TECHNICAL REPORT II

A Campus Project
Northeastern US

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Executive Summary

This Campus Project, located in the northeastern US, is a multi-building, multi-use project, built to serve as a community and cultural gathering place. It consists of five unique buildings, an underground parking garage, and a geothermal well field. The five buildings are the Turkish Bath, Convent/Monastery, Mosque, Cultural Center, and Fellowship Hall, as labeled in the image below.

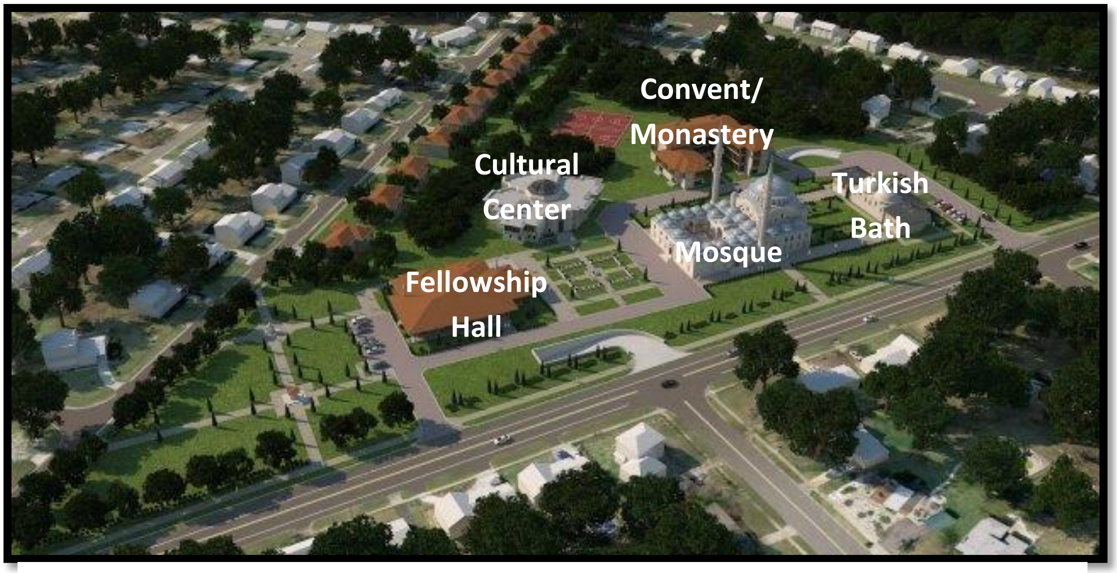


Figure 1. *Overall Site (courtesy of Balfour Beatty)*

This report will present an analysis of a variety of systems and issues on the project in greater detail than is explained here. The general schedule for the project lasts approximately two years and is phased in order to accelerate construction due to the extensive excavation. The detailed schedule for the Turkish Bath shows that it resides on the critical path and can greatly influence the schedule. The Structural and MEP systems were calculated to be $1,043,000 and $2,569,000 respectively. When compared to the actual costs of the systems, which are $1,170,000 and $2,803,000, it yields a difference of $127,000 and $234,000 respectively, attributable to human and RS Means error. The General Conditions estimate was calculated to $3,084,000, which is comparable to the actual value of $2,956,000. However, numbers are deceiving because there are numerous variations that plague RS Means unit costs and create large discrepancies between the two estimates. Four site logistics plans, two excavation plans, a crane plan, and a building plan are used to show how the site develops over time. They are carefully analyzed to verify that safe and efficient practices are being utilized on site.

Constructability issues that faced the project staff will be explained and their solutions analyzed for effectiveness. These issues are: (1) a retaining wall between the Parking Garage and the Turkish Bath potentially delaying construction, (2) designing a way to smoothly finish the surface of a concrete dome, and (3) developing a formwork structure that can support the concrete loads of a 44 foot arch, built 45 feet in the air. Last, the challenges of planning and coordinating the work between two different cultures include insufficient information flow, difference in construction priorities, and safety risks due to religious practice.

Project Schedule

Construction of the project takes place from September 19, 2012 to September 18, 2014. In order to decrease the length of the schedule, it is completed in four phases of excavation, proceeding in overlap. This also helps with the opportunity to develop float in the schedule in anticipation of any issues that would delay construction. Since there are five buildings on site, totaling thousands of activities, two schedules are used to present the project.

The first schedule, beginning on page A-1, is a general overview of the entire project from start to completion. It provides a basic understanding of how construction of each individual building fits together and how they overlap. Each building is shown in a different color for clear organization. The critical path of the schedule is controlled by the Parking Garage, the Turkish Bath, and the Hardscaping and Landscaping. The foundations of the garage proceed from west to east in four sections, divided at column lines. **Figure 2**, to right, shows the four sections of the garage. A larger plan can be found in Appendix E. It is essential to erect the ground level slab of the garage according to the schedule. Any delay in its installation will delay the overall project.

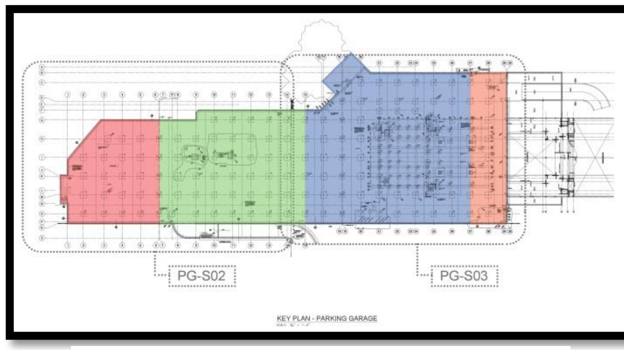


Figure 2. *Excavation Phases*

Of particular note is the Work by Turkish Labor, noted towards the end of the schedule. This work involves culturally significant finishes and construction. These tasks can only be completed by Turkish workers, in the interest of preserving the cultural elements of their design. The work lasts approximately a whole year, with the majority taking place on the Mosque, due to the extensive amount of limestone cladding across the interior and exterior. Cultural and construction differences may cause delays to the schedule due to lack of information flow. These issues are discussed in Cultural Implications on page 18.

The second schedule, starting on page A-2, is a detailed look at the construction process for the Turkish Bath, shown in **Figure 3**. The Turkish Bath is a recreational facility totaling approximately 50,000 GSF. It consists of four total floors, two of which are below grade. The second basement is at a depth of 37', the deepest excavation on the project. An underground swimming pool and basketball court are located here, as well as a mechanical room to service those areas. The basement is at a depth of 15', with a mezzanine overlooking the pool that is at a depth of 20'. This floor contains fitness and gym areas as well as an additional mechanical room. Domestic water service enters the mechanical room

Figure 3. *Turkish Bath*

from the utility line before distribution to the rest of the project. Electrical service enters the electrical and generator rooms between the north wall and the entrance ramp to the garage. Several switchboards distribute the power throughout the site. The two above ground floors consist of spas, lounges, and warm rooms featuring radiant floor heating systems. Those spaces serve a purpose of spiritual connection and relaxation.

Construction on the Turkish Bath lasts approximately 18 months, from December 5, 2012 to May 26, 2014. A great majority of this time resides on the critical path of the schedule. The reason the bath critically affects the schedule is because of the depth of excavation as well as the electrical and domestic water utility connections. It will take approximately one year from the time excavation begins to complete the elevated deck at grade level. The two above grade stories are entirely dependent upon how underground work proceeds, and they will feel any delays that may occur.

Significant structural support is needed to support the loads of the pool, the above grade floors, and the soil pressure around the underground areas. Large retaining walls are used to hold back the soil. The wall between the bath and the garage posed some challenges during construction; further discussion of this issue can be found in Constructability Concerns on page 11. There are also several post-tensioned concrete beams at grade level to support the weight of the above ground floors. These beams vary in dimensions, but can reach sizes of up to 5' wide x 5' deep x 70' long. The extensiveness of excavation and foundations controls a majority of the construction sequence. Seven months, from December 5, 2012 to July 24, 2013, are dedicated to finishing these tasks, over half of which is foundation work.

The project is also dependent upon the connection of the electrical system into the Turkish Bath. Utility service is fed into an underground room near the entrance ramp to the Parking Garage. From here it is distributed to the rest of the site via several different switchboards. Domestic water service connects to the basement mechanical room by underground utility service. Then, it is pumped to the HVAC control center in the basement of the Mosque before being distributed throughout the site. The completion of the project depends upon these two services being installed and functional. Since the systems will need to be tested prior to occupancy, the earlier they are operational and ready for testing the better it is for the schedule.

Rough-in of MEP systems first begins on the second floor on October 17, 2013. From here it proceeds down the building by each floor. Electrical utility service will be connected to the building in November and the bath will have permanent operating power on November 7, 2013. Final MEP finishes should conclude on March 13, 2014, about five months later, on the basement level. These are predominantly plumbing finishes, which is understandable as this is where domestic water service is connected.

As stated previously, the detailed schedule can be found on page A-2. It is divided by floor level to separate installation of systems and material. Furthermore, the critical path for the building is shown highlighted in red. Any activities shown in red have direct influence on the duration of the project schedule.

Project Estimates

Figure 4. *Convent/Monastery*

For this report, estimates were only conducted for the Convent/Monastery. It is a U-shaped building, four story building, shown in **Figure 4** to the right, and is used as a guest house for visitors and other individuals. The basement level is exclusively reinforced concrete foundations, slabs, walls, and piers. These support the steel structure that forms the three above grade levels. On the basement level are laundry, mechanical, and electrical rooms. Access directly to and from the garage is also possible from this level. The ground floor contains a library, a lounge, space for club meetings and other guest accommodations. The second and third floors contain a total of 16 living spaces.

The mechanical system incorporates two rooftop air handling units to distribute air to the different spaces throughout the building. As a variable air volume system, it regulates the volume of air flow reaching each space. Individual fan coil units are provided in guest spaces to give explicit control of the environmental conditions in that space. The plumbing system is a typical DWV system using two gas fired water heaters to handle the needs of the occupants. The electrical system is sized at 1200 A and distributes power throughout the building to a total of 22 panelboards. Typically, recessed fluorescent light fixtures are used throughout the building; however, metal halide, halogen, and LED lights are used in specific locations.

In total, the structural steel and concrete systems involve about 1500 cubic yards of concrete and approximately 170 tons of steel. Utilizing a detailed take-off and unit costs from RS Means, this comes to a cost of $594,000 for concrete, and $449,000 for structural steel.

The actual costs for concrete and structural steel are $728,000 and $442,000 respectively. Compared to the estimated values, this yields a difference of $134,000 for concrete and $7,000 for structural steel. These results are summarized in Table 1 on the following page. The estimate for structural steel is within 2% of the actual value, validating the detailed estimate. However, the estimate for concrete is almost 20% short of the actual value. This high error can be attributed to human inaccuracies in judgment and assessment of concrete types. It can also be connected to RS Means generalizations of construction costs, which may not reflect the actual construction occurring. For example, the ground floor slab is fairly thick and heavily reinforced. This would probably yield a higher labor cost than RS Means would assume, but there is no way to adjust for this difference.

The costs of the mechanical and plumbing systems are $994,000 and $517,000 respectively, for a total of $1,511,000. The total cost of the electrical system is $1,059,000.

The actual costs of the mechanical/plumbing and electrical systems are $1,614,000 and $1,189,000. Both of the estimated values are slightly lower than these costs, in the amount of $103,000 between the mechanical/plumbing systems and $130,000 between the electrical systems. **Table 1**, below, summarizes these differences and comparisons. Both of these values are within 10% of the actual value, confirming their validity.

Estimate Costs vs. Actual Costs				
Type of Estimate	**Assemblies**		**Detailed**	
Division	**Mechanical/Plumbing**	**Electrical**	**Concrete**	**Structural Steel**
Estimated Value	$1,511,000	$1,059,000	$594,000	$449,000
Actual Value	$1,614,000	$1,189,000	$728,000	$442,000
Difference	$103,000	$130,000	$134,000	$7,000

Table 1. *Detailed Estimate Comparison*

These estimates can also be compared to the square foot estimate calculated in Technical Report I. These are summarized in **Table 2,** located below. The costs estimated in the square foot analysis are $1,180,000 for mechanical/plumbing, $545,000 for electrical, $346,000 for concrete, and $614,000 for structural steel. These values are extremely different from the actual costs for the work. Most of these differences can be attributed to the inaccuracy of RS Means. A square foot estimate involves using generic building data to represent the estimated building. In this case, College Dormitory was selected to represent the Convent/Monastery. It is not a perfect representation of the building, but it was the closest approximation based upon occupancy usage. This generic representation makes it difficult to adjust the estimate to represent the actual building.

In the case of concrete, much of this error can be attributed to RS Means' assumption that the exterior is CMU wall. This accounts for $318,000 of superstructure in the square foot estimate. In reality, some of this number would be concrete and some would be steel.

Assemblies/Detailed Estimates vs. Square Foot Estimate				
Division	**Mechanical/Plumbing**	**Electrical**	**Concrete**	**Structural Steel**
Assemblies Estimate	$1,510,000	$1,059,000	--	--
Detailed Estimate	--	--	$594,000	$449,000
Square Foot Estimate	$1,180,000	$545,000	$346,000	$614,000
Difference	$330,000	$514,000	$248,000	$165,000

Table 2. *Estimate Comparisons*

Comparing all of these estimates, the most accurate choice would be Assemblies and Detailed estimates. With an error under 2%, the detailed estimate for structural steel had the most accurate value. However, with an error of 20% for the concrete estimate, it also had one of the least accurate values. The assemblies estimates were both under 5%, giving them good validity and accuracy. In reflection, the detailed concrete estimate will need to be revisited in order to find where error developed, and to determine if there were any unique project conditions that were excluded from the project unintentionally.

More detailed structural estimate data can be found starting on page B-1. The specific quantity takeoffs and unit costs are shown on this page. In addition, the complete MEP Assemblies estimate can be found beginning on B-2. The exact RS Means systems chosen to represent building components are shown in detail.

General Conditions Estimate

A General Conditions estimate was conducted to calculate the amount of money spent on site establishment, temporary utilities, and other temporary site expenditures. This estimate includes project and staffing costs, but does not include home office overhead. The timeline for the estimate is 2 years. Most of the equipment or other temporary facilities was rented for this time period, rather than purchased. All of the data used in this estimate was gathered from project documents or RS Means. It is assumed that these costs are for the Construction Manager, Balfour Beatty Construction, only.

The total cost was found to be $3,084,000. Approximately $1,417,000 of this is spent on project management and field personnel, nearly 50% of the cost. The personnel estimated to be on site is based upon the staffing plan developed in Technical Report 1. This can be seen on page C-2. The actual General Conditions costs are equal to $2,956,000, about $128,000 less than the estimated value.

This difference could be attributed to several factors. In the GC estimate, a cost was included for rental and operation of the tower cranes. However, in the actual costs, these were not paid for by Balfour Beatty, but were paid for by a subcontractor. This was a charge of $793,000, which would significantly decrease the estimated value. To offset this drop, several of the actual costs were higher than estimated values. For example, field office supplies, equipment, and operation actual costs were over 10 times that of the estimate. **Table 3** below summarizes these discrepancies and several more.

	Estimate Value	Actual Value	Difference
General Conditions Estimate	**$3,084,000**	**$2,956,000**	**+$128,000**
Field Office Expenses	$12,000	$131,000	-$119,000
Field Office Set-Up	$65,000	$94,000	-$29,000
Jobsite Cleanup	$18,000	$213,000	-$195,000
Temporary Utilities	$492,000	$138,000	+$354,000
Field Personnel	$1,417,000	$1,760,000	-$343,000

Table 3. *General Conditions Estimates Comparison*

The differences between individual costs could be due to varying quality of estimation or assumptions. RS Means may use unit costs that are higher than those used by Balfour Beatty, or vice-versa. RS Means also has an incomplete database of unit costs, making it difficult to give a cost to all of the items that would be included in the General Conditions costs of a construction manager. Furthermore, an incomplete knowledge of what work is provided by the Construction Manager and what work is provided by the subcontractors would also attribute to these discrepancies. Hence, the inclusion of tower crane operation, when it was not part of the CM's scope.

Site Logistics Planning

Four site logistics plans have been provided to accurately represent the layout of the project as it develops. These plans can be used to ensure safety on site and adequate laydown area for all parties involved. The four plans cover two stages of excavation, a crane establishment plan, and developed plan for when building construction begins. These represent the progression of the project and change in order to provide additional features as necessary for the work going on then.

Excavation Plan 1

Excavation Plan 1 is the initial excavation plan at the very start of the project. There are two areas of excavation. Excavation 1, in yellow, is relatively shallow excavation to a typical depth of 13 feet. It is predominantly excavation for the Parking Garage. Excavation 2, in orange, is deeper excavation to a depth of 37 feet. This is the excavation for the Turkish Bath. Temporary power for the site is provided at both the south west and south east corners of the site. Temporary water is provided at the north of the site near the Trailers and Laydown Area. There are four entrances onto site to allow plenty of movement for trucks removing excavated dirt. In addition, there are four removable sections of fence that can be pulled out for emergencies and for special deliveries. Of particular importance is the Emergency Rally Point located at the far corner of the Trailers and Laydown Area. Construction and Super Silt Fencing surrounds site in order to provide protection and security.

