

DORMITORY BUILDINGS C & D

MANSFIELD UNIVERSITY, MANSFIELD PA



TECHNICAL REPORT NO. 2

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EXECUTIVE SUMMARY

In tech report number 2, there are five main sections of investigation. There is a detailed schedule analysis, where a trade by trade schedule was created for the entire project. There is a detailed structural estimate, where a cost estimate of a typical bay was created. There is a detailed general conditions estimate, where the cost was estimated for all of the general conditions during the project. There is a Building Information Modeling (BIM) uses evaluation, where all of the uses of BIM were briefly researched and the most significant uses were examined in detail. Finally, there is a constructability challenges section, where three main constructability issues were inspected and then solutions were recommended.

The detailed schedule was broken into two buildings and then phases in each building. The schedule showed seven main phases of construction: 2 structural steel core and 5 modular construction phases. The schedule of Building C is tighter than Building D, because it is expected to open for the first day of classes in the fall 2013 semester. A typical floor by floor schedule was broken down for a steel core phase and a modular construction phase.

The detailed structural estimate used *RS MEANS Costworks* to provide unit prices. The structural cost for a typical modular unit was calculated first. The modular units were built with dimensional lumber. The units had to be designed with the strength to be transported by tractor trailer and lifted into place by a crane. The roof was constructed using pre-engineered wood trusses, 24 inches apart. The foundation has a concrete footer with masonry block walls. A 4 inch slab on grade was poured with 4 foot by 4 foot spread footings underneath the structural steel columns. The columns were attached to wide flange beams that support the modular units above. The detailed cost estimate for the modular construction is \$4,275,039.20.

The general condition estimate used the staffing plan from technical report one to produce the staffing costs, and *RS MEANS* was used to find the unit prices. With a Project Manager and two Superintendents costing almost 66% of the total staffing cost, the staffing costs were about a quarter of the total general conditions costs. Insurance, bond and permit costs were 36% of the general conditions. Temporary Utilities were 8.6% of the general conditions cost. The total general conditions cost was estimated to be \$3,030,000.

BIM was used on the project to detect field conflicts. Before construction, the subcontractors bought into 3D modeling along with clash detection to virtually design the MEP systems. Some other uses of BIM were evaluated for the owner: evaluating the phasing plan, identifying concerns between architectural and modular designs, maintenance technician support and site logistics are a few.

The Mansfield University dormitories were designed with some construction challenges. The three challenges investigated in this report are: (1) modular construction, (2) design-build subcontractor coordination, and (3) daily university operations. These issues place specific restrictions on the construction process. Because it is very early in construction on the project, not all of these challenges have occurred yet, but there is a plan in place for when they arise.

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DETAILED PROJECT SCHEDULE

*See Appendix A for Detailed Project Schedule

OVERVIEW

The project schedule for these dormitories is extremely important for the Mansfield University. For every day late, the University loses \$65 per a bed. They have set Building C's completion date to the beginning of the fall semester 2013. The construction manager, Wohlsen Construction, was given the notice to proceed on August 16, 2012. Building C is due to be completed by September 5, 2013 and Building D is due by October 17, 2013. The project will span approximately 15 months.

PHASING

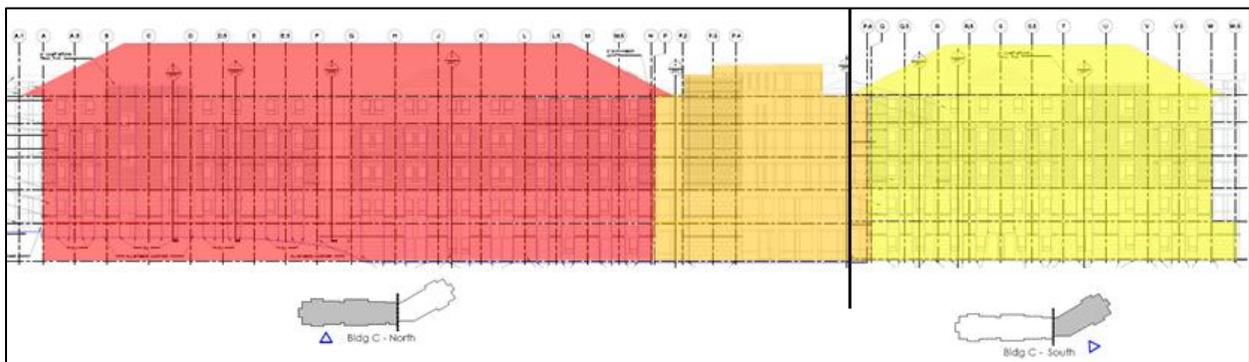


Figure 1 Building C Phasing Plan

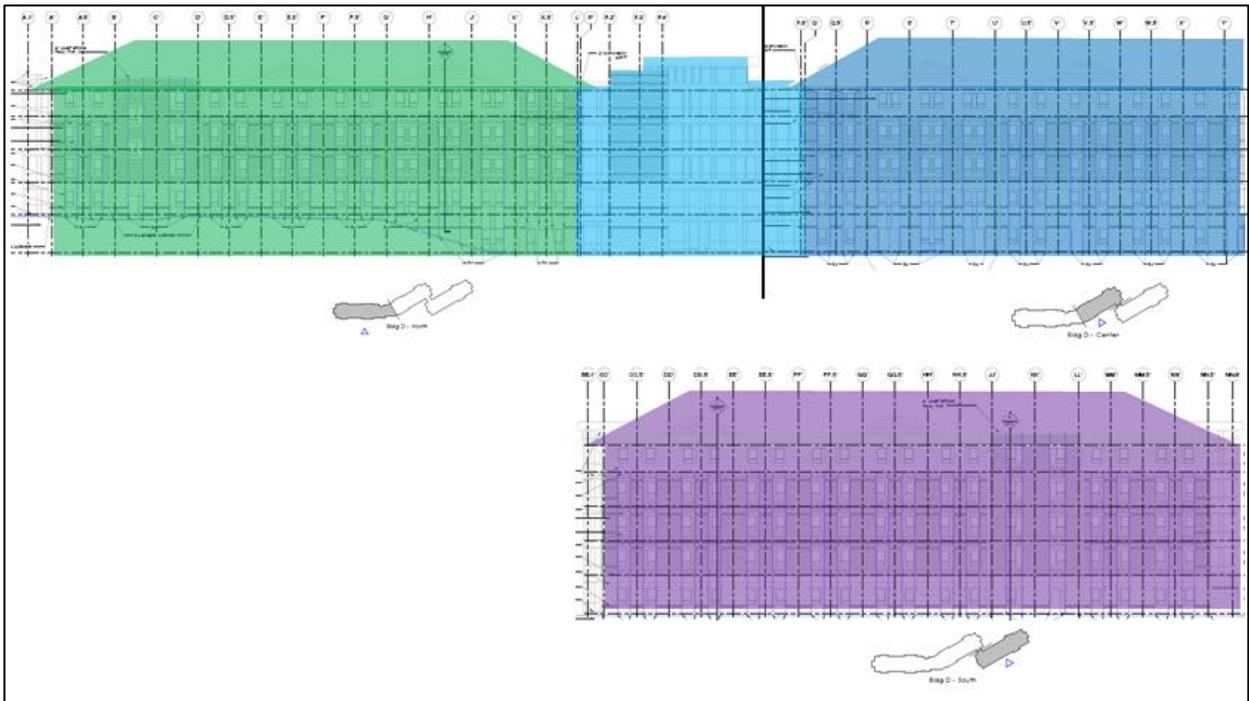


Figure 2 Building D Phasing Plan

The 200 activities in the detailed schedule are split into two categories, one for each dormitory building. There are 2 structural steel “core” phases and 5 modular construction phases. The phases can be seen in the Figures 1 and 2 above. The basement floor is made of CMU block and will be built before any of the units can be set and is part of the exterior construction section. The core spaces of each building also will be completed before the modular units are set. The core spaces are orange on Building C and light blue on Building D. The modular phases will begin with the red (phase 1) and then move on accordingly: yellow (2), green (3), blue (4) and finally purple (5). The Final section of the schedule highlights the end of construction activities that are required for substantial completion.

EXCAVATION, GRADING AND FOUNDATION

Excavation, grading and foundation construction will require 201 days in Building C and 211 days in Building D. The excavation also involves digging all of the geothermal wells. Once the geothermal wells are complete, the rough grading can start. During the winter months, there is a gap in work due to the harsh weather combined with the frozen ground conditions.

CORE CONSTRUCTION

The core construction will take 186 days for Building C and 163 days for Building D. The core construction is broken down into the floor by floor construction for Building C. The schedule would look similar floor by floor for Building D. The MEP's receive about 60 days per a floor and will be working on all four floors concurrently. The MEP's need to have the manpower required to work on all four floors at the same time; all of the other trades can work with one crew.

