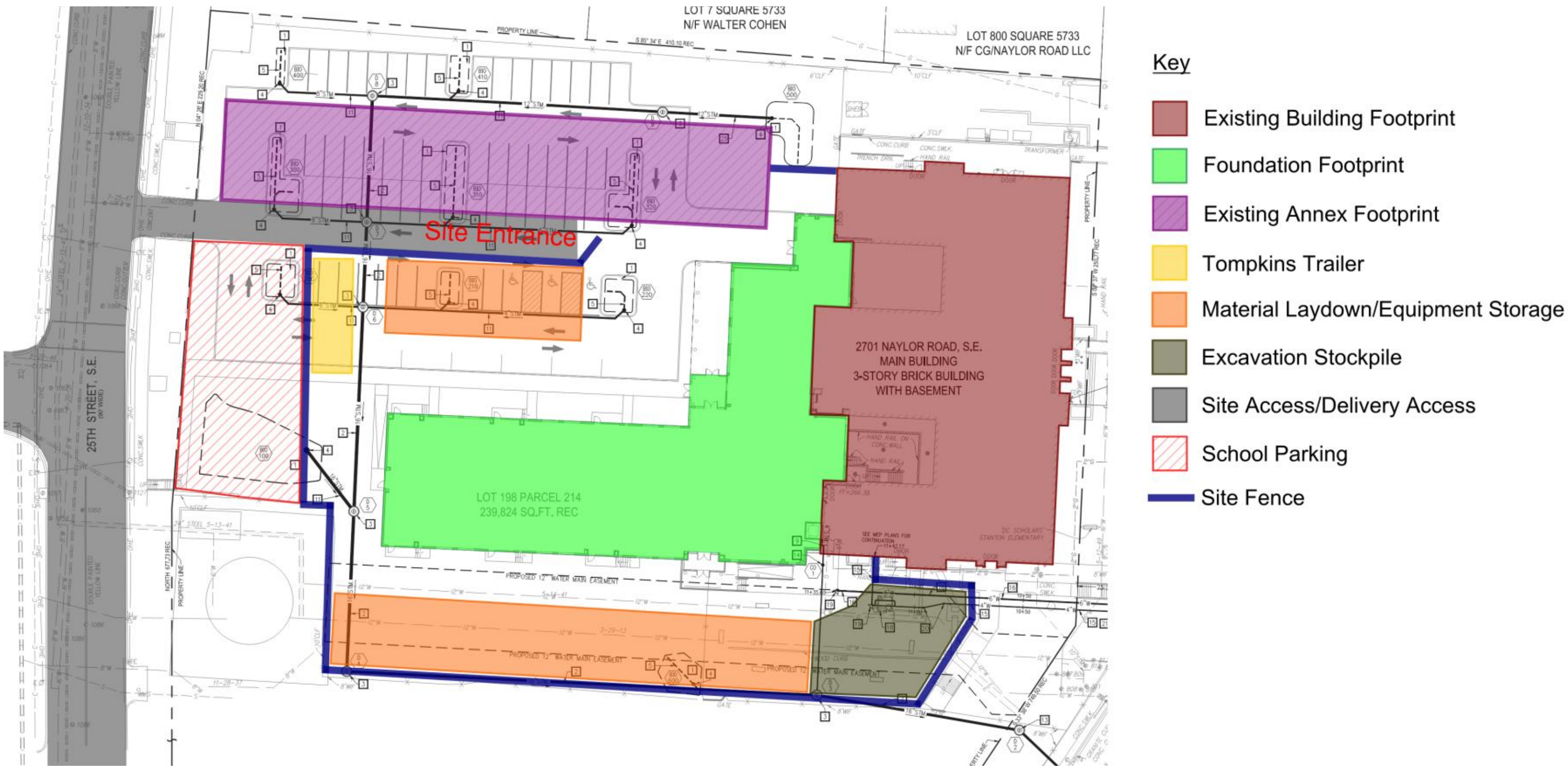


Figure 2: End of Foundation Phase Site Utilization Plan – Transition to Superstructure Site Utilization

Appendix D: Field Supervisor Interview Dialogue

Superintendent Interview

Peter Kapsidelis, Tompkins Builders

Do you know the size of the piles that were used on the project?

The piles varied in size based on the location in which they were drilled. In general, the sizes range from 5 feet to 30 feet.

How did the sitework fit into the phasing of drilling of the piles and placing the pile caps with regard to backfilling and placement of the underslab MEP systems?

Backfilling and compaction was not performed all at once. Backfill and compaction of the undersoil was performed up to the level of the MEP systems. The MEP conduit was placed at this level. Backfilling was then performed up to the level of the pile caps. Pile caps were formed and placed. Once the pile caps had set, the remaining backfilling could occur up to the level of the slab on grade. This was done to limit the amount of undercutting that would need to occur when installing the MEP systems and pile caps.

The drawings are slightly unclear and are not up-to-date with the change to the piles and pile caps system. Does the foundation include continuous footings around the perimeter of the floor slab?

Yes, the building uses concrete block continuous footings around the perimeter of the building. Concrete footings are about 2'-6" by about 1'-0" for the majority, if not all of the continuous footings.

How did you perform the work of the elevator shaft wall?

The elevator shaft wall was a major inconvenience and very frustrating. In the end, the elevator shaft was dug out by hand. Formwork was then placed, and the concrete was poor. Digging out the elevator shaft was a bit of a nuisance.

Why was the decision made to switch from spread footings to a piles and pile caps system?

In general, the foundation design was incorrect because there were unsuitable soils to support the proposed foundation system. The design was completely changed from spread footings to piles and a pile cap system because of this. Utilizing helical piles and pile caps allowed for much quicker installation and was also a cheaper option. Additionally, it was deemed as an easier process than spread footing installation since this phase in construction was occurring during the winter months. Helical piles required much less excavation than spread footings. Also, helical piles could be extended well beyond the point of spread footings for increased structural support. In general, this was much safer and provided less risk on the project. Installing helical piles was a known price, whereas excavating could potentially run up the project coast if any unforeseen conditions were revealed during excavation. With this quantified risk, helical piles made much more sense

What were the site logistics like on this project?

The site is very small in general, and this was the biggest issue logistically. However, the site was probably used to its fullest potential and could not have really improved. In a perfect world, the site would be bigger; however, the school was unwilling to provide additional space to us.

Could the method of construction improved in any way?

Absolutely. The biggest issue was with the subcontractor that was hired for the helical piles installation. They were very inexperienced and worked very slowly. They were operating with new machines, a new auger, new workers, and their machines did not work properly all the time.

Looking back, how would you have addressed that issue?

Looking back, I would have changed subcontractors. Their inexperience really slowed down the construction process and we should have brought in a new subcontractor after we realized that the current subcontractor was doing such a poor job.

If you could improve anything that occurred throughout the foundation installation of the project, what would it be?

As I said, I would have used a much stronger, more experienced subcontractor for the piles installation. We also had issues with the delivery of the rebar which held up construction a little bit. It would have been great if that process could have gone more smoothly, and if the rebar could have arrived on time.