Excavation Plan 2

Excavation Plan 2 is the secondary excavation plan highlighting the major changes made to augment further development of the site. At this point, western and eastern excavation has been completed, noted by the cross hatching. The remaining excavation is in the center. Major changes to note are an extension of construction roads, especially a road into the central portion where excavation is still continuing. This additional access will allow trucks to get closer to excavators, decreasing the haul distance and speeding up the excavation process. It will also allow trucks to make concrete, rebar, and other foundation deliveries. Two access ladders have been installed at the western end of the excavated pit to give workers a way down. A ramp has been placed to connect excavation 1 and 2, due to their large difference in depth. In addition, three laydown areas have been designated for Facchina, JCM, and SOE. These areas will the trades to establish material staging areas to help them with their work flow. Lastly, two trailers have been added so each of these trades has one near the entrance.

Crane Plan

The Crane Plan is a detailed plan that tracks a number of changes and additions to the logistics plan, particularly the erection of the two tower cranes used on site. The positioning of these two cranes gives them the reach to cover nearly the entire site. Only a portion of the Fellowship Hall is outside of the boom radius of the western crane. A mobile crane will brought in to facilitate construction as needed. At this point, the elevated deck has been completed from the western edge of the excavated pit to the center. A laydown area for the waterproofing subcontractor has been established on the deck to help facilitate their work. Facchina's laydown area has moved since their primary concrete work has now shifted to the Mosque basement area located in the center of the excavation pit. Additional laydown areas have been established for Helix, Hopke, and Chesapeake Geo as they begin to do their work. A pedestrian walkway has been installed to give workers and established path to the busier site, increasing safety. A Tree Save Area has been designated near the Soil Stockpile in order to protect site greenery from damage. Because of the higher number of workers on site, a second Emergency Rally Point has been established at the western corner of the site. In cases of emergency, workers will go to the closest rally point as directed by their superintendents. The fencing around the Soil Stockpile and Trailers and Laydown Area has been reduced to allow workers to travel to the site more easily.

As the site is now becoming more congested, the layout plan becomes increasingly important. Trades will need space closest to their work area in order to operate most efficiently. Careful designation of space will give trades the space they need, while also creating a safe work environment by marking spaces out for each trade.

Building Plan

The Building Plan is designed to lead into some of the final stages of construction. The elevated deck has been completed for the entire parking garage and building footprints will begin to take shape as they are constructed. Several ramps and staircases lead down to the basement of the parking garage, where trades are utilizing the open space for material storage. Southern construction roads have been slightly adjusted so that trucks and vehicles and drive directly into the underground parking garage, making deliveries far easier. At this time, Chesapeake Geo will begin drilling the 250 geothermal wells on site.

Constructability Concerns

On a complex project such as this Campus Project, it is expected that a number of issues will come up during construction. These difficult challenges can potentially cause delays if they are not handled with careful preparation or planning. The majority of the issues that arose are caused by differences in typical construction practices, due to the owner's foreign background. These are working issues that come up because the respective team members do not typically follow the same methods during construction, and they will be addressed in a later section.

Three of the major issues that the construction team dealt with will be explained and assessed based on the team's solution to the problem. First, the retaining wall between the Parking Garage and Turkish Bath posed a challenge because surcharge loads caused by the elevated deck of the garage could potentially disrupt the sequence of construction. Second, the smaller domes of the Mosque presented difficulty in finding a way to give the concrete a smooth finished surface. Third, the four large arches supporting the main dome of the Mosque a challenge in designing the formwork that would be used to form them.

Case 1 – Retaining Wall

The retaining wall between the Parking Garage and the Turkish Bath is needed due to the difference in excavation height. The garage is excavated to a depth of about 13 feet while the bath is excavated to 37 feet. That leaves 24 feet of soil pushing on the wall from the side of the garage. The retaining wall is 22 feet tall along the meeting of the two buildings, and extends a distance of 175 feet. **Figure 5** shows a plan of the wall.

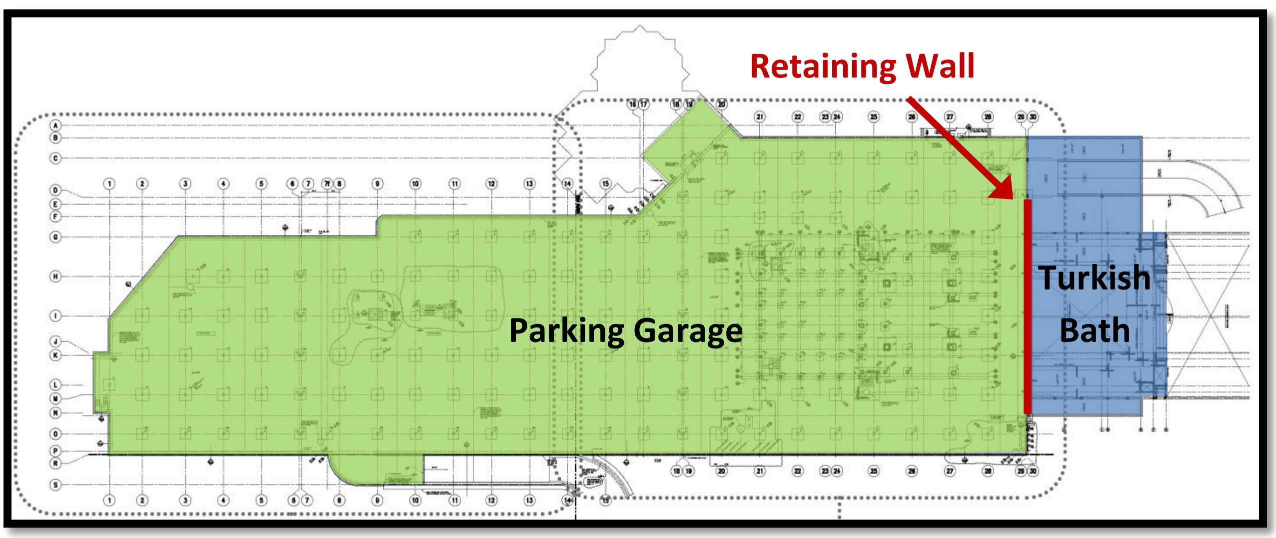


Figure 5. *Plan View of Retaining Wall*

On the second basement floor of the Turkish Bath is an underground swimming pool and basketball court. Other than two mezzanine areas overlooking the pool from either end, the basement is predominantly open space until the slab at grade level. This means that there is little support other than this retaining wall and several columns holding back about 24 feet of soil underneath the parking garage. Therefore, the retaining wall is essential to the structural integrity of the site. **Figure 6**, to the right shows a profile of the wall, provided in the construction drawings. As can be seen, the garage is at a significantly higher elevation than the bath. This difference will cause construction loads that if not analyzed properly, could potentially cause the wall to overturn.

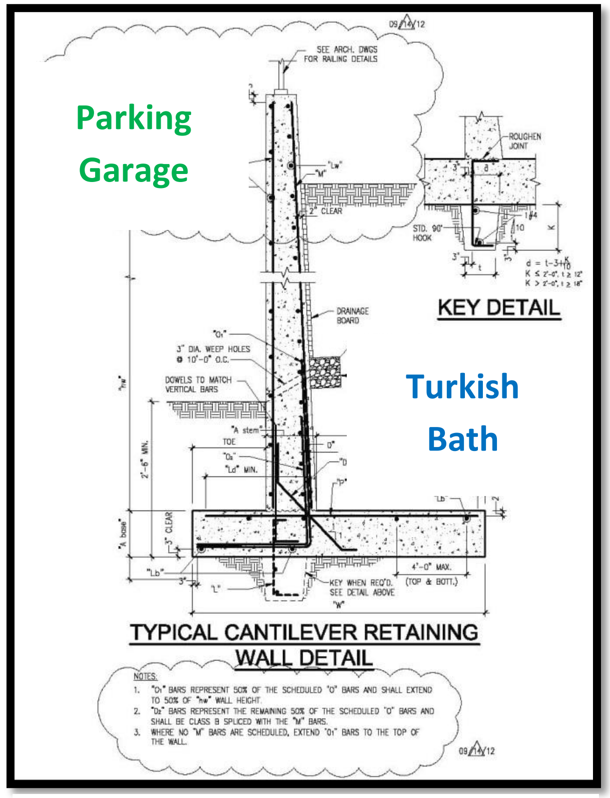


Figure 6. *Profile View of Retaining Wall*

In the schedule, it was anticipated that foundation work in the bath and the garage would proceed at similar rates of speed and construction would reach the point along the retaining wall at the same time. The imposed loads would balance on either side of the wall and there would be no issue. In reality, construction in the bath was completed faster than in the garage. The foundations were completed and poured and the team was waiting for the pool subcontractor to install underground piping for the pool. Then, they would backfill the pool area according to specifications, placing the load on the base of the retaining wall that would keep it steady.

Before the pool subcontractor arrived, construction of the garage had reached the wall and the elevated deck was next to be built. Concerned about imposed construction loads, the structural engineer was called in to analyze the situation. They decided that erecting or pouring the elevated deck before proper backfill was laid in the pool area would place too much stress on the retaining wall. Construction was at a standstill. The deck could not be poured without threatening to overturn the retaining wall, and the pool area could not be backfilled without delaying the installation of underground pipe.

Since the parking garage had more of an influence on the order of construction, it was decided that the elevated deck needed to be completed. The solution was to backfill the pool area with #57 stone, which was acceptable for structural material and would counterbalance construction loads. Then, the elevated deck was completed so that construction could continue. To install their pipe, the pool subcontractor dug out the backfill as necessary. The consequences of this issue were a delay to the schedule of several days and a change order which paid the pool subcontractor for additional work.

In hindsight, if this issue could have been anticipated, then construction in the bath could have been accelerated further to bring the pool subcontractor in earlier. With their work in place, backfill could be installed and the elevated deck could be erected, all without delaying the schedule. However, since it was not expected for the work in the bath to proceed faster than the garage, it would be almost impossible to prepare for this issue. Therefore, the possibility would be to deal with it when it occurred. With very few other options, the course of action taken was the appropriate method. The flow of construction work can be difficult to predict and expect. Although the solution delayed work in the pool area slightly, postponing work on the garage would have had more negative impacts on the schedule.

Case 2 – Auxiliary Domes

The Mosque is the most visually appealing and impressive building on the site. With a total of 29 domes and two 130' minarets, it is an architectural sight to behold. These features are predominantly made from cast-in-place concrete, which can be particularly difficult to cast in usual shapes. For instance, the smaller domes across the Mosque's roof held two challenges: (1) how to finish the curved surface of the dome to a smooth surface and (2) how to easily remove the Styrofoam form from the concrete casted to it.

Of the 29 domes, 27 are smaller domes across the roof. These can be seen in **Figure 7** to the right, which shows the Mosque from above. Although there are slight variances in size, the smaller domes are approximately 17 feet in diameter and 5 to 8 feet in height. They are formed of cement on metal lath, covered with a structure of cast-in-place concrete, several layers of insulation and barriers, and lead sheet metal roofing. Concrete is applied via crane and bucket, and typically several workers will be in place to help form it.

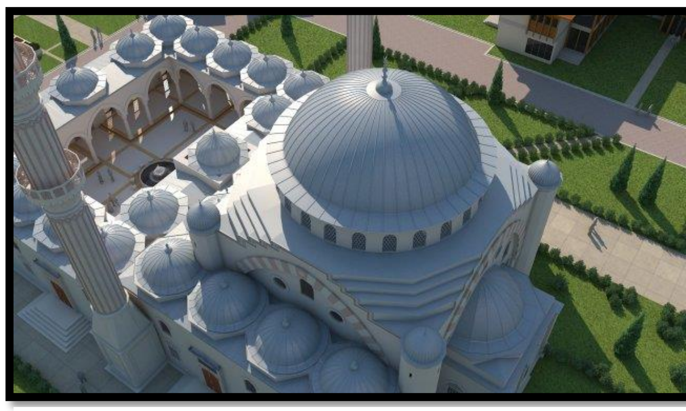


Figure 7. *Aerial View of Mosque*

A Styrofoam hemisphere is used to form the shape of each dome. They vary in size according to the corresponding dome and its shape. The hemisphere is brought on site in two pieces that are then attached together. A strip of tape is used to cover the joint between the pieces to keep the concrete from forming a ridge in the joint. One of these Styrofoam forms can be seen in **Figure 8**. The red lines across the form are glue joints where separate pieces of

Figure 8. *Styrofoam Form*

Styrofoam were glued together. This was done by the manufacturer prior to shipping the forms on site. The first constructability issue in this process is developing a method of finishing the domes to a smooth surface. Typically, concrete is poured to a flat surface, such as a slab or wall. Horizontal faces can be smoothed with screeds, and finished with various floats. Vertical surfaces are given a smooth surface by the material that is used as formwork. With a dome, the curvature of the surface makes it very difficult to give the surface a clean finish. There is no typical equipment or technique to this situation, as it is not very common. In addition, the surface of the dome is fairly steep, particularly at the edges. Until it has set, the concrete falls off of the dome and will need to be repeatedly lifted and pushed back into position, requiring the attention of several workers.

Finishing could be done by hand, but it would take several men working constantly to keep the concrete in place and smooth it. The labor would be tiring and congested, and would be very difficult to monitor for quality. A flat surface of concrete can be tested for correctness with a level, but there are very few ways, and even less convenient ways, of checking the correctness of a curved surface. Another solution could be the use of an outer form in conjunction with the inner Styrofoam form. It would be difficult and expensive to make, since several sizes would need to be made for the different domes, but it would guarantee a smoother surface. However, it would be very difficult to monitor the concrete's settlement inside the form and ensure that it would fill up all of the space. It may need to be poured in several lifts so that it could be handled more easily and could be vibrated to prevent honeycombing. Multiple lifts would create visible joints on the domes, which, although they would be covered by other roofing layers, are not desired by the owner.

Facchina, the concrete subcontractor, was faced with this dilemma. They have vast experience in cast-in-place concrete projects and came up with a unique solution that could be used for all of the domes. To give a smooth surface to the pour, they built their own screed. It was made of a semicircle arc of wood and shaped to the surface dimensions of each dome. At the peak, it connected to a large post and lintel frame via a pin, allowing the arc to rotate 360 degrees and smooth the surface of the concrete. The entire assembly was lifted into place over the dome by crane. As the screed was rotated and knocked concrete off the dome, workers lifted it back into place until it began to set and remain in place. Once completed, the custom screed could be lifted out of position and moved to the next dome. A picture of the screed in action can be seen in **Figure 9** and **10,** on the following page.

In comparison to the other options presented, Facchina's solution was the most logical and successful. It was inexpensive, reusable, and conformed to the owner's desires for the appearance of the dome. Based upon its effectiveness, it is the best solution to the problem and was the correct solution to the problem.

Figure 9. *Dome Pour*

Figure 10. Screed in Use

Case 3 – Main Dome Arches

Another constructability concern within the Mosque is the four large interior arches that form the square holding up the main dome. Each arch is an impressive 44' in diameter. They are made entirely of 8" of reinforced concrete, which thickens to 1'9" at the base, where they are supported by two columns. These columns are oversized in order to handle the heavy loads distributed by the arches. Two measure 5' x 5' and two measure 6'4" x 5'. Figure 6, to the right, shows a floor plan under the dome. The columns are highlighted in blue, while the arch spans are highlighted in red. The arch has a height of 22'. Adding the column base heights of 23', this means the apex of the arch is 45' above the finish floor.

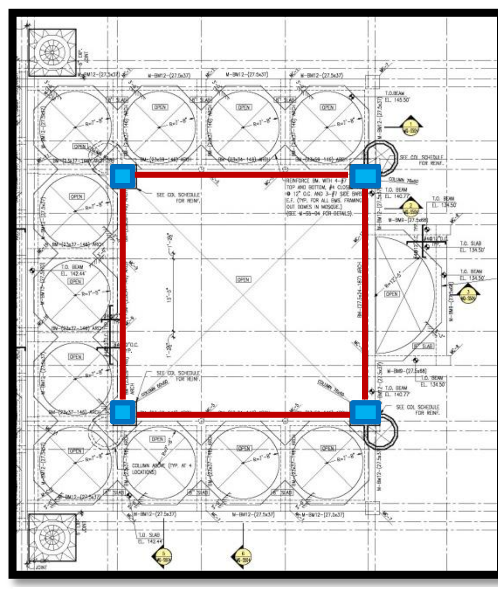


Figure 6 *Arch Floor Plan*

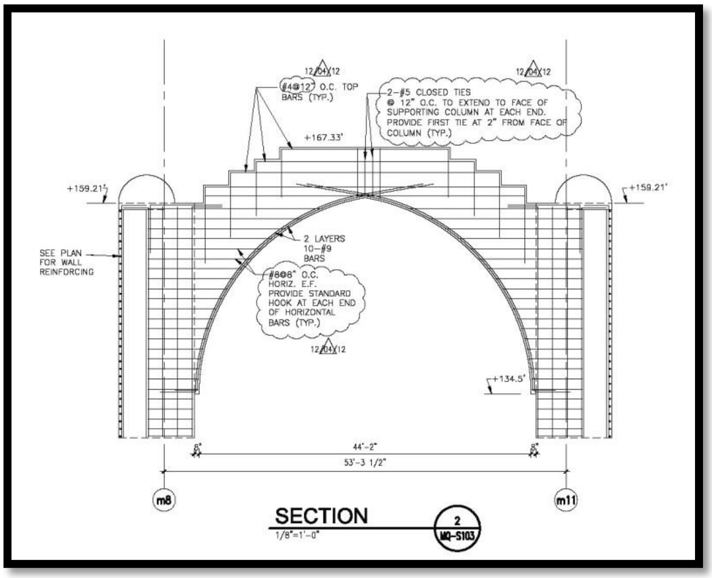


Figure 7 *Arch Profile*

Figure 7 to the left shows a view looking at the arch. As can be seen, the arch supports concrete above it (much more than is shown). The biggest issue here is how to form such a massive shape. A 44' span is an enormous length and is challenging enough to erect. Raise this item to 45' above the ground, and the problem gets even harder. The form to shape the concrete will need to be strong enough to support the weight of the concrete, as well as its own weight since it will be particularly massive.