MODULAR CONSTRUCTION

For the two modular phases in Building C, the construction will take 155 days. In Building D, the schedule becomes tighter allowing 156 days for three phases. The MEP's are scheduled for less time in the modular construction, because the modular units are made with all of the room MEP connections pre-installed. All the MEP's need to do is connect each room's feed to the mains in the hallways.

DETAILED STRUCTURAL ESTIMATE

*See Appendix B for Detailed Structural System Takeoff

OVERVIEW

RS MEANS Costworks was used to attain cost per unit prices. A typical modular bay was used to take off. The section is shown in Figures 3 and 4. A typical modular unit is 9' wide by 55' long. The structural estimate was broken down into three sections: modular, roof, and foundation.

Figure 3 Modular Section
Plan from Sheet A1.2C – Architectural Plans -WTW Architects

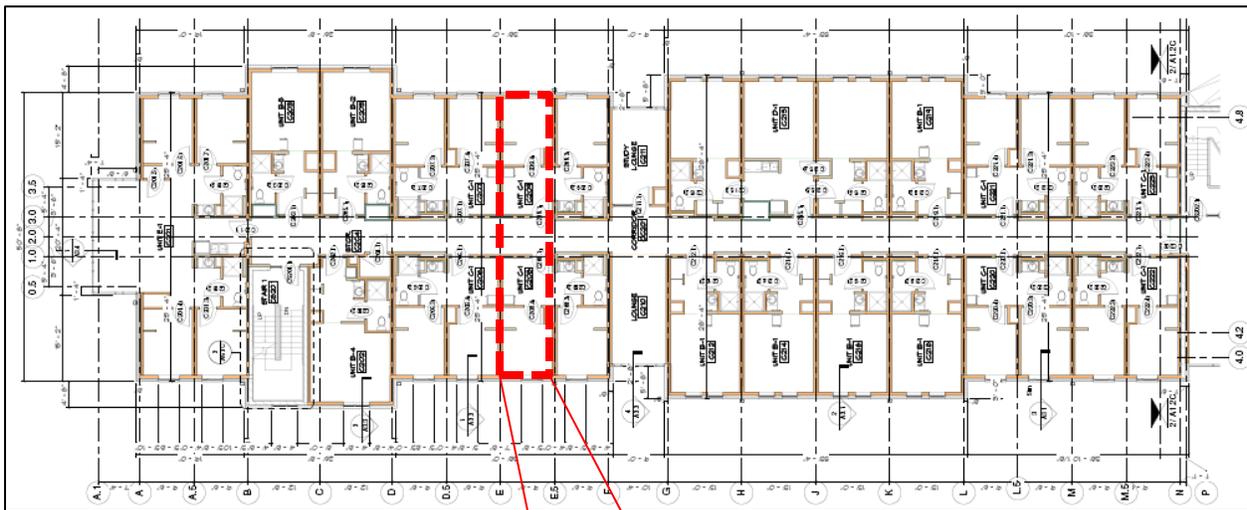


Figure 4 Modular Section
Elevation from Sheet A2.1C – Architectural Plans -WTW Architects

MODULAR ESTIMATE

The modular units are constructed with structural dimensional lumber. Figure 5 on the shows a section through the unit. The units are made with double 2x4 wood stud walls. A double 2x10 perimeter frame is attached to the top and bottom of each unit. 2x10 floor joists and 2x6 ceiling joists spaced 16 inches on center provide additional strength. Pneumatic nailing was assumed to be used because the modular contractor created the units in their factory.

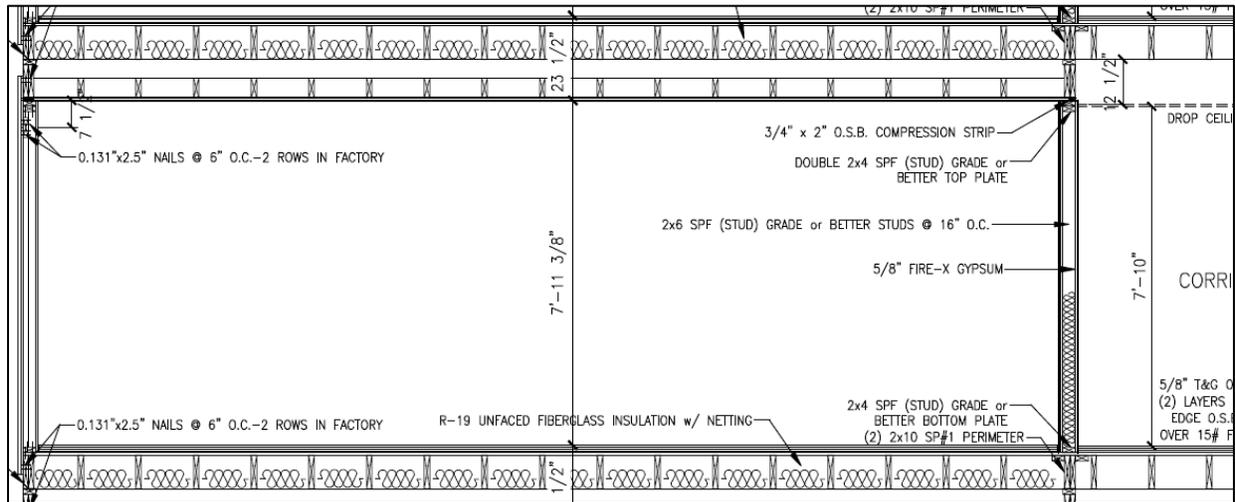


Figure 5 Typical Section - Half of a Modular Unit
Section from Sheet 407A – Shop Drawings – Simplex Industries

Table 1
Structural Cost per a Modular Unit

	Cost / Unit	Units	Cost
Walls			
2x4 Studs	\$11.38 LF	209 LF	\$2,378.42
Openings add	\$3.80 LF	12 LF	\$45.60
Window, Studs and Header	\$39.75 EA	4 EA	\$159.00
2x10 Blocking around perimeter	\$3.32 LF	517 LF	\$1,716.44
Floor Joist			
2x10	\$2.05 LF	432 LF	\$885.60
Flooring			
3/4" Tongue and Groove OSB	\$1.81 SF FLR	507 SF FLR	\$917.67
1/4" Noise Isolation Underlayment	\$2.60 SF FLR	507 SF FLR	\$1,318.20
3/4" Butt Edge OSB	\$1.81 SF FLR	507 SF FLR	\$917.67
1/2" FIBERROCK	\$2.99 SF FLR	507 SF FLR	\$1,515.93
5/8" T & G OSB	\$1.45 SF FLR	507 SF FLR	\$735.15
Exterior Panel			
1/2" Zip Board with 1" Foam Insul.	\$4.76 SF	167 SF	794.92
Ceiling Joists			
2x6	\$1.26 LF	306 LF	385.56
Total Structural Costs Per a Modular Unit			\$11,770.16

The total structural cost of one modular unit is \$11,770.16. There are 4 floors of modular units in one bay. In each bay, the modular structure cost was \$47,080.64.

FOUNDATION

The foundation system has three components: cast-in-place concrete footers, masonry block basement walls and structural steel support for the modular units above. The concrete footers are 3 feet under grade. The concrete slab on grade is 4 inches thick except for the spread footings. Figure 6 shows there are 4 foot square 1 foot thick spread footings underneath the columns to support the axial force. The cost of the foundation per each bay is outlined in Table 2. The estimated cost of the foundation is \$5,941.52.

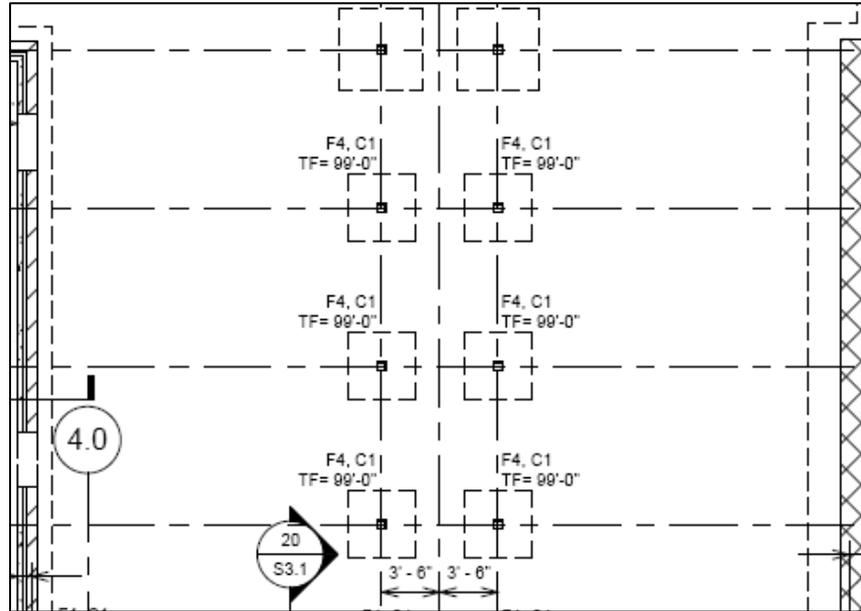


Figure 6 Spread Footings

Plan from Sheet S1.0C – Architectural Plans -WTW Architects

Table 2
Foundation Structural Cost

	Cost / Unit	Units	Cost
Concrete			
4" Slab on Grade	\$117.00 CY	7 CY	\$819.00
Concrete Footers	\$110.00 CY	2 CY	\$220.00
#5 Rebar	\$1,065.50 Ton	0.038 Tons	\$40.49
#4 Rebar	\$1,106.50 Ton	0.233 Tons	\$257.81
Anchor Bolts	\$7.17 EA	16.66 EA	\$119.45
Masonry			
8" Bond Beam, Grout Included	12.07 LF	18 LF	\$217.26
14" Thick 8x16 CMU	\$15.30 SF	45 SF	\$688.50
8" Thick 8x16 CMU	\$9.30 SF	180 SF	\$1,674.00
Steel			
HSS 6x6x3/8 Column	\$360.00 EA	2 EA	\$720.00
1-1/4" x 14" x 14" Column B. Plate	\$1.89 lb	140 lbs	\$264.60
W 14x61 Steel Beams	\$0.33 lb	2440 lbs	\$805.20
Wood			
Double 2.8 Sill	\$6.40 LF	18 LF	\$115.20
Foundation Costs per Modular Section			\$5,941.52

ROOFING

The roof was constructed with pre-engineered roof trusses spaced 24 inches apart. The trusses are constructed off site in three pieces. The three pieces are connected with anchors and plates shown in Figure 7. There is zip sheathing with pre-applied moisture resistance. Table 3 shows the total estimated cost of one bay section of the roofing is \$4,748.64.

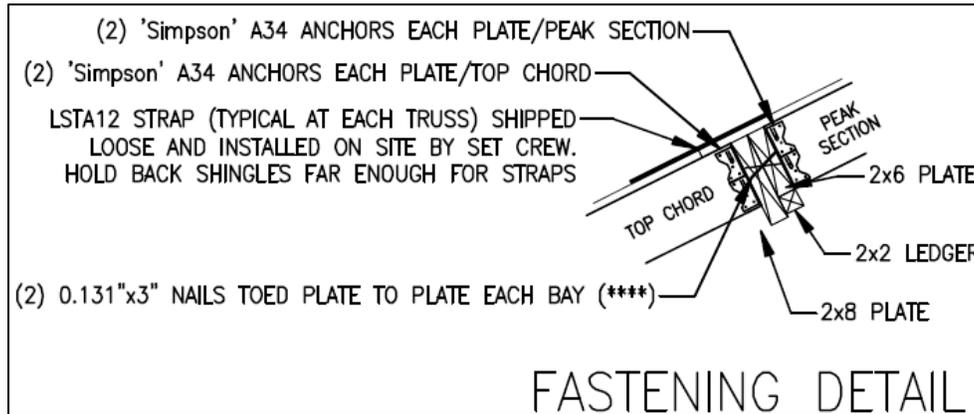


Figure 7 Typical Section - Half of a Modular Unit
Detail from Sheet 407A – Shop Drawings – Simplex Industries

Table 3
Roofing Structural Cost

	Cost / Unit	Units	Cost
Roofing			
Shingles	\$1.28 SF	749 SF	\$958.72
1/2" Zip Sheathing	\$1.13 SF	749 SF	\$846.37
Pre-engineered Roof Truss 59' Span	\$3.85 SF	539 SF	\$2,075.15
1-1/2"x16" LVL Roof Beams	\$3.34 SF	260 SF	\$868.40
Roofing Cost per Modular Section			\$4,748.64

CONCLUSION

The total cost of one bay is \$57,770.80. There are 74 modular bays in both buildings. Table 4 shows that the estimated total cost of the modular structure is \$4,275,039.20. This estimated cost does not include the steel structured core of both buildings. A source of error could be using RS MEANS Costworks. Their database calculates numbers from the traditional construction approaches. The modular contractor uses an assembly line technique in constructing their units. The productivity of the labor has been shown to increase when using an assembly line.

Table 4
Total Cost of Modular Structure

Cost per Modular Section	No. of Sections	Total Cost
\$57,770.80	74	\$4,275,039.20

GENERAL CONDITIONS ESTIMATE

*See Appendix C for Detailed General Conditions Estimate

GENERAL CONDITIONS NARRATIVE

RS Means was used to find the unit prices for the general conditions estimate. The RS Means pages can be found at the end of Appendix C. The total cost of the general conditions was estimated at \$3,030,000. With a project cost of approximately \$39 million, the general conditions are approximately 7.8% of the total cost.

STAFFING COSTS

The jobsite personnel for the construction manager were estimated at \$830,500. That is 27.4% of the general conditions cost. The breakdown is shown in Table 5.

Table 5
Staffing Cost

Staff	Cost
1 - Project Executive (20%)	\$58,200.00
1 - Project Manager (100%)	\$196,500.00
2 - Project Engineers (80%)	\$124,800.00
1 - Project Assistant (50%)	\$36,800.00
1 - Safety Coordinator (13%)	\$9,200.00
2 - Superintendents (100%)	\$366,000.00
1 - Working Foreman (100%)	\$39,000.00
Total	\$830,500.00

One Project Engineer is expected to be on the project for 100% of the duration. The other Project Engineer will only be on the project until all of the modular units are set. That is estimated to be 60% of the way through the project. Once the project gets to that point, the submittal process should be completed and RFI's should be settling down. Most of the staffing cost is the two full-time Superintendents. Their cost is 44% of the total staffing cost. Add the Project Manager to the Superintendents, the top onsite supervision costs are 66% of the total staffing costs.

STARTUP COSTS

Insurance, bonds, and permits were estimated to cost \$1,102,500. These figures were found by using percentages of the total project cost found in RS Means. All of these costs are at the very beginning of the project. It is 36.4% of the total general conditions cost.

Table 6
Initial Costs

	Cost per Unit	Construction Cost	Cost
Insurance	0.40% job	\$35,000,000.00 job	\$140,000.00
Performance Bond	1.50% job	\$35,000,000.00 job	\$525,000.00
Permits	1.25% job	\$35,000,000.00 job	\$437,500.00
Total			\$1,102,500.00

UTILITIES

Temporary utilities were estimated to cost \$260,139 over the 15 month project. That is 8.6% of the total. Temporary power, lighting, water, and heating in the winter are all necessary on the jobsite. The unit that was used to measure the utilities was hundreds of floor square feet. These numbers were for 12 months, not 15 months. I assumed that the RS Means data will work for this project, because not all of the site will be using power and water at the same time. The cost of utilities at the beginning will be extremely small compared to the cost at the end of the project.

Table 7
Temporary Utilities

	Cost per Unit	No. of Units	Cost
Temporary Heat, 12 hrs./day	\$46.00 csf flr	2150 csf flr	\$98,900.00
Lighting, wiring, outlets	\$22.00 csf flr	2150 csf flr	\$47,300.00
Power for Lighting	\$1.01 csf flr	2150 csf flr	\$2,171.50
Temporary Power	\$51.50 csf flr	2150 csf flr	\$110,725.00
Temporary Water	\$69.50 month	15 months	\$1,042.50
Total			\$260,139.00

OTHER

Finally, all of the other materials needed for adequate site logistics were calculated. The cleanup costs after the project are completed was estimated to cost \$210,000. All of the other costs including the jobsite trailer were estimated at \$626,925. The one major cost that could be taken out of the general conditions estimate is the crane. The 100 ton crawler crane used for setting the modular units should be part of the modular subcontractor's contract to better the construction cost to general conditions ratio. The total cost of the crane and mobilization is \$273,300. That is 9% of the general conditions cost. By taking that out of the general conditions cost, the general conditions shrinks to less than 7% of the total project cost.