Metal is a usable form. It is very strong and will easily support the weight of the dome. However, it may take some time to fabricate the shape needed and it will require significant bracing to support the form, which will be quite heavy. Wooden forms are possible, but it is unlikely it would be able to support the full weight of the arch. The arch could be cast on the ground and hoisted into position. It would be easier to form, safer to work with, and probably higher quality because it would be developed in a controlled environment. However, lifting the arch would be challenging to develop an appropriate hoisting system to support the arch without damaging it. Attaching the arch to the columns creates potential issues of poor bonding, preventing the loads from transferring properly to the columns. There is also the possibility that positioning the arches will damage the column or mar the surface in a way that it does meet the owner's satisfactions.

Figure 8 *Custom Arch Formwork*

Again, Facchina was tasked with developing a solution to this issue. Through consultation with the structural engineer, they developed a plan to form the arch in several lifts using wooden formwork. All of the formwork was custom built using plywood and 2x4 pieces. They were heavily braced underneath in order to support the heavy concrete loads. Each lift was carefully poured in order to ensure quality control. Facchina's formwork engineer was on duty to inspect the preparation work before any concrete was poured. This ensured the safety of the workers and an assurance that the formwork would perform properly. Figure 8 shows a custom built arch frame. It is used for the many smaller arches throughout the Mosque. At approximately one fourth the size of the main arch, it is no comparison in size, but it does show the intensive custom design that Facchina underwent for each arch. Since the main arches are significantly larger in size, they would undergo even more extensive design.

Out of the possibilities in front of them, Facchina chose the cheapest and easiest option. Wood is very inexpensive and plentiful, and skilled workers can easily build a variety of shapes from it. This method also ensured that no damage would befall any work in place due to installation of a prefabricated arch. Utilizing the structural engineer they made sure that their plan would have no detrimental impact on the strength of the arch once it was in place.

Cultural Implications

One of the most unique aspects of this Campus Project is the culture. Not only does it have a role in the end product, but it also has strong influence on the construction project itself. The owner has consistent and frequent input into the progress of construction and into the design. They give their input to ensure that the design meets their specifications and desires, which includes adhering to their cultural requirements. In addition, a large quantity of finishes needs to be completed by foreign artisans. Their work is coordinated into the schedule and they are brought to the United States to complete their work. For the purposes of this analysis, the Turkish culture will be examined, but should not be considered the culture of the foreign artisans brought on-site.

Turkey is a country located in the transitional area between Western Asia and Eastern Europe. It is a democratic nation that has gradually grown economically and politically, becoming a regional power. The national language, Turkish, is spoken by the majority of the population. It has no official religion, however, the majority of the population practices Islam. Several holidays within the Islamic faith may come to influence construction, the most notable of which is Ramadan, commonly known as fasting. For one month Muslims fast from dawn to sunset, denying themselves both food and drink. It is a time of spiritual reflection, improvement, and devotion. Abstaining from eating and drinking teaches self-discipline, self-control, sacrifice, and empathy for the less fortunate.

There are exceptions to participating in Ramadan, such as travel, severe illness, or pregnancy. However, any who are unable to fast are still required to make up the missed days later. Muslims are allowed one meal before sunrise and one meal after sunset. Fasting can greatly weaken those who are participating. If a construction worker is fasting, they may receive lighter workloads until Ramadan is over, in order to protect the worker's safety. Religious practice is a strong element of the Turkish culture, apparent by the country's registered mosques, which number of 80,000. Clearly they have perfected the art of building a Mosque.

There are also a number of cultural differences that may affect the construction process. These include religious practice, cultural holidays, typical construction practices, and language barriers. An understanding of the Turkish culture is necessary to help bridge this gap for two purposes: (1) to assist in the construction process to remain on schedule and on budget and (2) to better understand the meaning of the project culturally. Through this knowledge and understanding the project can perform better and be delivered to meet the owner's specifications.

There are several differences between the way construction proceeds in the United States and the way construction proceeds in Turkey. Here, construction is a very schedule and cost based activity. The goal is almost always to deliver as fast as possible at the lowest possible cost. The schedule is heavily managed and planned in order to optimize the flow of work across the construction project. This requires near constant information flow so each trade can understand the work of those around them. Typically, information and planning is developed prior to start of construction. For example, shop drawings are developed before work is begun so the different trades involved in that process can coordinate and plan the work efficiently. Planning and design prior to working in place is the norm.

In Turkey, priorities are not exactly the same. Because of differences in labor laws and hourly wages, schedule is not necessarily their primary concern. Shortening the schedule may not result in significant cost savings. In addition, shop drawings and designs are not as thoroughly documented over there. The workers there have been working and building for many, many years. They know their craft; they know their construction process. They do not absolutely need drawings to know where items connect or to know how different layers of an assembly intersect and overlap.

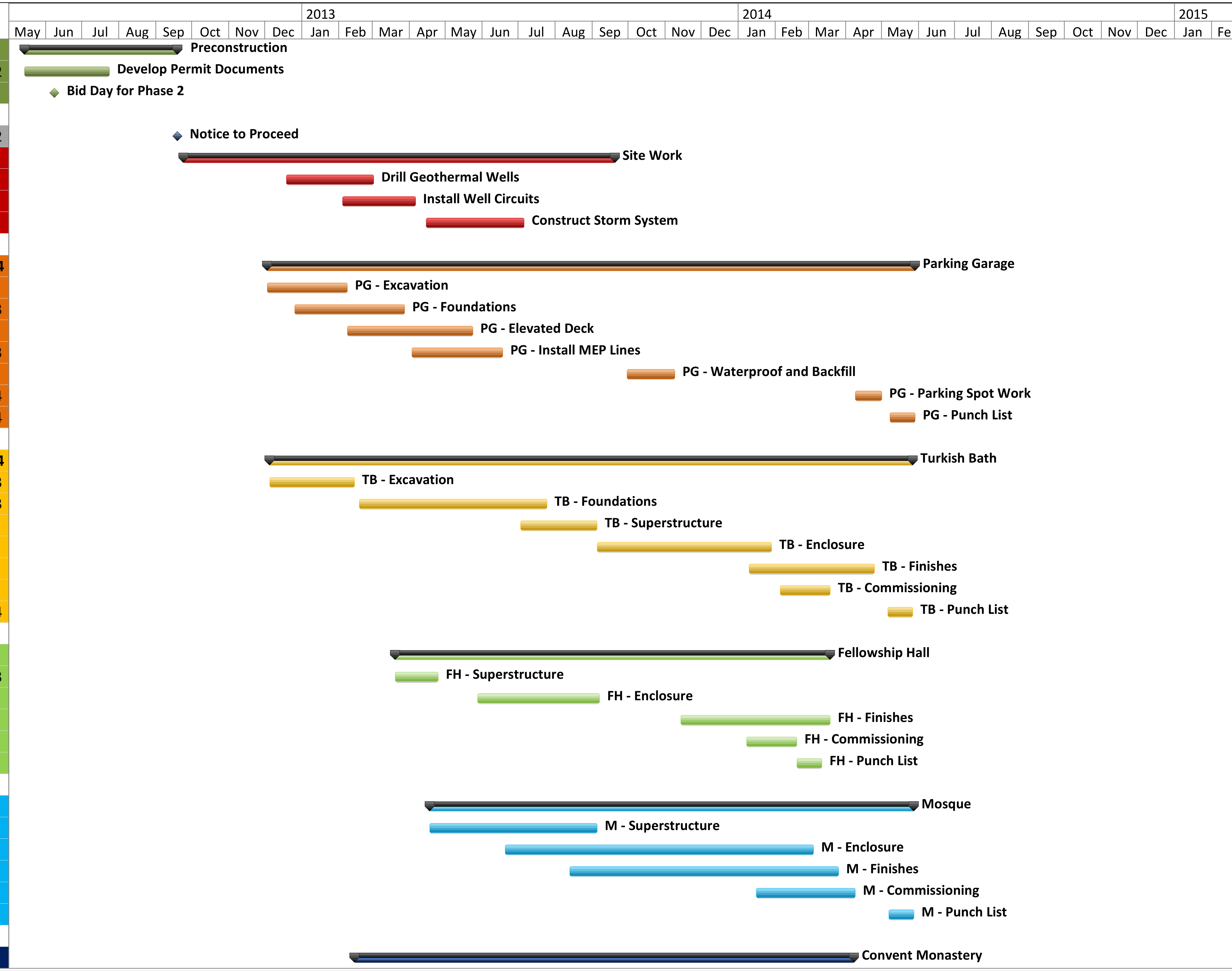
This is a profound difference from the way construction takes place in the States. Here, clearly documented designs are essential to getting and keeping work. If you do not have them, then you are failing to work with the other members of the team, and you will be quickly replaced. Explicit designs help construction managers maintain control over the project and ensure quality as work goes into place. It is a form of documentation of the work that went into place and proof that the work was completed to specification.

The difference between these construction practices is not necessarily a good or a bad thing. It is simply a difference; and when two extremes such as these meet and try to cooperate, it can be quite challenging. The project team has faced issues where this lack of information can be quite frustrating or slow construction. For example, when they were attempting to coordinate the work surrounding Mosque windows, they did not receive shop drawings for the installation of limestone around the windows, work that would be completed by the Turkish workers. Without these shop drawings they could not determine where flashing, metal trim, or other elements should be installed and integrated with the limestone panels. Unable to coordinate the process before construction, as would be typical here, the team observed the process in the field and then developed the plan to complete the work. Fortunately, in this situation, it caused no delay to schedule or otherwise. However, this method will not work for all construction activities, and some would cause delays to the schedule.

These issues of insufficient information are apparent project wide, but are heavily focused on the Mosque, where the majority of Turkish work is located. An additional issue that the team has faced is the design of the lead sheet metal roofing. The owner has not provided shop drawings of the roofing, which would indicate sheet sizes, seam locations, and other useful information. Without these drawings, the assembly cannot be coordinated which includes flashing, trim, and Z-bars. The consequence of these issues is that the team must figure out the construction sequence in the field, without adequate planning of the work.

Appendix A.1: Project Overview Schedule

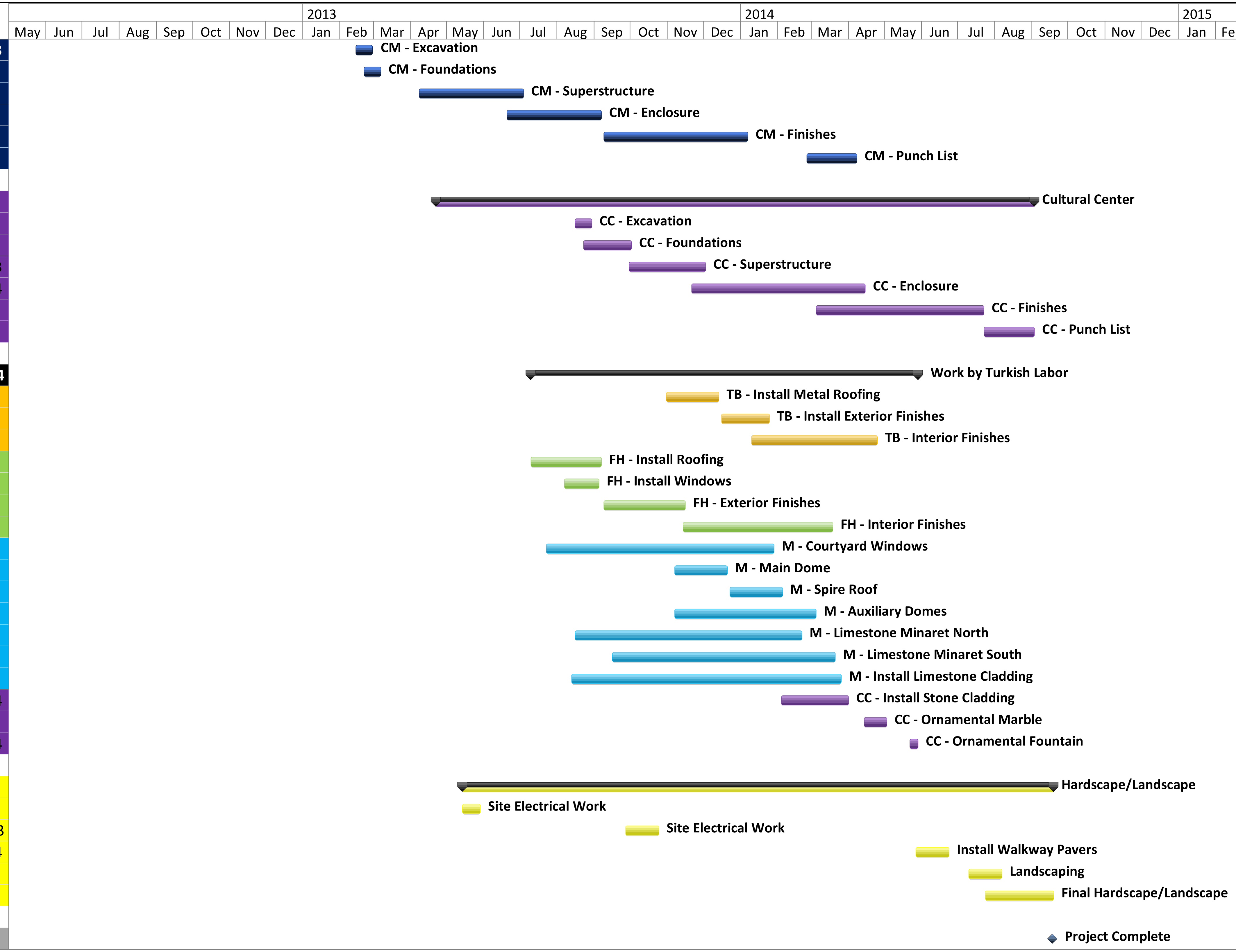
ID	Task Name	Duration	Start	Finish
1	**Preconstruction**	**92 days**	**Mon 5/14/12**	**Tue 9/18/12**
3	Develop Permit Documents	51 days	Mon 5/14/12	Mon 7/23/12
4	Bid Day for Phase 2	0 days	Fri 6/8/12	Fri 6/8/12
5				
6	Notice to Proceed	0 days	Wed 9/19/12	Wed 9/19/12
7	**Site Work**	**259 days**	**Mon 9/24/12**	**Thu 9/19/13**
9	Drill Geothermal Wells	53 days	Wed 12/19/12	Fri 3/1/13
10	Install Well Circuits	45 days	Mon 2/4/13	Fri 4/5/13
11	Construct Storm System	60 days	Mon 4/15/13	Fri 7/5/13
12				
13	**Parking Garage**	**388 days**	**Mon 12/3/12**	**Wed 5/28/14**
14	PG - Excavation	49 days	Mon 12/3/12	Thu 2/7/13
15	PG - Foundations	66 days	Wed 12/26/12	Wed 3/27/13
16	PG - Elevated Deck	75 days	Fri 2/8/13	Thu 5/23/13
17	PG - Install MEP Lines	54 days	Wed 4/3/13	Mon 6/17/13
18	PG - Waterproof and Backfill	30 days	Mon 9/30/13	Fri 11/8/13
19	PG - Parking Spot Work	16 days	Wed 4/9/14	Wed 4/30/14
20	PG - Punch List	15 days	Thu 5/8/14	Wed 5/28/14
21				
22	**Turkish Bath**	**384 days**	**Wed 12/5/12**	**Mon 5/26/14**
23	TB - Excavation	51 days	Wed 12/5/12	Wed 2/13/13
24	TB - Foundations	113 days	Mon 2/18/13	Wed 7/24/13
25	TB - Superstructure	46 days	Wed 7/3/13	Wed 9/4/13
26	TB - Enclosure	104 days	Thu 9/5/13	Tue 1/28/14
27	TB - Finishes	75 days	Fri 1/10/14	Thu 4/24/14
28	TB - Commissioning	30 days	Wed 2/5/14	Tue 3/18/14
29	TB - Punch List	15 days	Tue 5/6/14	Mon 5/26/14
30				
31	**Fellowship Hall**	**260 days**	**Wed 3/20/13**	**Tue 3/18/14**
32	FH - Superstructure	26 days	Wed 3/20/13	Wed 4/24/13
33	FH - Enclosure	74 days	Tue 5/28/13	Fri 9/6/13
34	FH - Finishes	89 days	Thu 11/14/13	Tue 3/18/14
35	FH - Commissioning	30 days	Wed 1/8/14	Tue 2/18/14
36	FH - Punch List	15 days	Wed 2/19/14	Tue 3/11/14
37				
38	**Mosque**	**289 days**	**Thu 4/18/13**	**Tue 5/27/14**
39	M - Superstructure	100 days	Thu 4/18/13	Wed 9/4/13
40	M - Enclosure	184 days	Thu 6/20/13	Tue 3/4/14
41	M - Finishes	161 days	Tue 8/13/13	Tue 3/25/14
42	M - Commissioning	59 days	Thu 1/16/14	Tue 4/8/14
43	M - Punch List	15 days	Wed 5/7/14	Tue 5/27/14
44				
45	**Convent Monastery**	**298 days**	**Thu 2/14/13**	**Mon 4/7/14**