Table 8
Other General Condition Costs

	Cost per Unit	No. of Units	Cost
Office Trailer 32' x 8'	\$203.00 month	15 months	\$3,045.00
Air Conditioning	\$45.50 month	4 months	\$182.00
Storage Boxes, 20' x 8'	\$79.00 month	90 months	\$7,110.00
Office Equipment	\$220.00 month	15 months	\$3,300.00
Office Supplies	\$82.50 month	15 months	\$1,237.50
Telephone/Internet Service	\$89.00 month	15 months	\$1,335.00
100-ton Crawler Crane	\$3,625.00 day	75 day	\$271,875.00
Scaffolding	\$217.00 csf	904 csf	\$196,168.00
Crane Mobilization	\$1,425.00 ea	1 ea	\$1,425.00
Gravel Road	\$14.45 sy	2595 sy	\$37,497.75
Winter Trap Protection	\$2.55 sf	904 sf	\$2,305.20
Temporary Fencing	\$9.25 lf	2740 lf	\$25,345.00
Cleanup After Job Completion	0.60% job	\$35,000,000.00 job	\$210,000.00
Gator, Gas Powered	\$5,600.00 ea	1 ea	\$5,600.00
Construction Truck	\$500.00 month	30 months	\$15,000.00
Sanitation	\$500.00 month	15 months	\$7,500.00
Recycling/Waste	\$2,400.00 month	15 months	\$36,000.00
Site Safety Materials	\$800.00 month	15 months	\$12,000.00

BUILDING INFORMATION MODELING USE EVALUATION

BIM USES FOR THE CONSTRUCTION MANAGER

BIM was used for 3D clash detection for the MEP's on this project. The architect created the Revit model that was used. BIM was not a requirement on the project, but because the MEP's are design-build, they decided that it would be an efficient way to start the coordination early. The mechanical contractor designed the duct work in the hallways and core first. They also inserted the mechanical units in the attic area. Then the electrical contractor designed their feeders, panel boards, electrical fixtures and lighting. Finally the plumbing and fire protection was added to the model to provide full MEP 3D coordination model. Running clash detection will eliminate MEP system conflicts allowing the tradesmen work more productively. The BIM manager of the 3D clash detection is the construction management company's project manager and two project engineers.

The modular units are created with low ceiling heights. The modular units have to be shipped to the site, so they must be able to fit under bridges and in tunnels. The maximum height of the unit is 11 feet. That means if the ceilings are 8 feet above finished floor, there is about a foot of space for the MEP systems. This is just another reason for more coordination.

POTENTIAL BIM USES

Table 9

Owner Goals, From BIM Execution Planning Guide

Priority	Goal Description	Potential BIM Uses
3	Reduce Field Conflicts	3D Coordination (const)
3	Evaluate Phasing Plan	4D Modeling
2	Identify Concerns Between Modular and Architectural Design	3D Coordination (design), Design Reviews
2	Maintenance Technician Support	Building Maintenance Scheduling
2	Site Logistics Plan	Site Utilization Planning, 4D Modeling
1	Accurate Record Set	Record Modeling
1	Cost Evaluation	Cost Estimation

There are many other uses of BIM besides clash detection. After evaluating the BIM uses to find the owner's goals, Table 9 was created to show the main goals of the owner. Priority level goes from 3 (highest priority) to 1 (lowest). Other than reducing field conflicts, evaluating the phasing plan was of high priority. As previously stated there are 2 core phases and 5 modular phases. The efficiency of the phasing is extremely important to finishing the project on time. There is a design goal, constructability goal and operation goal with a medium priority. There are two main designers, and coordination between the architect and modular unit designer is important. Much like Penn State, Mansfield should use BIM features to attach easily accessible information with each mechanical and electrical unit. The site logistics will be used to ensure the site is safe and productive during the construction process. The low priority goals are having an accurate record model and cost evaluation.

Table 10
BIM Use Matrix, From BIM Execution Planning Guide

Plan	Design	Construct	Operate
Programming	Design Authoring	Construction System Design	X Building Maintenance Scheduling
Site Analysis	X Design Reviews	X Site Utilization Planning	Building System Analysis
	X 3D Coordination	X 3D Coordination	Asset Management
	Engineering Analysis	Digital Fabrication	Space Management
	Sustainability Evaluation	3D Control and Planning	Disaster Planning
	Code Validation	Record Modeling	X Record Modeling
Phase Planning	X Phase Planning	X Phase Planning	Phase Planning
Cost Estimation	X Cost Estimation	Cost Estimation	Cost Estimation
Existing Conditions Modeling	Existing Conditions Modeling	Existing Conditions Modeling	Existing Conditions Modeling

BIM EXECUTION PLANNING PROCESS

*See Appendix D for Level 1 BIM Planning Process

COST ESTIMATION

Cost estimation is the process in which BIM can be used to assist in the generation of accurate quantity take-offs and cost estimates.

Role Players:	Owner	High
	Construction Manager	High
	Architect	Medium

Cost estimation was needed in the design phase. The owner needed the construction manager to provide some value engineering. The CM could have used BIM to quickly estimate price changes.

DESIGN REVIEWS

Design review is the process in which stakeholders view a 3D model and provide their feedbacks to validate multiple design aspects.

Role Players:	Owner	High
	Architect	High
	Modular Designer	High
	MEP Design-Builders	Low

Coordination between the architect and the modular designer was very important. The owner also needed to know what was being designed would fulfill the building's purpose.

PHASING PLAN

Phasing planning is the process in which a 4D model (3D models with the added dimension of time) is utilized to effectively plan the phased occupancy in a renovation, retrofit, addition, or to show the construction sequence and space requirements on a building site.

Role Players:	Construction Manager	High
	All Subcontractors	High

By providing a 4D model of the different phases of the project, the construction manager would make sure that the subcontractors are aware of the construction process. Also collaboration with between the subcontractors will allow the process to move without any speed bumps.

SITE UTILIZATION PLANNING

Site utilization planning is the process in which BIM is used to graphically represent both permanent and temporary facilities on site during multiple phases of the construction process.

Role Players:	Construction Manager	High
	All Subcontractors	Medium
	Owner	Low

The construction manager will generate site usage plans for temporary and permanent facilities. By providing these plans for the subcontractors, they will know where things are moving on site and the space they require as the construction progresses. This knowledge automatically makes everyone onsite safer.

BUILDING MAINTENANCE SCHEDULING

Building maintenance scheduling is the process in which the functionality of the building structure and equipment serving the building are maintained over the operational life of a facility.

Role Players:	Owner	High
	Construction Manager	High
	All Subcontractors	Medium

The university will want to plan maintenance activities proactively and track maintenance history. The subcontractors will have to provide the information that the maintenance personnel needs for maintenance repairs.

RECORD MODEL

Record Modeling is the process used to depict an accurate representation of the physical conditions, environment, and assets of a facility.

Role Players:	Owner	High
	Construction Manager	High

CONSTRUCTABILITY CHALLENGES

The Mansfield University dormitories were designed with some construction challenges. The top three challenges this project faces are: (1) modular construction, (2) design-build subcontractor coordination, and (3) daily university operations. These issues place restrictions on the construction process. Because it is very early in construction on the project, not all of these challenges have been dealt with yet, but there is a plan on how to handle them when they arrive.

MODULAR CONSTRUCTION

Modular construction was used on these dormitory buildings to shorten the project schedule and increase quality. There are limitations to modular construction, though; one has been noted in the BIM section. The space above the ceiling is limited. 3D coordination was used to solve that limitation. There are a few other issues that still need to be addressed.

FAMILIARITY

Mansfield University is located in north central Pennsylvania. The closest big city is New York City and it takes over four hours to drive there. Modular construction is most popular in large cities where there is very little site for storage. Modular construction companies tend to have their offices close to these large cities. Most of the subcontractors are local contractors that rarely have the opportunity to work on a modular construction project. There could be expected details from the modular contractor that the other subcontractors are unfamiliar with. The key to this challenge is communication.

The construction management company has previously built a modular elementary school. The construction company decided to use the same project manager from the elementary project on this dormitory project. The project manager learned many things from the previous job and the most important thing was coordination. There should be no confusion.

The CM has a weekly meeting with the owner and architect to review construction progress and discuss any issues. The CM also has weekly subcontractor meetings, where foremen from every contractor onsite meet to coordinate. The schedule will be reviewed at these meetings to make sure that everyone is hitting their dates. If there is confusion about the construction, communication during these meetings will help to resolve it. The mentality that is preached by the project management team is "everyone should be willing to compromise and the entire site should come together to fix any issues." Subcontractor buy-in to this mentality will help the project move past issues faster.

The modular subcontractor will take most of the coordination off of the rest of the subcontractors. They are responsible for making all of the connections between the units. Also before the units leave the site, they check that every connection is in the right location to connect to each other when assembled. All of this work by the modular contractor will allow for easier integration of the other subcontractors.

CRANE

To set the modular units, a 100 ton crawler crane will be used. Site logistics had to be planned for this sized crane. Eight crane pads were created at specific locations so the crane can reach every spot on the building. The swing radius of the crane is over 100 feet. Safety must be the main concern, while the crane setting the modular units. The delivery of the units must be figured into the site logistics also. There will be a gravel path created so the oversize loaded truck can make its way to the crane.

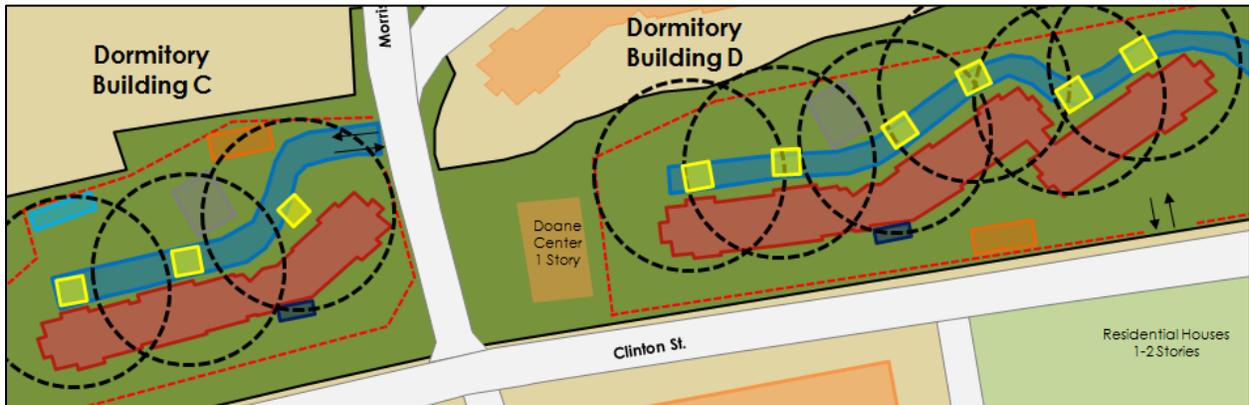


Figure 8 Site Plan
Modular Site Logistics



Figure 9 Modular Unit Setting
Picture Courtesy of Texas Construction.com

DESIGN-BUILD SUBCONTRACTORS

The mechanical/plumbing, electrical and fire protection subcontractors have a design-build contract with the construction manager. They are in charge of designing their company's part of construction. The modular contractor has all of the MEP's in the rooms, so all these contractors must do is connect each room to the mains in the hallways and each main to the right pieces of equipment. It sounds simple, but there was a lot of coordination done before the modular units were set into place.

BIM

As previously noted, BIM 3D coordination was used to design the remaining MEP's. After all of the subcontractors bought in to the 3D coordination, the HVAC system was designed first, then electrical, then plumbing and finally fire protection. The space between the ceilings and the floor above were so small that BIM all of the subcontractors saw the value in creating the model. Each contractor created their systems in Revit, and then clash detection was used. The contractors would change their systems accordingly, and the clash detection would be run through the model again. Once there were no clashes, the model was finished and the final design was complete.

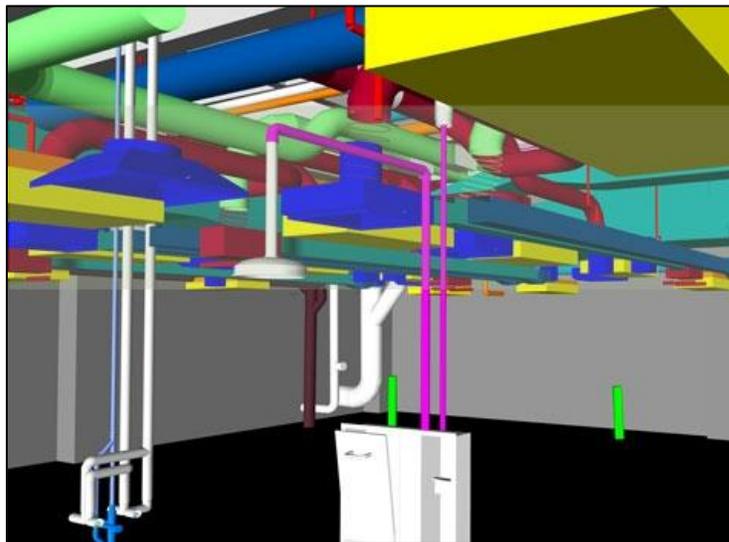


Figure 10 Clash Detection

Picture Courtesy of Allied Fire Protection

The BIM model allowed each subcontractor to see exactly where their work should be placed. Problems were avoided and the project should move faster. Because all of the MEP subcontractors saw the value in 3D coordination, the result will be a smoother and quicker construction process.

DAILY UNIVERSITY OPERATIONS

There were guidelines set by the university that the construction manager had to follow during the construction process. All of these guidelines make sure that normal university operations would not be altered by the construction. There are two different sets of people that are considered: students and university employees.

STUDENTS

While the students are taking classes, they provide many challenges for construction manager. The first and most important concern for the students is their safety. The 8 foot tall site fence will provide a barrier between pedestrian areas and construction areas. Also, a covering is placed on the fence. The university wanted a barrier from seeing the construction site from the outside. There are gates at both sites that will be locked whenever there is no construction going on. Security cameras will be used to monitor both sites after construction hours. The last thing the university needs is a student to hurt themselves on the construction site while no one is working.

Keeping existing sidewalks open is also important for the university. Building D's site is in between two dorms and the fitness center. A new sidewalk path was created to direct these students around the site to the fitness center. Also right next to Building D's site is an existing building called the Doane Center. The Doane Center has a door that exits toward the site fence. The sidewalk that provided a path to the door was demolished during site grading and a temporary one was provided, Figure 11. At no point in time will sidewalk be used for storage or parking for any construction activities. This will be explained at the site orientation that every construction worker must complete in order to work onsite.



Figure 11
Doane Center Access

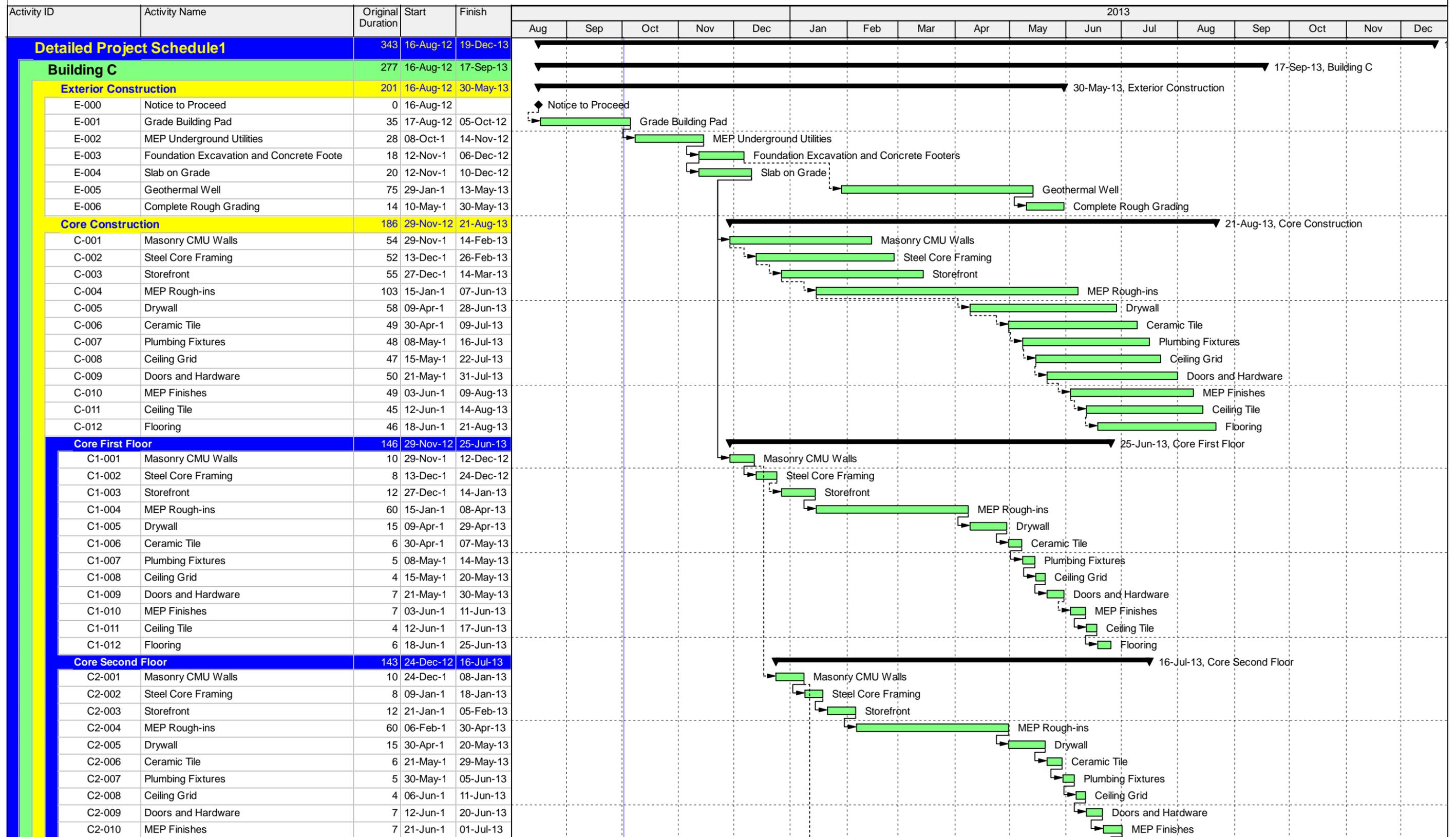
UNIVERSITY OPERATIONS

University teachers and maintenance must be able to do their job. This means that parking is available for them. Construction workers will only be allowed to park in the designated construction parking areas. There are two lots that are provided for workers. Also, no streets may be blocked due to construction deliveries or services. Gates are kept clear so there is no construction traffic backed up onto the road. The delivery of the modular units will be scheduled so that, as one truck leaves, the next one is arriving. There is not enough space onsite to park multiple delivery trucks. The modular subcontractor must keep their deliveries to this strict schedule.