Cultural Center, Northeast US
Project Overview
Technical Report 2

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

ID	Task Name	Duration	Start	Finish
46	CM - Excavation	10 days	Thu 2/14/13	Wed 2/27/13
47	CM - Foundations	10 days	Thu 2/21/13	Wed 3/6/13
48	CM - Superstructure	63 days	Mon 4/8/13	Wed 7/3/13
49	CM - Enclosure	57 days	Thu 6/20/13	Fri 9/6/13
50	CM - Finishes	86 days	Mon 9/9/13	Mon 1/6/14
51	CM - Punch List	30 days	Tue 2/25/14	Mon 4/7/14
52				
53	**Cultural Center**	**357 days**	**Mon 4/22/13**	**Tue 9/2/14**
55	CC - Excavation	10 days	Fri 8/16/13	Thu 8/29/13
56	CC - Foundations	28 days	Fri 8/23/13	Tue 10/1/13
57	CC - Superstructure	46 days	Mon 9/30/13	Mon 12/2/13
58	CC - Enclosure	103 days	Thu 11/21/13	Mon 4/14/14
59	CC - Finishes	100 days	Wed 3/5/14	Tue 7/22/14
60	CC - Punch List	30 days	Wed 7/23/14	Tue 9/2/14
61				
62	**Work by Turkish Labor**	**231 days**	**Wed 7/10/13**	**Wed 5/28/14**
63	TB - Install Metal Roofing	32 days	Thu 10/31/13	Fri 12/13/13
64	TB - Install Exterior Finishes	30 days	Mon 12/16/13	Fri 1/24/14
65	TB - Interior Finishes	75 days	Fri 1/10/14	Thu 4/24/14
66	FH - Install Roofing	43 days	Wed 7/10/13	Fri 9/6/13
67	FH - Install Windows	21 days	Wed 8/7/13	Wed 9/4/13
68	FH - Exterior Finishes	50 days	Mon 9/9/13	Fri 11/15/13
69	FH - Interior Finishes	89 days	Thu 11/14/13	Tue 3/18/14
70	M - Courtyard Windows	136 days	Tue 7/23/13	Tue 1/28/14
71	M - Main Dome	32 days	Thu 11/7/13	Fri 12/20/13
72	M - Spire Roof	32 days	Mon 12/23/13	Tue 2/4/14
73	M - Auxiliary Domes	84 days	Thu 11/7/13	Tue 3/4/14
74	M - Limestone Minaret North	135 days	Fri 8/16/13	Thu 2/20/14
75	M - Limestone Minaret South	134 days	Mon 9/16/13	Thu 3/20/14
76	M - Install Limestone Cladding	161 days	Tue 8/13/13	Tue 3/25/14
77	CC - Install Stone Cladding	40 days	Tue 2/4/14	Mon 3/31/14
78	CC - Ornamental Marble	15 days	Mon 4/14/14	Fri 5/2/14
79	CC - Ornamental Fountain	5 days	Thu 5/22/14	Wed 5/28/14
80				
81	**Hardscape/Landscape**	**353 days**	**Tue 5/14/13**	**Thu 9/18/14**
82	Site Electrical Work	11 days	Tue 5/14/13	Tue 5/28/13
83	Site Electrical Work	20 days	Fri 9/27/13	Thu 10/24/13
84	Install Walkway Pavers	20 days	Tue 5/27/14	Mon 6/23/14
85	Landscaping	20 days	Thu 7/10/14	Wed 8/6/14
86	Final Hardscape/Landscape	41 days	Thu 7/24/14	Thu 9/18/14
87				
88	Project Complete	0 days	Thu 9/18/14	Thu 9/18/14

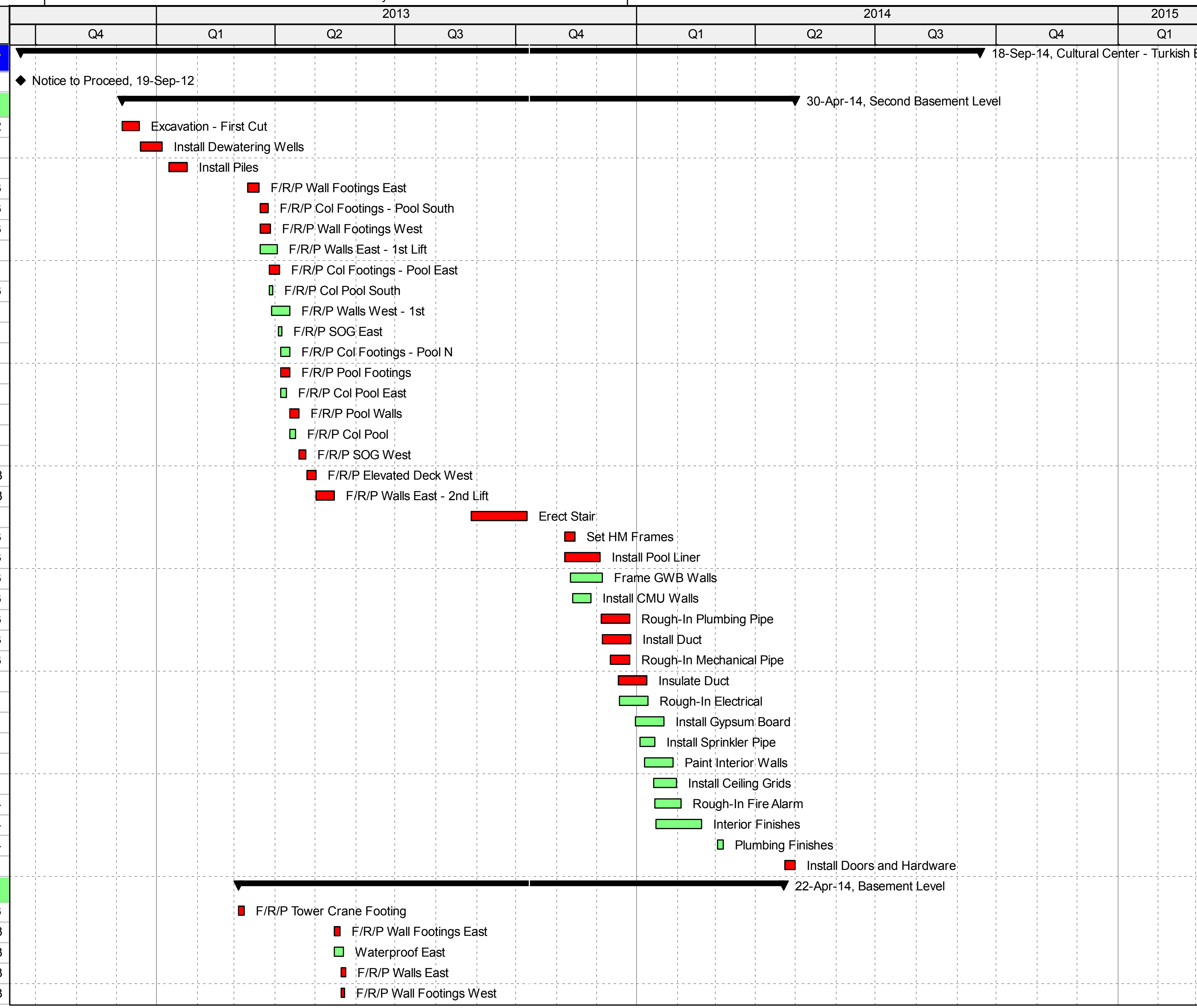


Cultural Center, Northeast US
Project Overview
Technical Report 2

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

Appendix A.2: Detailed Schedule – Turkish Bath

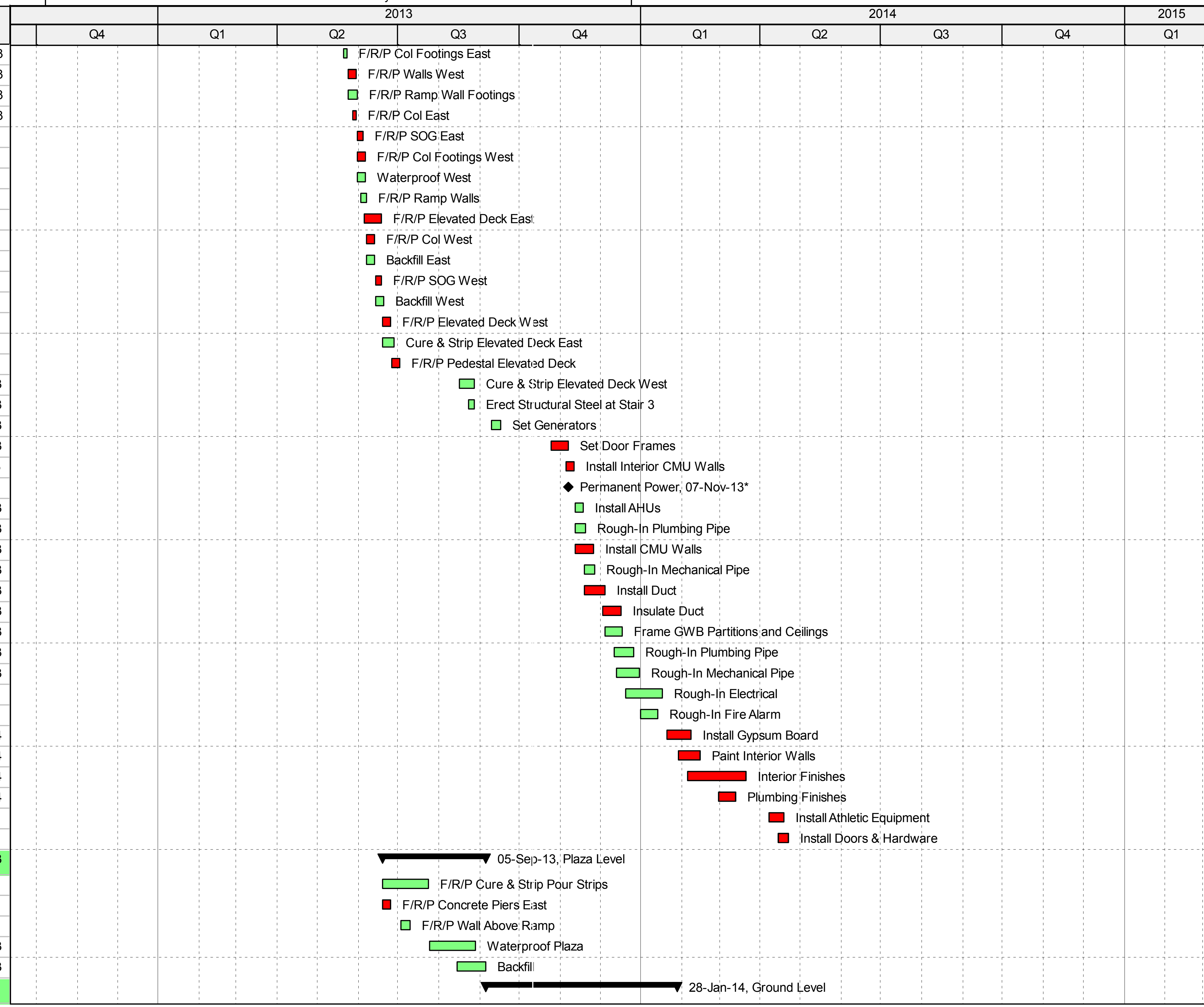
Activity ID	Activity Name	Original Duration	Start	Finish
Cultural Center - Turkish Bath		514	19-Sep-12	18-Sep-14
A1000	Notice to Proceed	0	19-Sep-12	
Second Basement Level		359	05-Dec-12	30-Apr-14
A1010	Excavation - First Cut	10	05-Dec-12	18-Dec-12
A1020	Install Dewatering Wells	11	19-Dec-12	04-Jan-13
A1030	Install Piles	10	10-Jan-13	23-Jan-13
A1040	F/R/P Wall Footings East	7	11-Mar-13	19-Mar-13
A1050	F/R/P Col Footings - Pool South	5	20-Mar-13	26-Mar-13
A1060	F/R/P Wall Footings West	7	20-Mar-13	28-Mar-13
A1070	F/R/P Walls East - 1st Lift	10	20-Mar-13	02-Apr-13
A1080	F/R/P Col Footings - Pool East	7	27-Mar-13	04-Apr-13
A1090	F/R/P Col Pool South	3	27-Mar-13	29-Mar-13
A1100	F/R/P Walls West - 1st	10	29-Mar-13	11-Apr-13
A1110	F/R/P SOG East	3	03-Apr-13	05-Apr-13
A1120	F/R/P Col Footings - Pool N	5	05-Apr-13	11-Apr-13
A1130	F/R/P Pool Footings	5	05-Apr-13	11-Apr-13
A1140	F/R/P Col Pool East	3	05-Apr-13	09-Apr-13
A1150	F/R/P Pool Walls	5	12-Apr-13	18-Apr-13
A1160	F/R/P Col Pool	3	12-Apr-13	16-Apr-13
A1170	F/R/P SOG West	4	19-Apr-13	24-Apr-13
A1180	F/R/P Elevated Deck West	5	25-Apr-13	01-May-13
A1190	F/R/P Walls East - 2nd Lift	10	02-May-13	15-May-13
A1200	Erect Stair	30	28-Aug-13	09-Oct-13
A1210	Set HM Frames	6	07-Nov-13*	14-Nov-13
A1220	Install Pool Liner	18	07-Nov-13*	03-Dec-13
A1230	Frame GWB Walls	18	11-Nov-13*	05-Dec-13
A1240	Install CMU Walls	10	13-Nov-13*	26-Nov-13
A1250	Rough-In Plumbing Pipe	16	04-Dec-13*	26-Dec-13
A1260	Install Duct	16	05-Dec-13*	27-Dec-13
A1270	Rough-In Mechanical Pipe	11	11-Dec-13*	26-Dec-13
A1280	Insulate Duct	16	17-Dec-13*	08-Jan-14
A1290	Rough-In Electrical	16	18-Dec-13*	09-Jan-14
A1300	Install Gypsum Board	17	30-Dec-13*	21-Jan-14
A1310	Install Sprinkler Pipe	8	03-Jan-14*	14-Jan-14
A1320	Paint Interior Walls	17	06-Jan-14*	28-Jan-14
A1330	Install Ceiling Grids	14	13-Jan-14*	30-Jan-14
A1340	Rough-In Fire Alarm	15	14-Jan-14*	03-Feb-14
A1350	Interior Finishes	25	15-Jan-14*	18-Feb-14
A1360	Plumbing Finishes	5	03-Mar-14*	07-Mar-14
A1370	Install Doors and Hardware	6	23-Apr-14*	30-Apr-14
Basement Level		292	04-Mar-13	22-Apr-14
A1380	F/R/P Tower Crane Footing	5	04-Mar-13*	08-Mar-13
A1390	F/R/P Wall Footings East	3	16-May-13	20-May-13
A1400	Waterproof East	5	16-May-13	22-May-13
A1410	F/R/P Walls East	4	21-May-13	24-May-13
A1420	F/R/P Wall Footings West	3	21-May-13	23-May-13



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

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish
A1430	F/R/P Col Footings East	3	21-May-13	23-May-13
A1440	F/R/P Walls West	4	24-May-13	30-May-13
A1450	F/R/P Ramp Wall Footings	5	24-May-13	31-May-13
A1460	F/R/P Col East	3	28-May-13	30-May-13
A1470	F/R/P SOG East	3	31-May-13	04-Jun-13
A1480	F/R/P Col Footings West	5	31-May-13	06-Jun-13
A1490	Waterproof West	5	31-May-13	06-Jun-13
A1500	F/R/P Ramp Walls	5	03-Jun-13	07-Jun-13
A1510	F/R/P Elevated Deck East	10	05-Jun-13	18-Jun-13
A1520	F/R/P Col West	5	07-Jun-13	13-Jun-13
A1530	Backfill East	5	07-Jun-13	13-Jun-13
A1540	F/R/P SOG West	3	14-Jun-13	18-Jun-13
A1550	Backfill West	5	14-Jun-13	20-Jun-13
A1560	F/R/P Elevated Deck West	5	19-Jun-13	25-Jun-13
A1570	Cure & Strip Elevated Deck East	8	19-Jun-13	28-Jun-13
A1580	F/R/P Pedestal Elevated Deck	5	26-Jun-13	02-Jul-13
A1590	Cure & Strip Elevated Deck West	8	16-Aug-13	27-Aug-13
A1600	Erect Structural Steel at Stair 3	3	23-Aug-13	27-Aug-13
A1610	Set Generators	5	10-Sep-13	16-Sep-13
A1620	Set Door Frames	9	25-Oct-13*	06-Nov-13
A1630	Install Interior CMU Walls	5	05-Nov-13*	11-Nov-13
A1640	Permanent Power	0	07-Nov-13*	
A1650	Install AHUs	5	12-Nov-13*	18-Nov-13
A1660	Rough-In Plumbing Pipe	6	12-Nov-13*	19-Nov-13
A1670	Install CMU Walls	10	12-Nov-13*	25-Nov-13
A1680	Rough-In Mechanical Pipe	6	19-Nov-13*	26-Nov-13
A1690	Install Duct	11	19-Nov-13*	04-Dec-13
A1700	Insulate Duct	10	03-Dec-13*	16-Dec-13
A1710	Frame GWB Partitions and Ceilin	10	04-Dec-13*	17-Dec-13
A1720	Rough-In Plumbing Pipe	11	11-Dec-13*	26-Dec-13
A1730	Rough-In Mechanical Pipe	11	13-Dec-13*	30-Dec-13
A1740	Rough-In Electrical	19	20-Dec-13*	16-Jan-14
A1750	Rough-In Fire Alarm	10	31-Dec-13*	13-Jan-14
A1760	Install Gypsum Board	15	20-Jan-14*	07-Feb-14
A1770	Paint Interior Walls	13	29-Jan-14*	14-Feb-14
A1780	Interior Finishes	33	05-Feb-14*	21-Mar-14
A1790	Plumbing Finishes	10	28-Feb-14*	13-Mar-14
A1800	Install Athletic Equipment	10	07-Apr-14*	18-Apr-14
A1810	Install Doors & Hardware	7	14-Apr-14*	22-Apr-14
Plaza Level		55	19-Jun-13	05-Sep-13
A1820	F/R/P Cure & Strip Pour Strips	25	19-Jun-13*	24-Jul-13
A1830	F/R/P Concrete Piers East	5	19-Jun-13*	25-Jun-13
A1840	F/R/P Wall Above Ramp	5	03-Jul-13*	10-Jul-13
A1850	Waterproof Plaza	25	25-Jul-13	28-Aug-13
A1860	Backfill	15	15-Aug-13	05-Sep-13
Ground Level		102	05-Sep-13	28-Jan-14