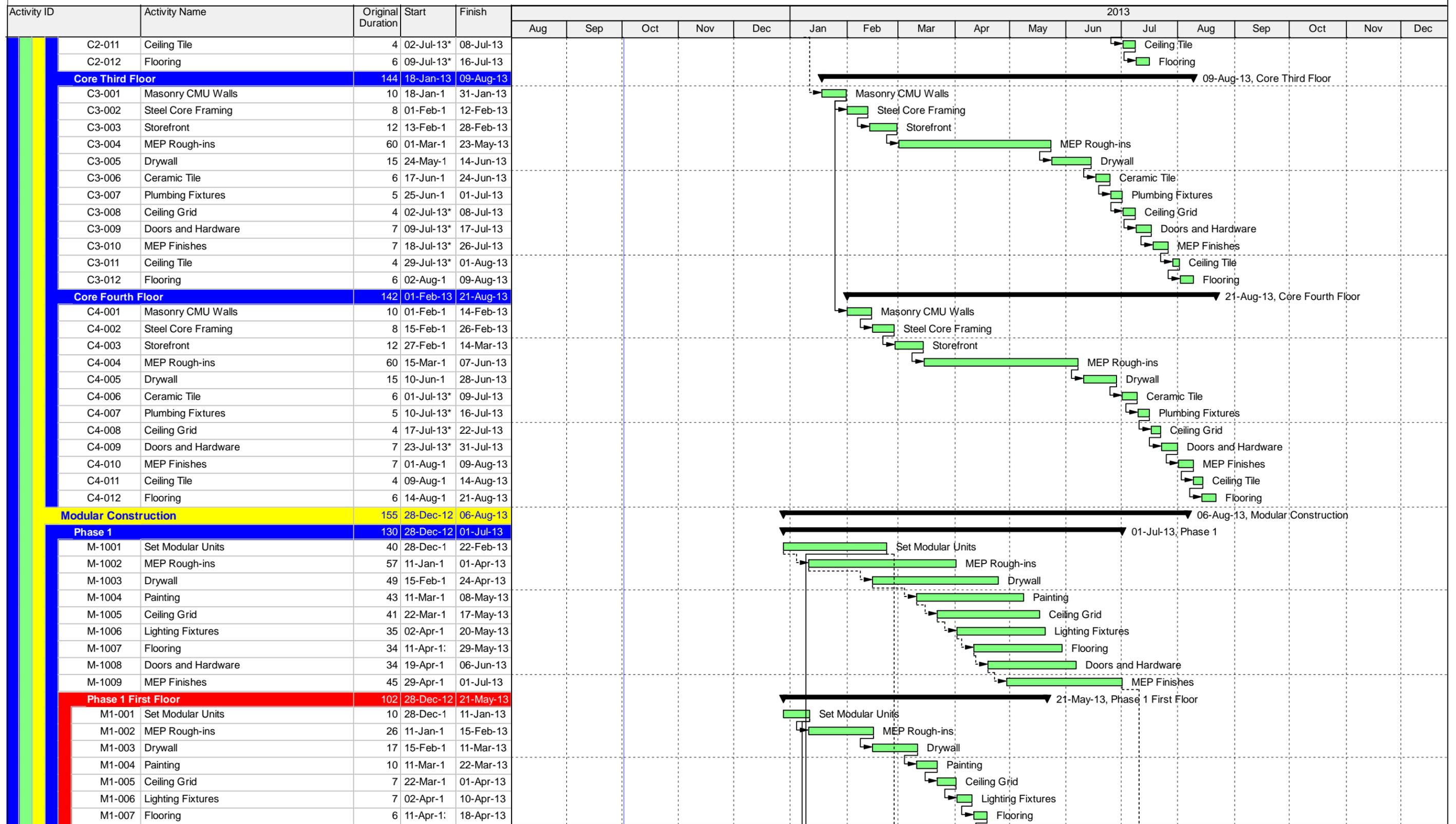
When shutting down any services for other buildings, the university must be notified two weeks in advance. They need to give their employees and students notification in advance. There will be tie-ins to the electric and water that will affect the two dorms east of Building D. Those tie-ins will be scheduled once the main equipment is installed but will still be two weeks in advance. Once the date is set, the subcontractors will be obligated to tie in at that time.

APPENDIX A

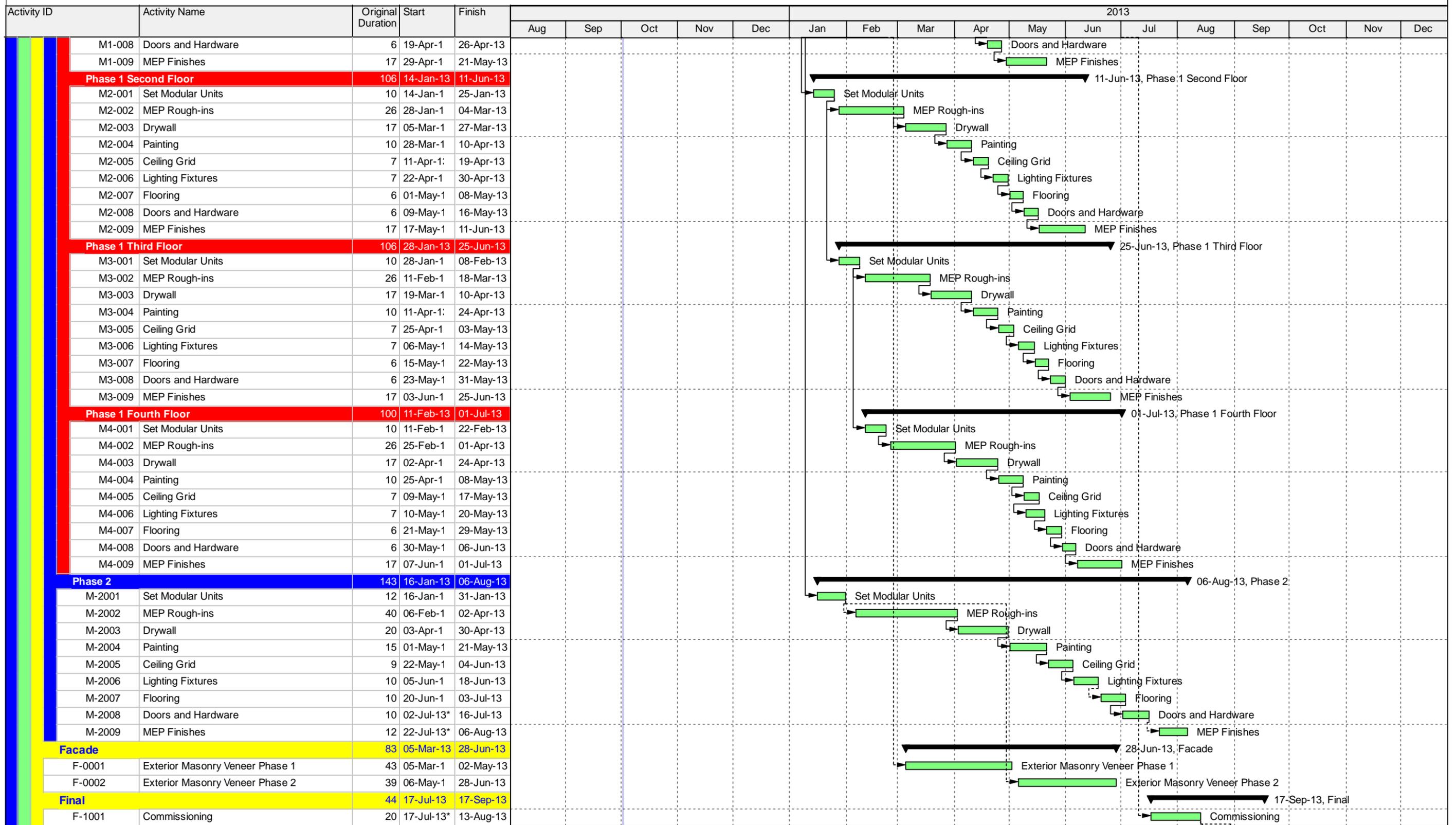
DETAILED PROJECT SCHEDULE



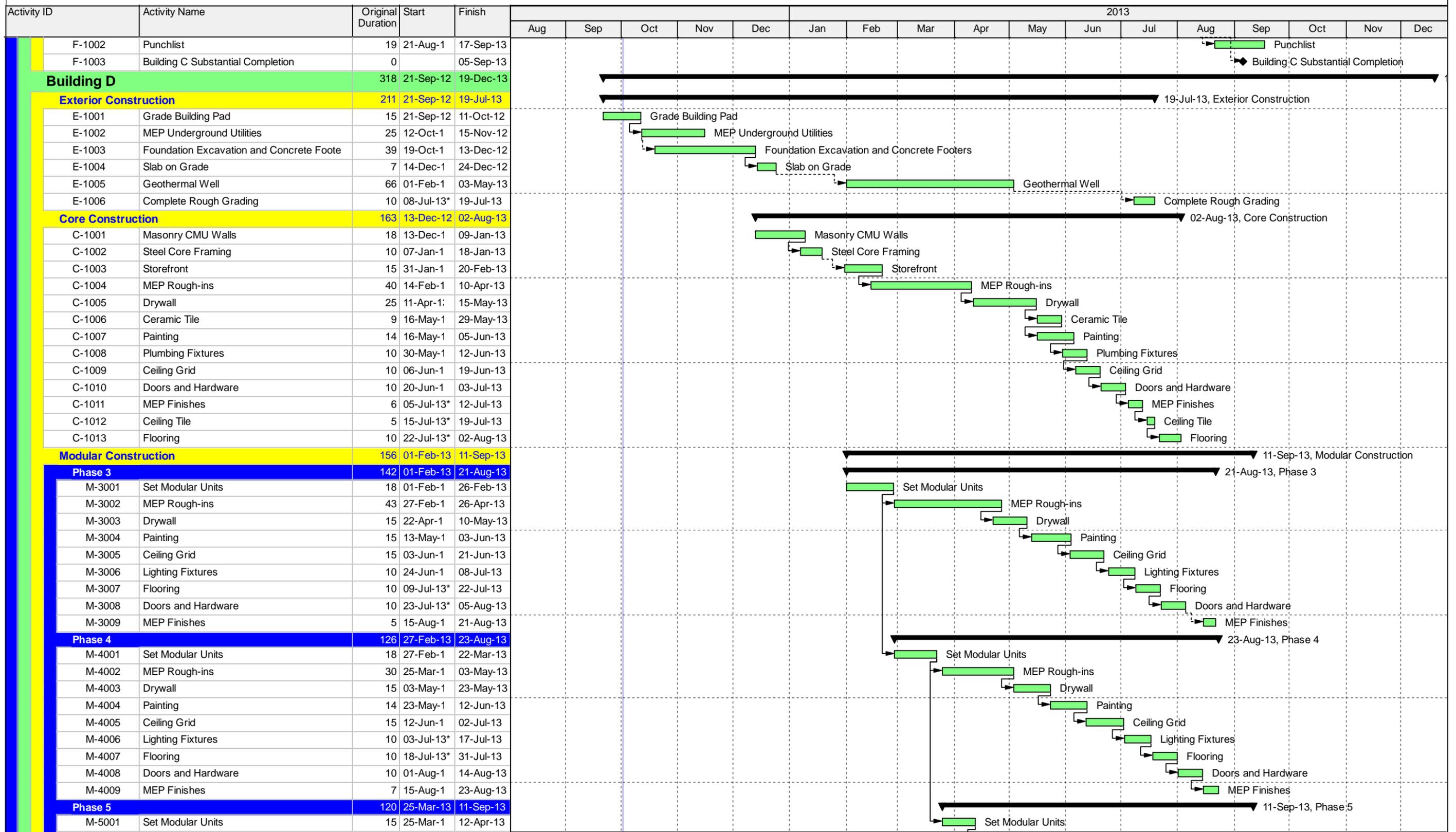
█ Actual Work
 █ Critical Remaining Work
 Summary
 Remaining Work
 ◆ Milestone



█ Actual Work █ Critical Remaining Work ▶ Summary
 Remaining Work ◆ Milestone



Actual Work Remaining Work Critical Remaining Work Summary Milestone



Actual Work Critical Remaining Work Summary
 Remaining Work Milestone

Activity ID	Activity Name	Original Duration	Start	Finish	2013																	
					Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
M-5002	MEP Rough-ins	20	15-Apr-1	10-May-13										█								
M-5003	Drywall	14	13-May-1	31-May-13										█								
M-5004	Painting	15	03-Jun-1	21-Jun-13											█							
M-5005	Ceiling Grid	15	24-Jun-1	15-Jul-13												█						
M-5006	Lighting Fixtures	10	16-Jul-13*	29-Jul-13													█					
M-5007	Flooring	10	30-Jul-13*	12-Aug-13														█				
M-5008	Doors and Hardware	10	13-Aug-1	26-Aug-13															█			
M-5009	MEP Finishes	5	05-Sep-1	11-Sep-13																█		
Final		75	05-Sep-13	19-Dec-13																		
A1860	Commissioning	20	05-Sep-1	02-Oct-13																	█	
A1870	Punchlist	20	19-Sep-1	16-Oct-13																		█
A1880	Building D Substantial Completion	0		17-Oct-13																		◆
A1890	Close Out	29	08-Nov-1	19-Dec-13																		█

█ Actual Work
 █ Critical Remaining Work
 ▶ Summary
█ Remaining Work
 ◆ Milestone

APPENDIX B

DETAILED STRUCTURAL ESTIMATE

Structural Cost Per a Modular Unit

	Cost / Unit	Units	Cost
Walls			
2x4 Studs	\$11.38 LF	209 LF	\$2,378.42
Openings add	\$3.80 LF	12 LF	\$45.60
Window, Studs and Header	\$39.75 EA	4 EA	\$159.00
2x10 Blocking around perimeter	\$3.32 LF	517 LF	\$1,716.44
Floor Joist			
2x10	\$2.05 LF	432 LF	\$885.60
Flooring			
3/4" Tongue and Groove OSB	\$1.81 SF FLR	507 SF FLR	\$917.67
1/4" Noise Isolation Underlayment	\$2.60 SF FLR	507 SF FLR	\$1,318.20
3/4" Butt Edge OSB	\$1.81 SF FLR	507 SF FLR	\$917.67
1/2" FIBERROCK	\$2.99 SF FLR	507 SF FLR	\$1,515.93
5/8" T & G OSB	\$1.45 SF FLR	507 SF FLR	\$735.15
Exterior Panel			
1/2" Zip Board with 1" Foam Insul.	\$4.76 SF	167 SF	794.92
Ceiling Joists			
2x6	\$1.26 LF	306 LF	385.56
Total Structural Costs Per a Modular Unit			\$11,770.16

Roofing

	Cost / Unit	Units	Cost
Roofing			
Shingles	\$1.28 SF	749 SF	\$958.72
1/2" Zip Sheathing	\$1.13 SF	749 SF	\$846.37
Pre-engineered Roof Truss 59' Span	\$3.85 SF	539 SF	\$2,075.15
1-1/2"x16" LVL Roof Beams	\$3.34 SF	260 SF	\$868.40
Roofing Cost per Modular Section			\$4,748.64

Foundation

	Cost / Unit	Units	Cost
Concrete			
4" Slab on Grade	\$117.00 CY	7 CY	\$819.00
Concrete Footers	\$110.00 CY	2 CY	\$220.00
#5 Rebar	\$1,065.50 Ton	0.038 Tons	\$40.49
#4 Rebar	\$1,106.50 Ton	0.233 Tons	\$257.81
Anchor Bolts	\$7.17 EA	16.66 EA	\$119.45
Masonry			
8" Bond Beam, Grout Included	12.07 LF	18 LF	\$217.26
14" Thick 8x16 CMU	\$15.30 SF	45 SF	\$688.50
8" Thick 8x16 CMU	\$9.30 SF	180 SF	\$1,674.00
Steel			
HSS 6x6x3/8 Column	\$360.00 EA	2 EA	\$720.00
1-1/4" x 14" x 14" Column B. Plate	\$1.89 lb	140 lbs	\$264.60
W 14x61 Steel Beams	\$0.33 lb	2440 lbs	\$805.20
Wood			
Double 2.8 Sill	\$6.40 LF	18 LF	\$115.20
Foundation Costs per Modular Section			\$5,941.52

Structural Cost per a Modular Section

	Cost Per Floor	No. of Floors	Total Cost
Cost of Modular Unit	\$11,770.16	4 Floors	\$47,080.64
Cost of Roofing	\$4,748.64	1 Floors	\$4,748.64
Cost of Foundation	\$5,941.52	1 Floors	\$5,941.52
Structural Cost per a Modular Section			\$57,770.80

Total Modular Structural Cost of Both Buildings

Cost per Modular Section	No. of Sections	Total Cost
\$57,770.80	74	\$4,275,039.20