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

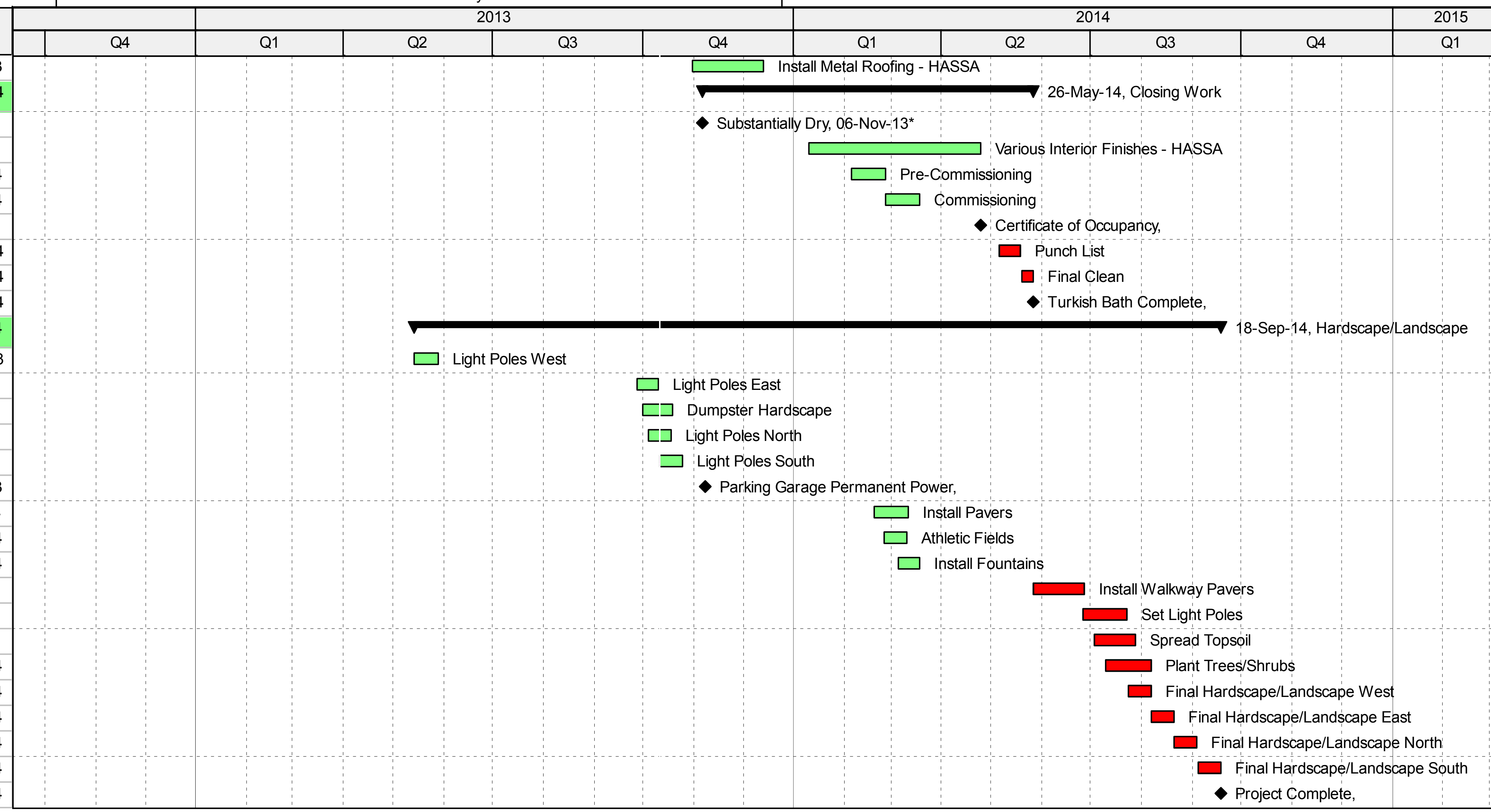
TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish
A1870	Install Gypsum Sheathing	5	05-Sep-13	11-Sep-13
A1880	Install Exterior CMU Walls	15	26-Sep-13	16-Oct-13
A1890	Install Windows	5	17-Oct-13*	23-Oct-13
A1900	Set Door Frames	6	17-Oct-13*	24-Oct-13
A1910	Install Interior CMU Walls	10	22-Oct-13*	04-Nov-13
A1920	Install Curtainwall	5	24-Oct-13*	30-Oct-13
A1930	Frame GWB Partitions & Ceilings	8	29-Oct-13*	07-Nov-13
A1940	Rough-In Plumbing Pipe	7	04-Nov-13*	12-Nov-13
A1950	Install Duct	9	05-Nov-13*	15-Nov-13
A1960	Rough-In Mechanical Pipe	7	06-Nov-13*	14-Nov-13
A1970	Rough-In Electrical	6	08-Nov-13*	15-Nov-13
A1980	Rough-In Fire Alarm	6	12-Nov-13*	19-Nov-13
A1990	Install Sprinkler Pipe	7	15-Nov-13*	25-Nov-13
A2000	Install Gypsum Board	7	21-Nov-13*	02-Dec-13
A2010	Paint Interior Walls	7	26-Nov-13*	05-Dec-13
A2020	Interior Finishes	15	03-Dec-13*	23-Dec-13
A2030	Install Ceiling Grid	6	05-Dec-13*	12-Dec-13
A2040	Install Exterior Finishes - HASSA	31	16-Dec-13*	28-Jan-14
A2050	Plumbing Finishes	15	16-Dec-13*	06-Jan-14
A2060	Electrical Finishes	6	26-Dec-13*	02-Jan-14
Second Floor Level		108	03-Jul-13	04-Dec-13
A2070	F/R/P Columns	6	03-Jul-13	11-Jul-13
A2080	Install ERVs	2	17-Oct-13*	18-Oct-13
A2090	Frame GWB Partitions & Ceilings	9	17-Oct-13*	29-Oct-13
A2100	Install Duct	8	18-Oct-13*	29-Oct-13
A2110	Install Fire Dampers	3	22-Oct-13*	24-Oct-13
A2120	Install Mechanical Pipe	7	25-Oct-13*	04-Nov-13
A2130	Install Sprinkler Pipe	7	25-Oct-13*	04-Nov-13
A2140	Rough-In Electrical	5	29-Oct-13*	04-Nov-13
A2150	Exterior Wall Assembly	5	04-Nov-13*	08-Nov-13
A2160	Install Radiant Floor & Wall Tubin	5	06-Nov-13*	12-Nov-13
A2170	Pour Topping Slab	6	08-Nov-13*	15-Nov-13
A2180	Install Gypsum Board	6	13-Nov-13*	20-Nov-13
A2190	Interior Finishes	12	18-Nov-13*	04-Dec-13
Roof Level		109	12-Jul-13	13-Dec-13
A2200	F/R/P Elevated Deck	8	12-Jul-13	23-Jul-13
A2210	F/R/P Columns to Roof	7	24-Jul-13	01-Aug-13
A2220	F/R/P Elevated Deck	7	24-Jul-13	01-Aug-13
A2230	F/R/P Roof Domes	10	02-Aug-13	15-Aug-13
A2240	Install Dome Skylights	5	16-Aug-13	22-Aug-13
A2250	Cure & Strip Elevated Decks	8	16-Aug-13	27-Aug-13
A2260	Erect Structural Steel	5	16-Aug-13	22-Aug-13
A2270	Install Trusses	5	23-Aug-13	29-Aug-13
A2280	Lay Metal Decking	3	30-Aug-13	04-Sep-13
A2290	Install Fixed Unit Skylights	5	12-Sep-13	18-Sep-13
A2300	Roofing Assembly	30	19-Sep-13	30-Oct-13

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

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish
A2310	Install Metal Roofing - HASSA	31	31-Oct-13*	13-Dec-13
Closing Work		142	06-Nov-13	26-May-14
A2320	Substantially Dry	0	06-Nov-13*	
A2330	Various Interior Finishes - HASSA	75	10-Jan-14*	24-Apr-14
A2340	Pre-Commissioning	15	05-Feb-14*	25-Feb-14
A2350	Commissioning	15	26-Feb-14*	18-Mar-14
A2360	Certificate of Occupancy	0		24-Apr-14
A2370	Punch List	10	06-May-14*	19-May-14
A2380	Final Clean	5	20-May-14*	26-May-14
A2390	Turkish Bath Complete	0		26-May-14
Hardscape/Landscape		348	14-May-13	18-Sep-14
A2400	Light Poles West	10	14-May-13	28-May-13
A2410	Light Poles East	10	27-Sep-13	10-Oct-13
A2420	Dumpster Hardscape	15	30-Sep-13	18-Oct-13
A2430	Light Poles North	10	04-Oct-13	17-Oct-13
A2440	Light Poles South	10	11-Oct-13	24-Oct-13
A2450	Parking Garage Permanent Powe	0		07-Nov-13
A2460	Install Pavers	15	19-Feb-14*	11-Mar-14
A2470	Athletic Fields	10	25-Feb-14*	10-Mar-14
A2480	Install Fountains	10	05-Mar-14*	18-Mar-14
A2490	Install Walkway Pavers	24	27-May-14*	27-Jun-14
A2500	Set Light Poles	20	26-Jun-14*	23-Jul-14
A2510	Spread Topsoil	18	03-Jul-14*	28-Jul-14
A2520	Plant Trees/Shrubs	20	10-Jul-14*	06-Aug-14
A2530	Final Hardscape/Landscape West	10	24-Jul-14*	06-Aug-14
A2540	Final Hardscape/Landscape East	10	07-Aug-14*	20-Aug-14
A2550	Final Hardscape/Landscape Nortl	10	21-Aug-14*	03-Sep-14
A2560	Final Hardscape/Landscape Soutl	11	04-Sep-14*	18-Sep-14
A2570	Project Complete	0		18-Sep-14



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

TASK filter: All Activities

Appendix B.1: Detailed Structural Estimate

Cost Code	Item	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total
Division 03 Concrete							**$594,436.24**
Formwork							
03 11 13.20 2650	Reinforced Concrete Beams	125	SFCA	$1.42	$5.85	--	$908.75
03 11 13.25 6150	Reinforced Concrete Pedestals	3190	SFCA	$1.36	$6.50	--	$25,073.40
03 11 13.25 6650	Reinforced Concrete Columns	165	SFCA	$1.58	$6.45	--	$1,324.95
03 11 13.35 2150	Elevated Slab	6880	SF	$2.31	$4.21	--	$44,857.60
03 11 13.35 7101	Elevated Slab - Edge Forms	430	SFCA	$0.62	$7.05	--	$3,298.10
03 11 13.85 4230	Foundation Walls	13125	SFCA	$1.36	$9.55	--	$143,193.75
Waterstops							
03 15 13.50 2000	Rubber Self-Expanding Waterstop	750	LF	$22.00	$2.72	--	$18,540.00
Construction Joints							
03 15 16.20 0140	Control Joint - Sawcut	1350	LF	$0.07	$0.44	$0.11	$837.00
03 15 16.30 2250	Expansion Joint - Cork	1050	LF	$2.70	$1.22	--	$4,116.00
Anchor Bolts							
03 15 19.10 1340	Anchor Bolts - 3/4"Ø x 42" Long	36	Set	$45.00	$23.00	--	$2,448.00
03 15 19.10 1460	Anchor Bolts - 1¼"Ø x 42" Long	18	Set	$110.00	$29.50	--	$2,511.00
03 15 19.10 1540	Anchor Bolts - 1½"Ø x 42" Long	14	Set	$158.00	$33.50	--	$2,681.00
Reinforcement Bars							
03 21 11.60 0150	Reinforced Concrete Beams	1.4	Ton	$1,000.00	$1,025.00	--	$2,835.00
03 21 11.60 0200	Reinforced Concrete Columns & Pedestals	22.8	Ton	$1,000.00	$1,075.00	--	$47,310.00
03 21 11.60 0400	Elevated Slab	30.0	Ton	$1,000.00	$560.00	--	$46,800.00
03 21 11.60 0500	Footings	13.2	Ton	$1,000.00	$770.00	--	$23,364.00
03 21 11.60 0700	Foundation Walls	13.4	Ton	$1,000.00	$540.00	--	$20,636.00
Grid Reinforcement							
03 22 05.50 0100	Welded Wire Fabric, W1.4 x W1.4	20480	SF	$0.14	$0.23	--	$7,434.24
03 22 05.50 0200	Welded Wire Fabric, W2.0 x W2.0	26290	SF	$0.22	$0.26	--	$12,356.30
Concrete Material							
03 31 13.35 0150	Concrete, 3000 psi	427	CY	$99.00	--	--	$42,273.00
03 31 13.35 0350	Concrete, 4500 psi	300	CY	$107.00	--	--	$32,100.00
03 31 13.35 0400	Concrete, 5000 psi	514	CY	$110.00	--	--	$56,540.00

Placing Concrete							
03 31 13.70 0100	Reinforced Concrete Beams	8	CY	--	$63.50	$27.50	$728.00
03 31 13.70 0800	Reinforced Concrete Columns & Pedestals	50	CY	--	$41.00	$17.50	$2,925.00
03 31 13.70 1400	Elevated Slab	418	CY	--	$30.00	$12.90	$17,932.20
03 31 13.70 1950	Footings - Continuous	28	CY	--	$32.00	$13.60	$1,276.80
03 31 13.70 2650	Footings - Spread	193	CY	--	$28.50	$12.25	$7,864.75
03 31 13.70 4350	Slab-on-Grade	300	CY	--	$26.00	$11.15	$11,145.00
03 31 13.70 5100	Foundation Walls	244	CY	--	$32.00	$13.60	$11,126.40
						Total	**$594,436.24**

Cost Code	Item	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total
Division 05 Metals							**$449,399.11**
Columns							
05 12 23.17 4550	Column HSS Tubing	74	EA	$775.00	$56.00	$30.50	$63,751.00
05 12 23.17 6850	Column Steel	1430	LF	$45.00	$2.60	$1.42	$70,106.77
Beams							
05 12 23.75 0300	W8x10	2349	LF	$14.60	$4.68	$2.55	$51,280.85
05 12 23.75 0350	W8x18	61	LF	$30.50	$4.68	$2.55	$2,297.00
05 12 23.75 0600	W10x12	239	LF	$17.50	$4.68	$2.55	$5,899.34
05 12 23.75 0620	W10x15	311	LF	$22.00	$4.68	$2.55	$9,094.04
05 12 23.75 0700	W10x17	35	LF	$32.00	$4.68	$2.55	$1,388.74
05 12 23.75 0700	W10x19	48	LF	$32.00	$4.68	$2.55	$1,896.77
05 12 23.75 0740	W10x30	204	LF	$48.00	$5.10	$2.78	$11,390.58
05 12 23.75 0740	W10x33	24	LF	$48.00	$5.10	$2.78	$1,315.42
05 12 23.75 1100	W12x14	366	LF	$23.50	$3.19	$1.74	$10,397.42
05 12 23.75 1100	W12x16	154	LF	$23.50	$3.19	$1.74	$4,391.87
05 12 23.75 1300	W12x19	416	LF	$32.00	$3.19	$1.74	$15,349.22
05 12 23.75 1500	W12x26	283	LF	$38.00	$3.19	$1.74	$12,136.74
05 12 23.75 1900	W14x22	371	LF	$38.00	$2.84	$1.54	$15,738.24
05 12 23.75 1900	W14x26	147	LF	$38.00	$2.84	$1.54	$6,217.99
05 12 23.75 2100	W14x30	486	LF	$43.50	$3.12	$1.70	$23,506.71
05 12 23.75 2300	W14x34	343	LF	$49.50	$3.47	$1.89	$18,835.08
05 12 23.75 2320	W14x38	97	LF	$62.50	$3.47	$1.89	$6,612.28
05 12 23.75 2320	W14x43	146	LF	$62.50	$3.47	$1.89	$9,896.70
05 12 23.75 2340	W14x53	122	LF	$77.50	$3.51	$1.91	$10,132.82
05 12 23.75 2360	W14x61	236	LF	$108.00	$3.70	$2.01	$26,828.74
05 12 23.75 2380	W14x90	29	LF	$131.00	$3.80	$2.07	$3,956.91
Metal Deck							
05 31 13.50 5300	Floor Deck	16976	SF	$2.05	$0.46	$0.04	$43,288.80
05 31 23.50 2100	Roof Deck	9995	SF	$1.97	$0.37	$0.03	$23,689.07
						Total	**$449,399.11**

Appendix B.2: MEP Assemblies Estimate

Assemblies Code	Description	Number	Cost Per SF Material	Cost Per SF Installation	Total
Division 21 & 22 - Plumbing and Fire Suppression					
Sprinkler System					
D4010 410 1080	Wet pipe sprinkler systems, grooved steel, black sch. 40 pipe, light hazard, one floor, 10000 SF		$1.89	$1.70	$113,085.00
D4010 410 1200	Each additional floor, 10000 SF		$0.74	$1.47	$69,615.00
D4010 410 1220	Each additional floor, 10000 SF		$0.74	$1.47	$69,615.00
Plumbing Fixtures		**Number**	**Cost per Each**		
D2010 310 1560	Lavatory w/trim, vanity top, PE on CI, 20"x18", vanity top by others	3	$800.00	$715.00	$4,545.00
D2010 420 2080	Laundry sink with trim, plastic, on wall or legs, 20" x 24" single compartment	1	$665.00	$755.00	$1,420.00
D2010 410 1960	Kitchen sink w/trim, countertop, stainless steel, 33" x 22" double bowl	1	$1,575.00	$845.00	$2,420.00
D2010 310 1640	Lavatory w/ trim, vanity top, PE on CI, 18" round, vanity top by others	2	$705.00	$715.00	$2,840.00
D2010 410 1920	Kitchen sink w/trim, countertop, stainless steel, 25" x 22" single bowl	16	$1,200.00	$785.00	$31,760.00
D2010 924 1180	Bathroom, 3 fixture, one wall plumbing, share common plumbing wall	16	$3,100.00	$2,300.00	$86,400.00
D2010 920 1200	Bathroom, 2 fixture, lavatory & water closet, 2 wall plumbing, share common wall	8	$1,600.00	$1,700.00	$26,400.00
Electric Water Heaters - Commercial		**Number**	**Cost per Each**		
D2020 250 2140	Gas fired water heater, commercial, 100°F rise, 300 MBH input, 278 GPH	2	$13,500.00	$3,275.00	$33,550.00
Piping - Installed - Unit Costs		**Length (ft)**	**Cost per LF**		
D2090 810 0840	Cast iron, soil, B & S, service weight, 2" diameter*	210	$10.00	$19.20	$6,132.00
D2090 810 0860	3" diameter	115	$14.05	$20.00	$3,915.75
D2090 810 0880	4" diameter*	485	$18.60	$22.00	$19,691.00
D2090 810 0900	5" diameter	40	$25.00	$25.00	$2,000.00
D2090 810 1220	Copper tubing, hard temper, solder, type K, 1/2" diameter	70	$6.10	$8.60	$1,029.00
D2090 810 1260	3/4" diameter*	160	$10.75	$9.10	$3,176.00
D2090 810 1280	1" diameter*	180	$14.40	$10.20	$4,428.00
D2090 810 1300	1-1/4" diameter	220	$17.90	$12.00	$6,578.00
D2090 810 1320	1-1/2" diameter	170	$23.50	$13.45	$6,281.50
D2090 810 1340	2" diameter	180	$36.00	$16.80	$9,504.00
D2090 810 1360	2-1/2" diameter	100	$55.00	$20.00	$7,500.00
D2090 810 1380	3" diameter	50	$77.00	$22.50	$4,975.00
			Total		**$516,860.25**

Assemblies Code	Description			
Division 23 - Heating, Ventilation, and Air Conditioning				**$993,789.00**
		Cost per SF		**Total**
Air Handling Units		**Material**	**Installation**	
D3050 155 1280	Rooftop, multizone, AC, Apartment Corridors, 3000 SF, 5.5 ton	$10.70	$4.93	$492,345.00
D3050 155 1280	Rooftop, multizone, AC, Apartment Corridors, 25000 SF, 45.80 ton	$7.05	$4.77	$372,330.00
			Cost Per Each	
Cabinet Unit Heaters		**Material**	**Installation**	**Total**
D3010 530	Unit Heater, 1 speed propeller, horizontal, 200deg EWT, 26.9 MBH	$1,680.00	$3,208.00	$5,888.00
D3010 530	Unit Heater, 1 speed propeller, horizontal, 200deg EWT, 26.9 MBH	$1,680.00	$3,208.00	$5,888.00
D3010 530	Unit Heater, 1 speed propeller, horizontal, 200deg EWT, 26.9 MBH	$1,680.00	$3,208.00	$5,888.00
D3010 530	Unit Heater, 1 speed propeller, horizontal, 200deg EWT, 26.9 MBH	$1,680.00	$3,208.00	$5,888.00
D3010 530	Unit Heater, 1 speed propeller, horizontal, 200deg EWT, 26.9 MBH	$1,680.00	$3,208.00	$5,888.00
D3010 530	Unit Heater, 1 speed propeller, horizontal, 200deg EWT, 26.9 MBH	$1,680.00	$3,208.00	$5,888.00
Fan Coil Units				
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00

D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
D3010 520	Radiation, stell 1-1/4" tube & 4-1/4" fin w/cover & damper, wall hung	$1,806.00	$1,428.00	$3,234.00
		Total		**$993,789.00**

Assemblies Code	Description	Length (ft)	Material	Installation	Total
Division 26 - Electrical					**$1,058,629.75**
High Voltage Distribution			**Cost per LF**		
D5010 110 1080	High voltage cable, neutral & conduit included, Copper 350kcmil, 35kV	170	$72.50	$50.00	$20,825.00
D5010 110 0200	High voltage cable, neutral & conduit included, Copper #2, 35kV	170	$17.30	$24.00	$7,021.00
Distribution Panels			**Cost per Each**		
D5010 120 0485	3P, 4W, 120/208 V, 1200A, w/groundfault switchboard	--	$36,100.00	$9,800.00	$45,900.00
D5010 120 0245	3P, 4W, 120/208 V, 100A, w/circuit breaker	--	$1,650.00	$1,425.00	$3,075.00
Floor Panelboards			**Cost per Each**		
D5010 250 1000	Panelboards, NQOD, 4 wire, 120/208 V, 225A, 0 stories, 0' horizontal	--	$2,375.00	$1,750.00	$4,125.00
D5010 250 1000	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 0 stories, 0' horizontal	--	$1,275.00	$1,325.00	$2,600.00
D5010 250 1020	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 1 stories, 25' horizontal	--	$1,700.00	$1,900.00	$3,600.00
D5010 250 1020	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 1 stories, 25' horizontal	--	$1,700.00	$1,900.00	$3,600.00
D5010 250 3000	Panelboards, NQOD, 4 wire, 120/208 V, 400A, 5 stories, 50' horizontal	--	$8,500.00	$7,600.00	$16,100.00
D5010 250 2020	Panelboards, NQOD, 4 wire, 120/208 V, 225A, 5 stories, 50' horizontal	--	$6,175.00	$4,800.00	$10,975.00
Invidual Room Panels			**Cost per Each**		
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00
D5010 250 1060	Panelboards, NQOD, 4 wire, 120/208 V, 100A, 10 stories, 75' horizontal	--	$3,475.00	$4,350.00	$7,825.00

Feeder Installation			**Cost per LF**		
D5010 230 0320	600V, including RGS conduit & XHHW wire, 400A	10	$56.00	$45.50	$1,015.00
D5010 230 0240	600V, including RGS conduit & XHHW wire, 100A	70	$11.75	$15.00	$1,872.50
D5010 230 0240	600V, including RGS conduit & XHHW wire, 100A	115	$11.75	$15.00	$3,076.25
D5010 230 0240	600V, including RGS conduit & XHHW wire, 100A	115	$11.75	$15.00	$3,076.25
D5010 230 0320	600V, including RGS conduit & XHHW wire, 400A	145	$56.00	$45.50	$14,717.50
D5010 230 0320	600V, including RGS conduit & XHHW wire, 400A	155	$56.00	$45.50	$15,732.50
Branch Installation			**Cost per LF**		
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	65	$11.30	$12.65	$1,556.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	45	$11.30	$12.65	$1,077.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	20	$11.30	$12.65	$479.00
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	35	$11.30	$12.65	$838.25
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	45	$11.30	$12.65	$1,077.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	85	$11.30	$12.65	$2,035.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	115	$11.30	$12.65	$2,754.25
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	125	$11.30	$12.65	$2,993.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	145	$11.30	$12.65	$3,472.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	60	$11.30	$12.65	$1,437.00
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	45	$11.30	$12.65	$1,077.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	20	$11.30	$12.65	$479.00
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	40	$11.30	$12.65	$958.00
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	50	$11.30	$12.65	$1,197.50
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	85	$11.30	$12.65	$2,035.75
D5010 230 1480	600V, including EMT conduit and THW wire, 130A	95	$11.30	$12.65	$2,275.25
Receptacle (by Wattage)			**Cost per SF**		
D5020 110 0680	20 per 1000 SF, 2.4 watts per SF	--	$0.73	$3.15	$122,220.00
Wall Switch by SF			**Cost per SF**		
D5020 130 0400	10.0 per 1000 SF	--	$0.54	$1.98	$79,380.00
Miscellaneous Power			**Cost per SF**		
D5020 135 0520	3 watts	--	$0.18	$0.58	$23,940.00
Safety Switch			**Cost per Each**		
D5020 165 0760	200A fused, 3P, 50 HP 200V or 60 HP 230 V	--	$1,025.00	$530.00	$1,555.00

Motor Installation			**Cost per Each**		
D5020 145 1560	3P, 230V, 30 HP motor size	--	$2,375.00	$2,125.00	$4,500.00
Lighting Fixtures			**Cost per SF**		
D5020 210 0580	Flourescent, Recessed, T8, energy saver 32W, 4W per SF, 1000FC, 25 per 1000 SF	--	$4.08	$9.05	$413,595.00
Communication and Alarm Systems			**Cost per SF**		
D5030 920 0104	Data communication, 4 data/voice outlets per 1000 SF	--	$0.34	$0.92	$39,532.50
Communication and Alarm Systems			**Cost per Each**		
D5030 910 0440	Fire detection system, 100 detectors	--	$21,200.00	$40,000.00	$61,200.00
D5030 910 0459	Fire alarm control panel, 12 zone, excluding wire and conduit	--	$2,575.00	$1,875.00	$4,450.00
			Total		**$1,058,629.75**

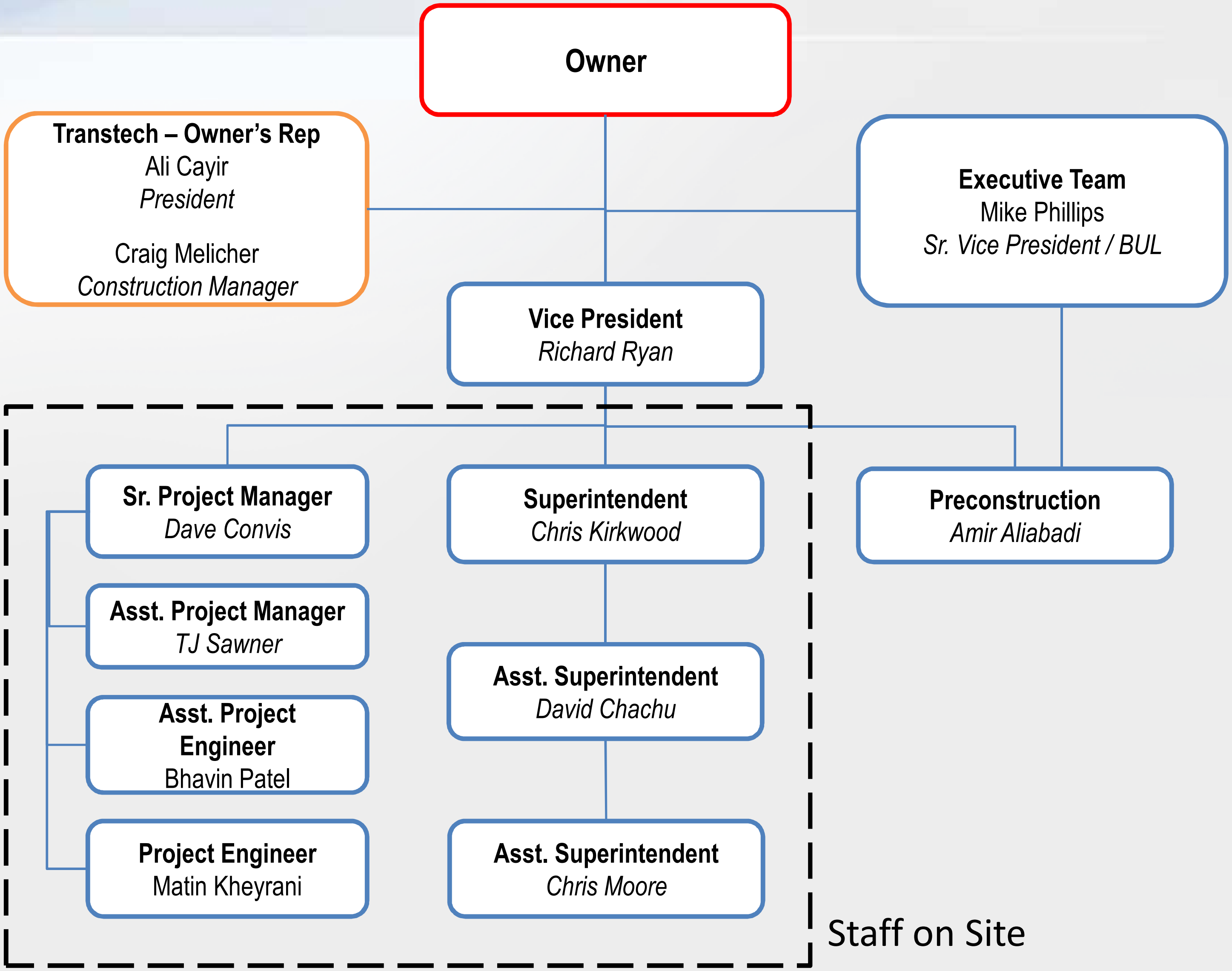
Appendix C.1: General Conditions Estimate

Cost Code	Item Description	Quantity	Unit	Costs Material	Labor	Equipment	Total Cost
Division 01 General Conditions							$3,084,438.48
Project Management - Field Personnel							**$1,417,800.00**
01 31 13.20 0120	Assistant Project Engineer	102	Week	--	$1,350.00	--	$137,700.00
01 31 13.20 0140	Project Engineer	102	Week	--	$1,525.00	--	$155,550.00
01 31 13.20 0200	Assistant Project Manager	102	Week	--	$2,225.00	--	$226,950.00
01 31 13.20 0220	Senior Project Manager	102	Week	--	$2,525.00	--	$257,550.00
01 31 13.20 0240	Assistant Superintendent	102	Week	--	$1,875.00	--	$191,250.00
01 31 13.20 0260	Assistant Superintendent	102	Week	--	$2,050.00	--	$209,100.00
01 31 13.20 0280	Superintendent	102	Week	--	$2,350.00	--	$239,700.00
Temporary Utilities							
01 51 13.80 0100	Heating	2800	CSF	$28.00	$3.78	--	$88,984.00
01 51 13.80 0360	Lighting	2800	CSF	$5.85	$25.00	--	$86,380.00
01 51 13.80 0430	Power for Temp Lighting	2800	CSF	$3.30	--	--	$9,240.00
01 51 13.80 0650	Power for Job	2800	CSF	$110.00	--	--	$308,000.00
01 52 13.20 0450	Office Trailer, 50' x 10'	72	Month	$305.00	--	--	$21,960.00
01 52 13.20 0550	Office Trailer, 50' x 12'	96	Month	$350.00	--	--	$33,600.00
01 52 13.20 0800	Delivery	24	Month	$430.00	--	--	$10,320.00
Field Office Expenses							
01 52 13.40 0100	Office Equipment	24	Month	$200.00	--	--	$4,800.00
01 52 13.40 0120	Office Supplies	24	Month	$75.00	--	--	$1,800.00
01 52 13.40 0140	Telephone Bill	24	Month	$81.00	--	--	$1,944.00
01 52 13.40 0160	Lights & HVAC	24	Month	$152.00	--	--	$3,648.00
Temporary Cranes							
01 54 19.60 0100	Tower Crane Crew	24	Month	--	$8,850.00	$24,200.00	$793,200.00
Vehicular Access and Parking							
01 55 23.50 0050	Gravel Road, 4" depth	15000	SY	$3.98	$2.60	$0.51	$106,350.00
Temporary Barricades							
01 56 23.10 1000	Wooden Guardrail	2000	LF	$1.29	$3.67	--	$9,920.00
01 56 26.50 0100	Chain Link Fence	4500	LF	$2.95	$1.95	--	$22,050.00

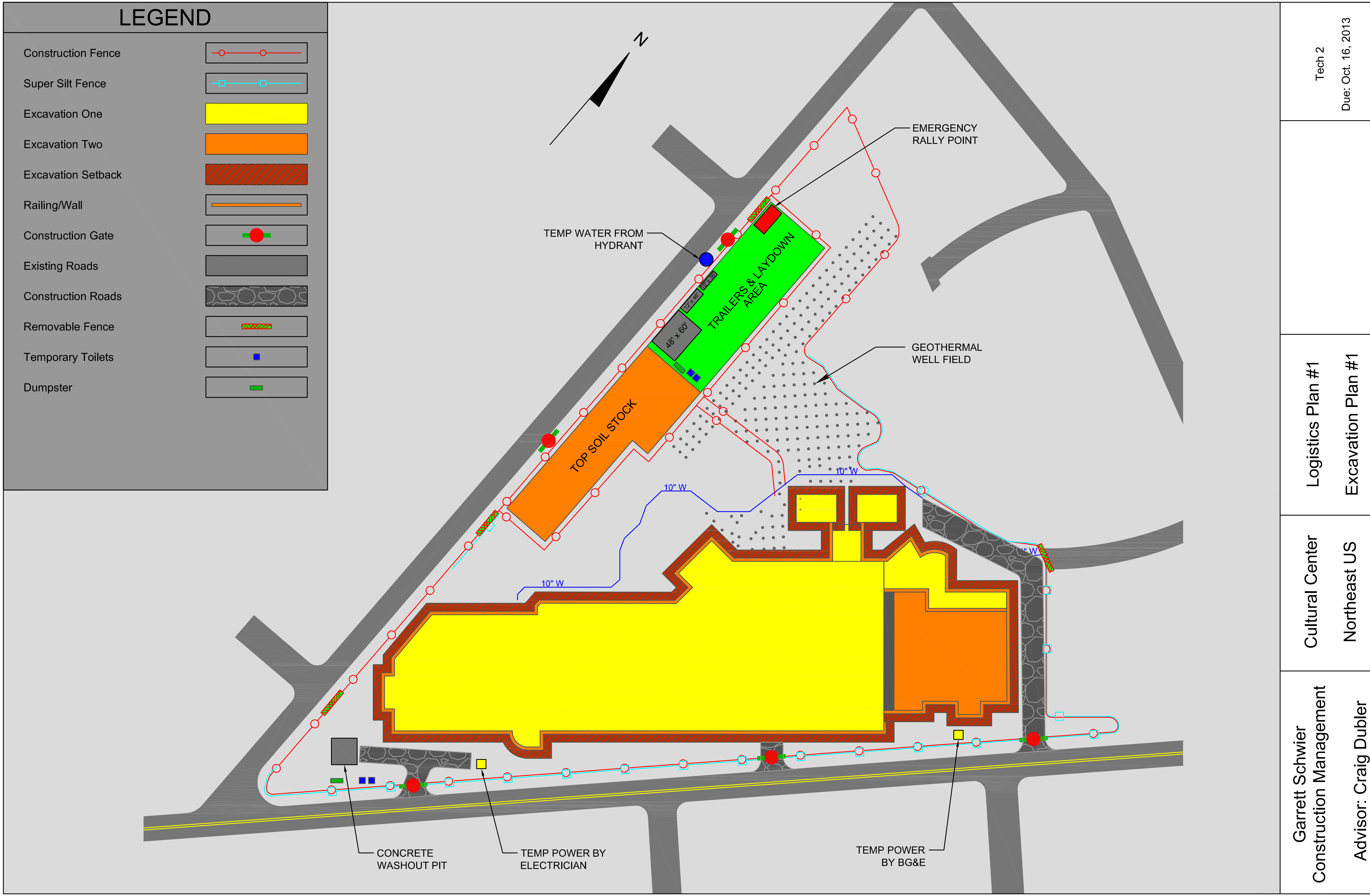
Temporary Project Signage							
01 58 13.50 0020	Signs	100	SF	$31.50	--	--	$3,150.00
Temporary Security							
01 56 32.50 0020	Uniformed Security Service	5712	HR	$25.00	--	--	$142,800.00
Cleaning and Waste Management							
01 74 13.20 0050	Cleanup at End of Job	288	MSF	$0.86	$57.50	$5.85	$18,492.48
						Total	**$3,084,438.48**

Appendix C.2: Staffing Plan

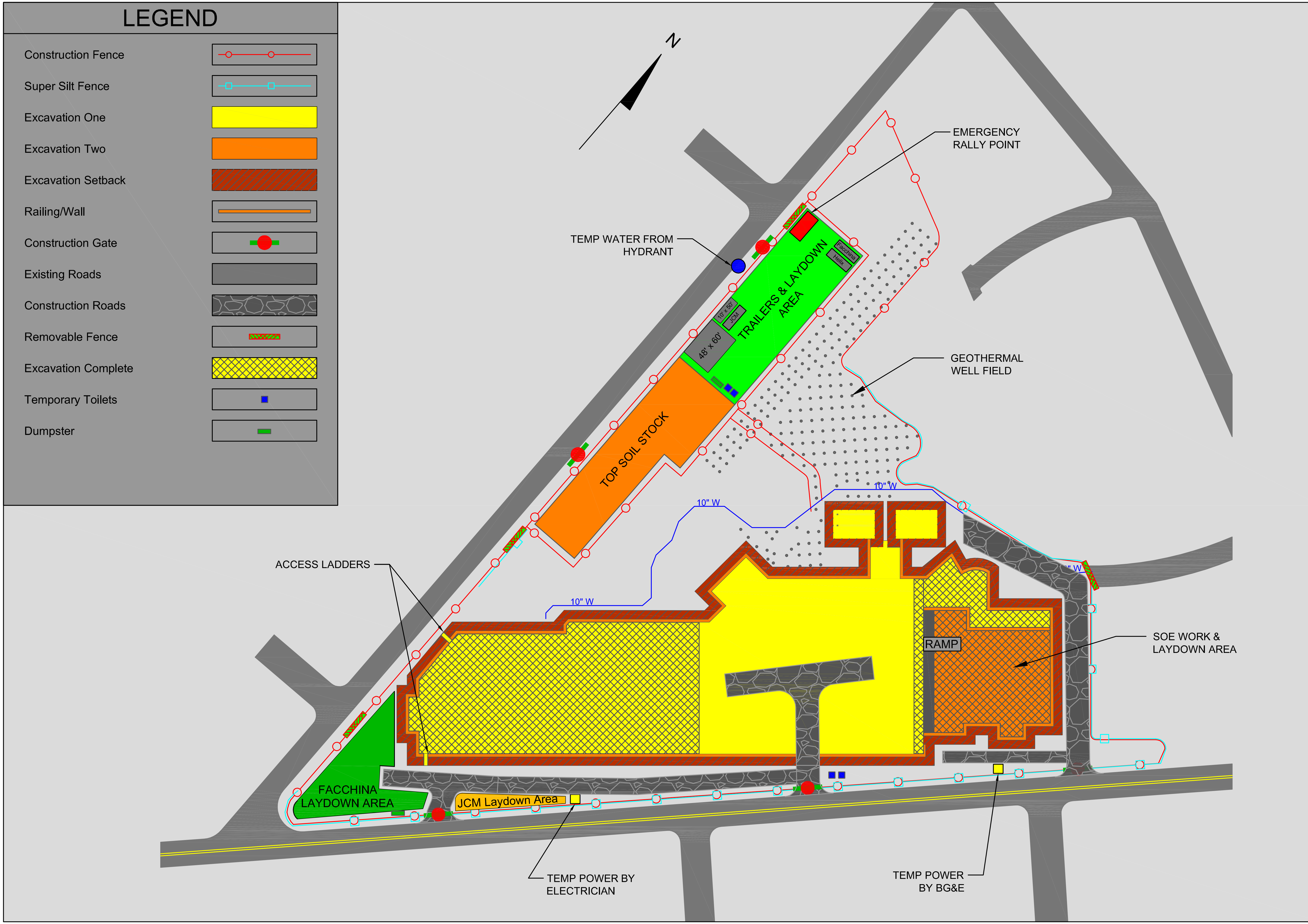
Staffing Plan



Appendix D.1: Excavation Plan I


LEGEND
Construction Fence
Super Silt Fence
Excavation One
Excavation Two
Excavation Setback
Railing/Wall
Construction Gate
Existing Roads
Construction Roads
Removable Fence
Temporary Toilets
Dumpster
N
EMERGENCY RALLY POINT
TEMP WATER FROM HYDRANT
TRAILERS & LAYDOWN AREA
48' x 60'
TOP SOIL STOCK
GEOTHERMAL WELL FIELD
10" W
10" W
10" W
CONCRETE WASHOUT PIT
TEMP POWER BY ELECTRICIAN
TEMP POWER BY BG&E
Tech 2
Due: Oct. 16, 2013
Logistics Plan #1
Excavation Plan #1
Cultural Center
Northeast US
Garrett Schwier
Construction Management
Advisor: Craig Dubler

Appendix D.2: Excavation Plan II



Tech 2

Due: Oct. 16, 2013

Logistics Plan #2

Excavation Plan #2

Cultural Center

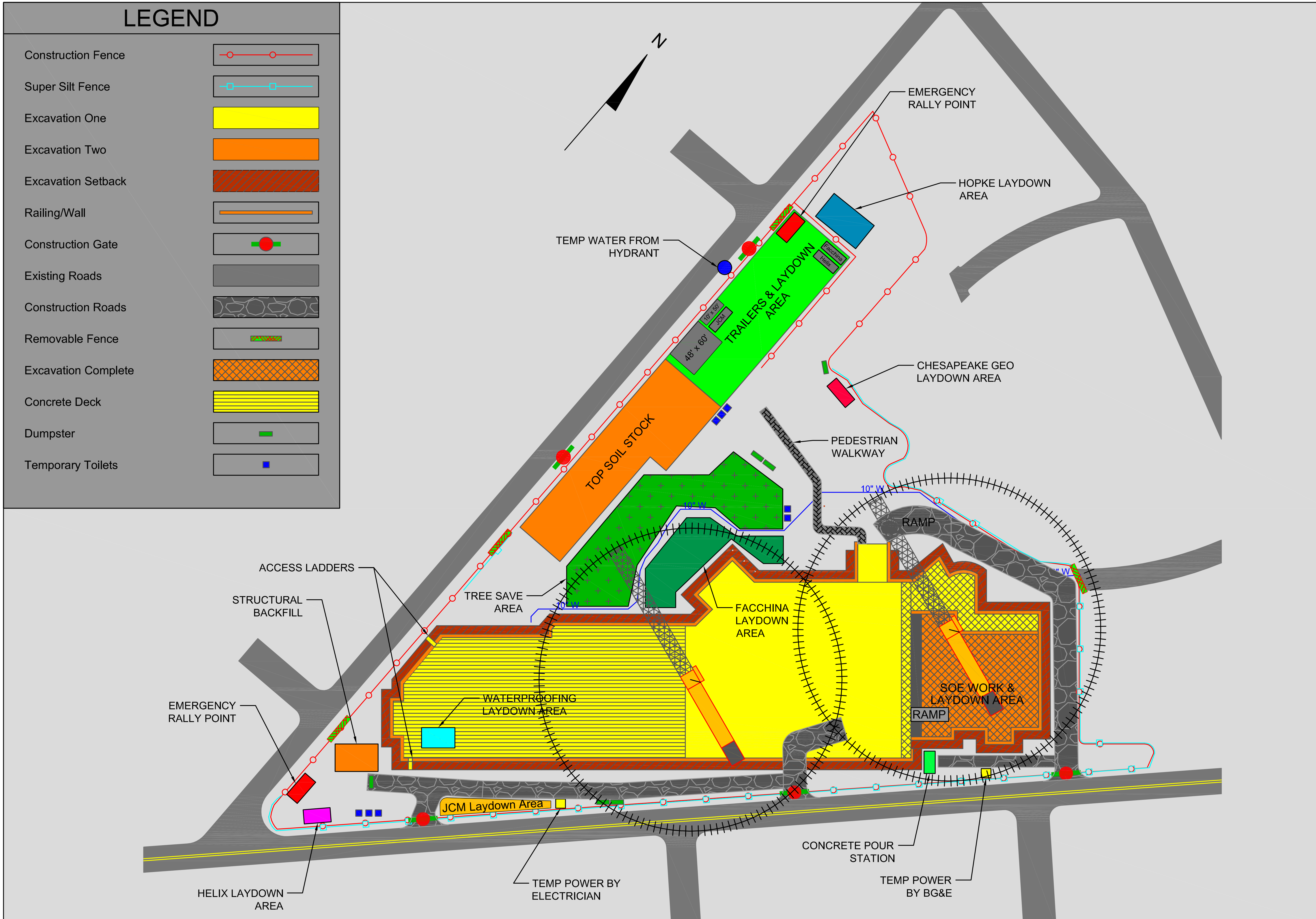
Northeast US

Garrett Schwier

Construction Management

Advisor: Craig Dubler

Appendix D.3: Crane Plan



Tech 2

Due: Oct. 16, 2013

Logistics Plan #3

Crane Plan

Cultural Center

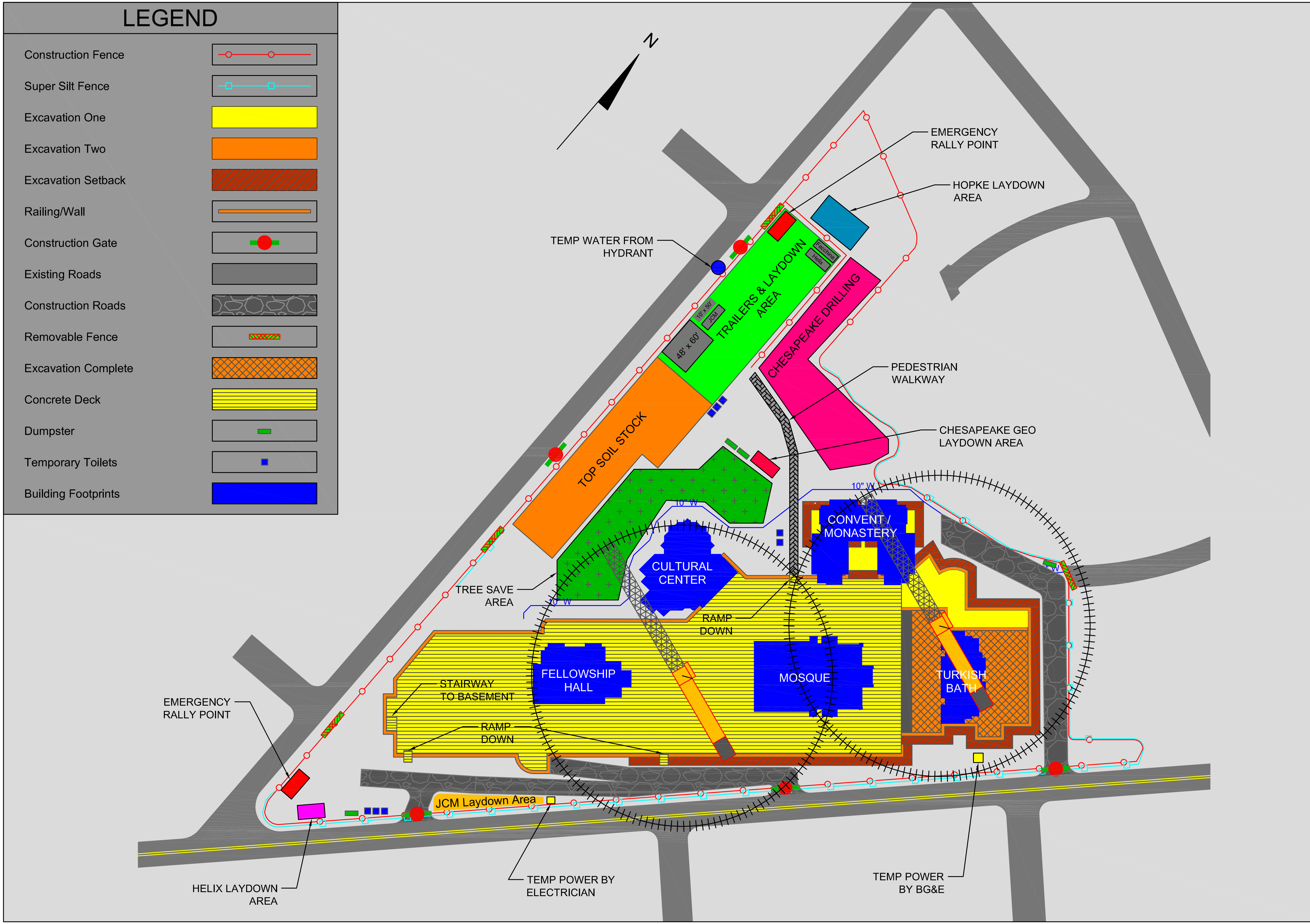
Northeast US

Garrett Schwier

Construction Management

Advisor: Craig Dubler

Appendix D.4: Building Plan



Tech 2

Due: Oct. 16, 2013

Logistics Plan #4

Building Plan

Cultural Center

Northeast US

Garrett Schwier

Construction Management

Advisor: Craig Dubler

Appendix E: Enlarged Plans

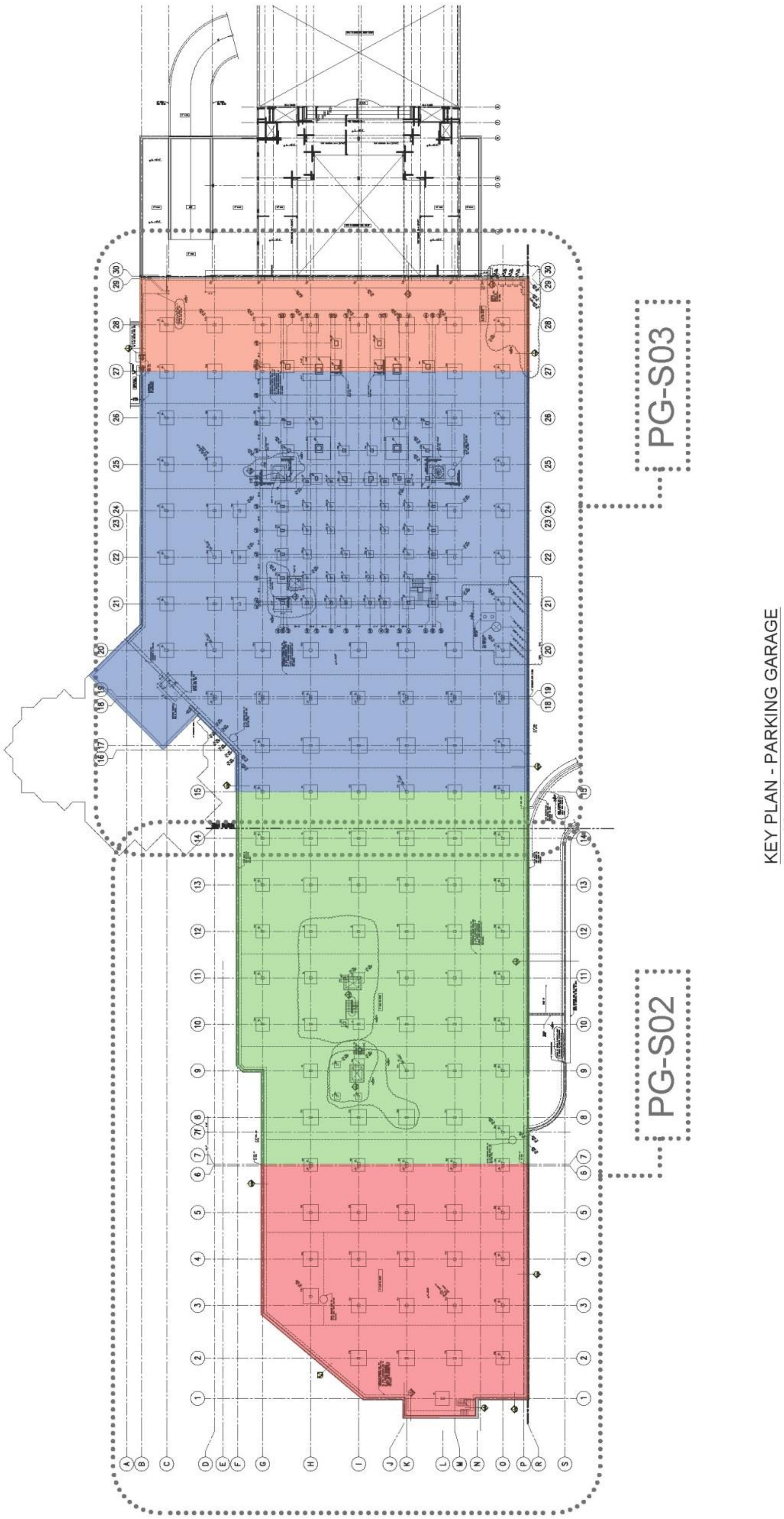


Figure 2. *Excavation Phases*

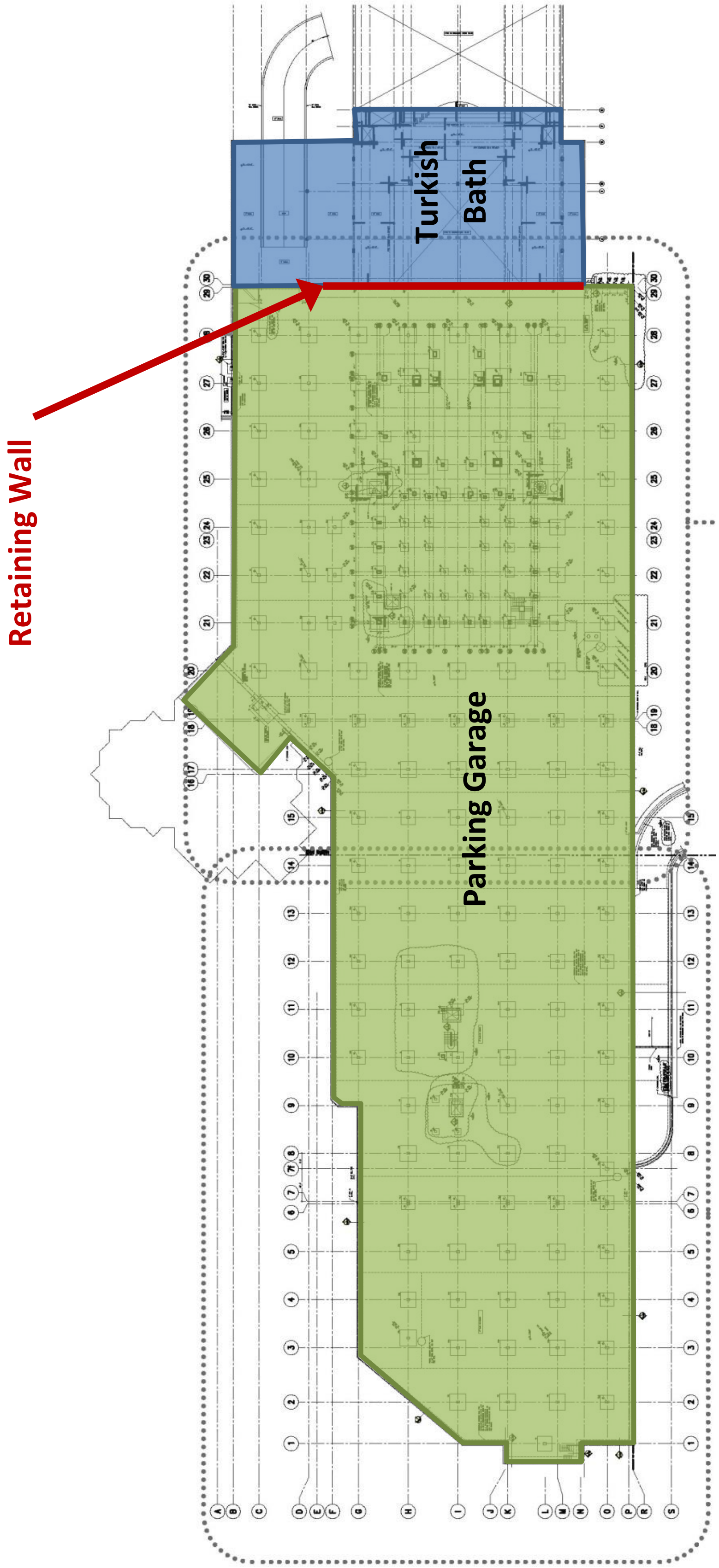


Figure 5. *Plan View of Retaining Wall*

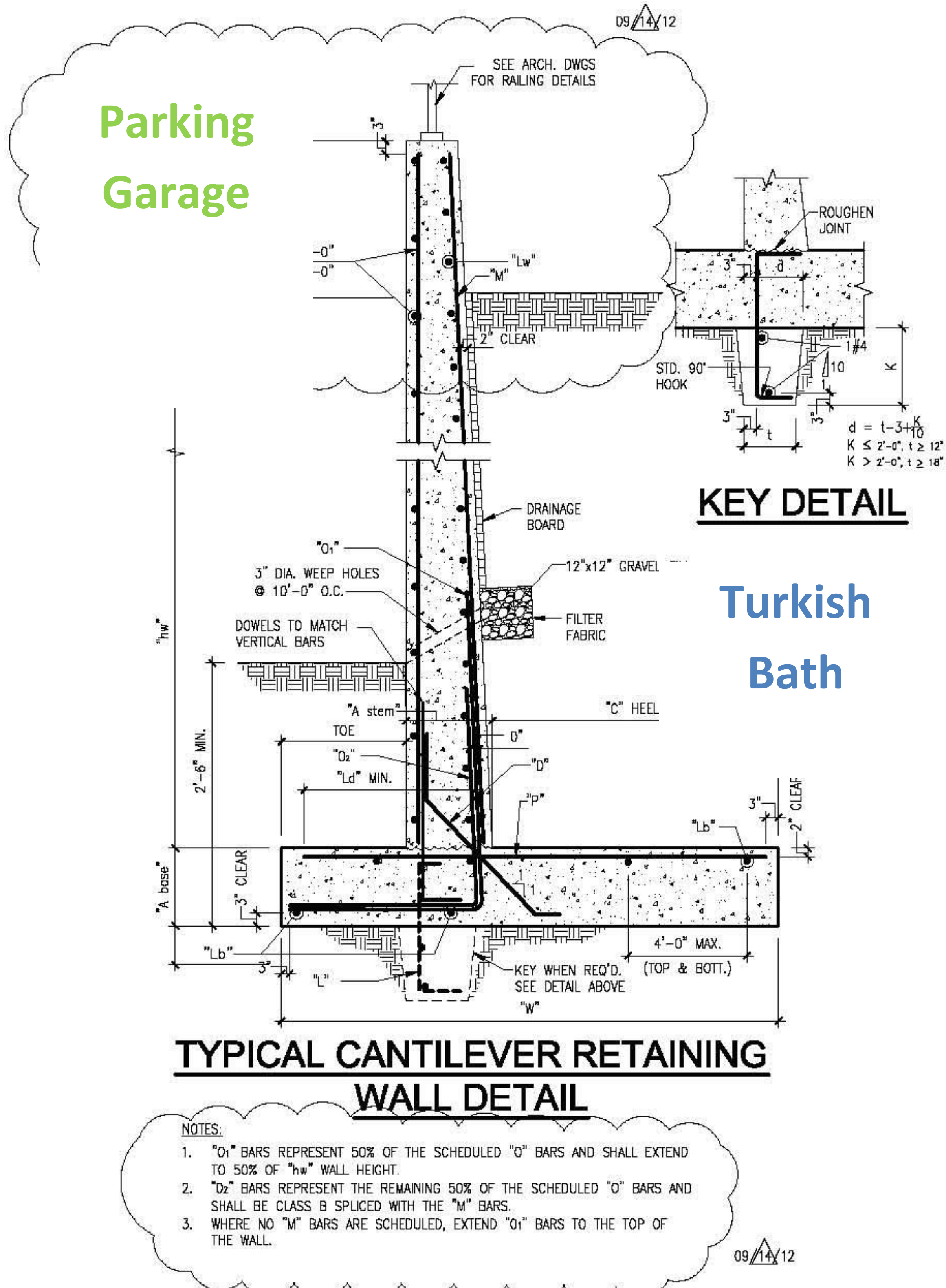


Figure 6. *Profile View of Retaining Wall*

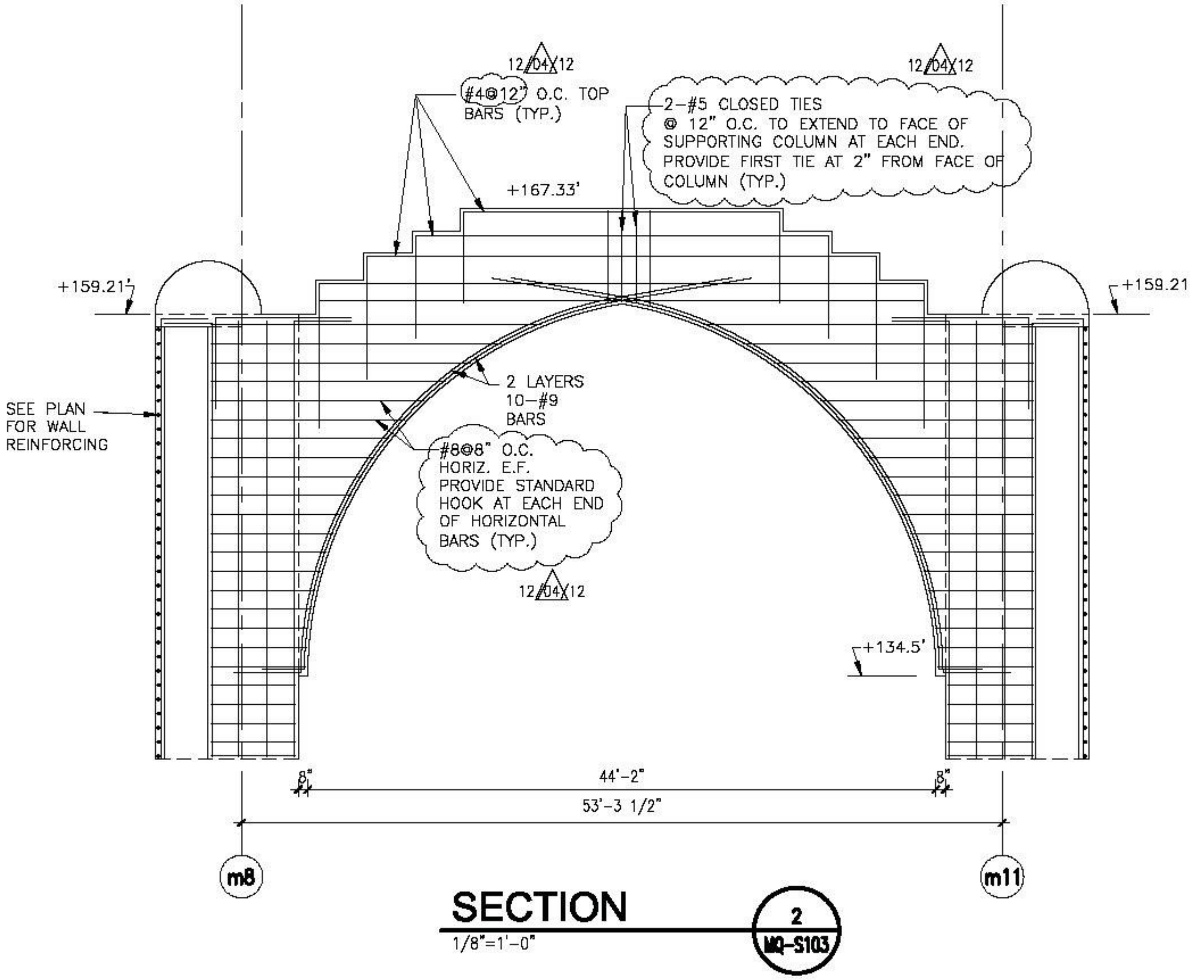


Figure 7. *Arch Profile*

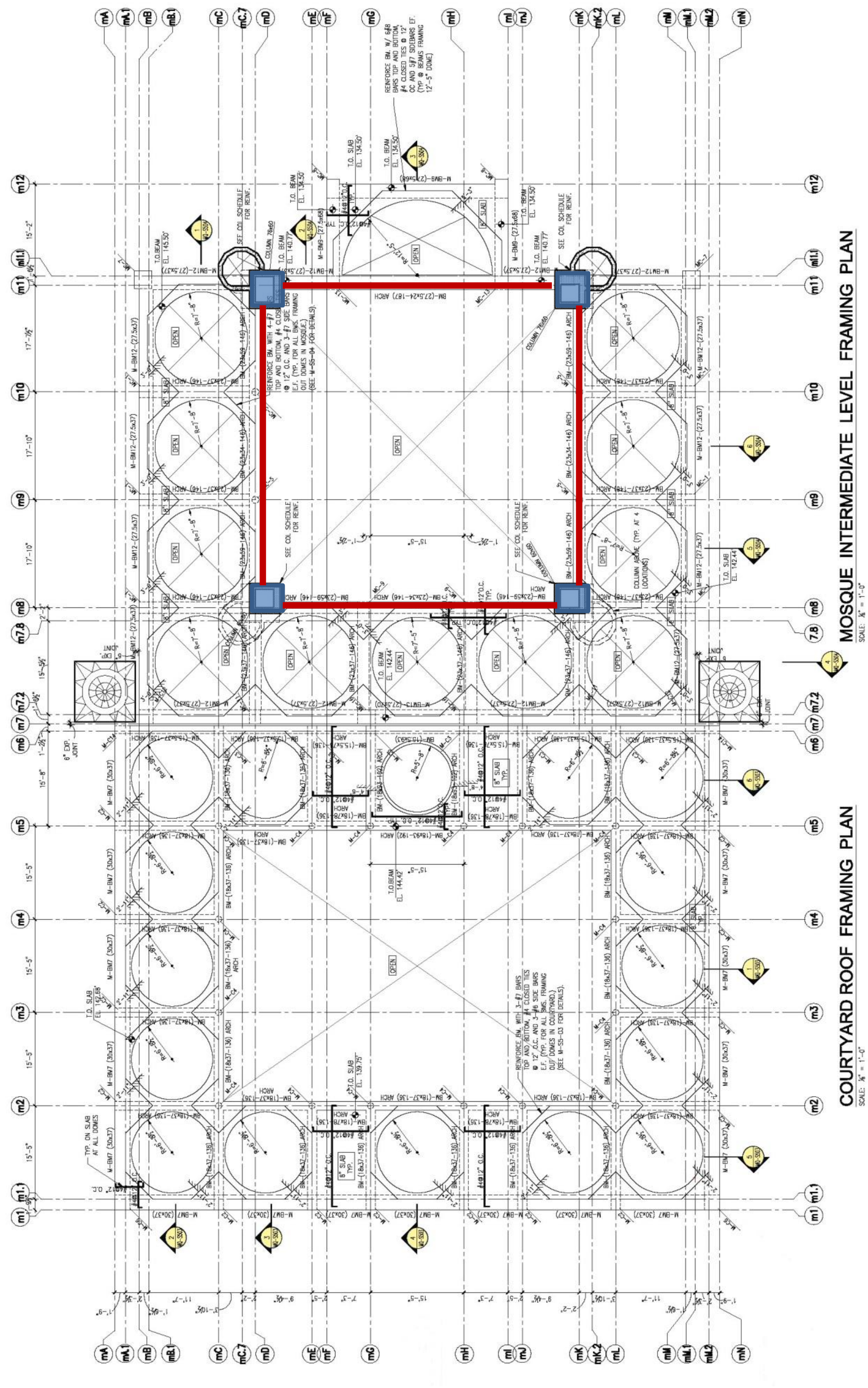


Figure 6. *Arch Floor Plan*