APPENDIX C

GENERAL CONDITIONS ESTIMATE

	Cost per Unit	Units	Cost
01 31 13.20			
Project Executive	\$4,850.00 week	12 week	\$58,200.00
Project Manager	\$3,275.00 week	60 week	\$196,500.00
Project Engineer	\$1,300.00 week	96 week	\$124,800.00
Project Assistant	\$1,150.00 week	32 week	\$36,800.00
Safety Coordinator	\$1,150.00 week	8 week	\$9,200.00
Superintendent	\$3,050.00 week	120 week	\$366,000.00
Forman	\$650.00 week	60 week	\$39,000.00
01 31 13.30			
Insurance	0.40% job	\$35,000,000.00 job	\$140,000.00
01 31 13.90			
Performance Bond	1.50% job	\$35,000,000.00 job	\$525,000.00
01 41 26.50			
Permits	1.25% job	\$35,000,000.00 job	\$437,500.00
01 51 13.80			
Temporary Heat, 12 hrs/day	\$46.00 csf flr	2150 csf flr	\$98,900.00
Lighting, wiring, outlets	\$22.00 csf flr	2150 csf flr	\$47,300.00
Power for Lighting	\$1.01 csf flr	2150 csf flr	\$2,171.50
Temporary Power	\$51.50 csf flr	2150 csf flr	\$110,725.00
Temporary Water	\$69.50 month	15 months	\$1,042.50
01 52 13.20			
Office Trailer 32' x 8'	\$203.00 month	15 months	\$3,045.00
Air Conditioning	\$45.50 month	4 months	\$182.00
Storage Boxes, 20' x 8'	\$79.00 month	90 months	\$7,110.00
01 52 13.40			
Office Equipment	\$220.00 month	15 months	\$3,300.00
Office Supplies	\$82.50 month	15 months	\$1,237.50
Telephone/Internet Service	\$89.00 month	15 months	\$1,335.00
01 54 19.50			
100-ton Crawler Crane	\$ 3,625.00 day	75 day	\$271,875.00
01 54 23.70			
Scaffolding	\$ 217.00 csf	904 csf	\$196,168.00
01 54 36.50			
Crane Mobilization	\$ 1,425.00 ea	1 ea	\$1,425.00
01 55 23.50			
Gravel Road	\$ 14.45 sy	2595 sy	\$37,497.75
01 56 13.90			
Winter Trap Protection	\$ 2.55 sf	904 sf	\$2,305.20
01 56 26.50			
Temporary Fencing	\$ 9.25 lf	2740 lf	\$25,345.00
01 74 13.20			
Cleanup After Job Completion	0.60% job	\$35,000,000.00 job	\$210,000.00
01 93 08.50			
Gator, Gas Powered	\$ 5,600.00 ea	1 ea	\$5,600.00
Construction Truck	\$ 500.00 month	30 months	\$15,000.00
Others			\$0.00
Sanitation	\$ 500.00 month	15 months	\$7,500.00
Recycling/Waste	\$ 2,400.00 month	15 months	\$36,000.00
Site Safety Materials	\$ 800.00 month	15 months	\$12,000.00
			\$3,030,064.45

01 21 Allowances

01 21 57 - Overtime Allowance

Code	Description	Code	Daily Crew	Labor-Output	Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
								Labor	Equipment		

01 21 57.50 Overtime

0010	OVERTIME for early completion of projects or where	R012909-90									
0020	labor shortages exist, add to usual labor, up to				Costs			100%			

01 21 61 - Cost Indexes

01 21 61.20 Historical Cost Indexes

0010	HISTORICAL COST INDEXES (See Reference Section)										
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01 21 63 - Taxes

01 21 63.10 Taxes

0010	TAXES	R012909-80									
0020	Sales tax, State, average				%			5.07%			
0050	Maximum	R012909-85						9.25%			
0200	Social Security, on first \$110,100 of wages							7.65%			
0300	Unemployment, combined Federal and State, minimum							.80%			
0350	Average							7.80%			
	Maximum							14.36%			

Project Management and Coordination

- Project Coordination

01 31 13.20 Field Personnel

0010	FIELD PERSONNEL										
0020	Clerk, average			Week				420	420	650	
0100	Field engineer, minimum							995	995	1,550	
0120	Average							1,300	1,300	2,000	
0140	Maximum							1,475	1,475	2,275	
0160	General purpose laborer, average							1,375	1,375	2,125	
0180	Project manager, minimum							1,850	1,850	2,850	
0200	Average							2,125	2,125	3,275	
0220	Maximum							2,425	2,425	3,750	
0240	Superintendent, minimum							1,800	1,800	2,775	
0260	Average							1,975	1,975	3,050	
0280	Maximum							2,250	2,250	3,475	
0290	Timekeeper, average							1,150	1,150	1,775	

01 31 13.30 Insurance

0010	INSURANCE	R013113-40									
0020	Builders risk, standard, minimum			Job							24%
0050	Maximum	R013113-60									64%
0200	All-risk type, minimum										25%
0250	Maximum										62%
0400	Contractor's equipment floater, minimum			Value							50%
0450	Maximum			"							1.50%
0800	Workers' compensation & employer's liability, average										
0850	by trade, carpentry, general			Payroll				14.96%			
0900	Clerical							.49%			
0950	Concrete							12.70%			
1000	Electrical							5.58%			
1050	Excavation							9.01%			
1100	Glazing							12.57%			
1150	Insulation							11.85%			
1200	Lathing							7.82%			
1250	Masonry							12.10%			

01 31 Project Management and Coordination

01 31 13 - Project Coordination

Code	Description	Code	Daily Crew	Labor-Output	Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
								Labor	Equipment		

01 31 13.30 Insurance

1300	Painting & decorating					Payroll				10.70%	
1350	Pile driving									16.76%	
1400	Plastering									10.78%	
1450	Plumbing									6.91%	
1500	Roofing									28.83%	
1550	Sheet metal work (HVAC)									8.47%	
1600	Steel erection, structural									36.86%	
1650	Tile work, interior ceramic									8.01%	
1700	Waterproofing, brush or hand caulking									6.41%	
1800	Wrecking									30.43%	
2000	Range of 35 trades in 50 states, excl. wrecking, min.									1.80%	
2100	Average									13.70%	
2200	Maximum									124.10%	

01 31 13.40 Main Office Expense

0010	MAIN OFFICE EXPENSE Average for General Contractors	R013113-50									
0020	As a percentage of their annual volume										
0030	Annual volume to \$300,000, minimum					% Vol.					20%
0040	Maximum										30%
0060	To \$500,000, minimum										17%
0070	Maximum										22%
0080	To \$1,000,000, minimum										16%
0090	Maximum										19%
0110	To \$3,000,000, minimum										14%
0120	Maximum										16%
0130	To \$5,000,000, minimum										8%
0140	Maximum										10%

01 31 13.50 General Contractor's Mark-Up

0010	GENERAL CONTRACTOR'S MARK-UP on Change Orders										
0200	Extra work, by subcontractors, add					%					10%
0250	By General Contractor, add										15%
0400	Omitted work, by subcontractors, deduct all but										5%
0450	By General Contractor, deduct all but										7.50%
0600	Overtime work, by subcontractors, add										15%
0650	By General Contractor, add										10%

01 31 13.70 Overhead

0010	OVERHEAD As a percent of installing contractors direct costs	R013113-50									
0040	Includes an allowance for home office expenses, FICA,										
0060	Risk & public liability insur. and unemploy., minimum					%					5%
0080	Average										15%
0100	Maximum										30%
0120	With profit allowance, by size of project; under \$50,000										40%
0140	\$50,000 to \$100,000										35%
0160	\$100,000 to \$500,000										25%
0180	\$500,000 to \$1,000,000										
0200	Mark-up on general contractors total incl. O&P for										
0220	Handling subcontract, minimum					%					
0240	Average										
0260	Maximum										

01 31 13.90 Performance Bond

0010	PERFORMANCE BOND	R013113-80									
0020	For buildings, minimum					Job					60%
0100	Maximum					"					2.50%

01 32 Construction Progress Documentation

01 32 13 – Scheduling of work

	Daily Crew	Labor- Output	Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
01 32 13.50 Scheduling									
0010 SCHEDULING									
0020 Critical path, as % of architectural fee, minimum				%					.50%
0100 Maximum				"					1%
0300 Computer-update, micro, no plots, minimum				Ea.				455	500
0400 Including plots, maximum				"				1,450	1,600
0600 Rule of thumb, CPM scheduling, small job (\$10 Million)				Job					.05%
0650 Large job (\$50 Million +)									.03%
0700 Including cost control, small job									.08%
0750 Large job									.04%

01 32 33 – Photographic Documentation

01 32 33.50 Photographs

	Daily Crew	Labor- Output	Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
01 32 33.50 PHOTOGRAPHS									
0020 8" x 10", 4 shots, 2 prints ea., std. mounting				Set	475			475	520
0100 Hinged linen mounts					530			530	580
0200 8" x 10", 4 shots, 2 prints each, in color					415			415	460
0300 For I.D. slugs, add to all above					5.30			5.30	5.85
0500 Aerial photos, initial fly-over, 6 shots, 1 print ea., 8" x 10"					845			845	925
0550 11" x 14" prints					1,025			1,025	1,125
0600 16" x 20" prints					1,200			1,200	1,325
0700 For full color prints, add					40%				40%
0750 Add for traffic control area				▼	305			305	335
0900 For over 30 miles from airport, add per				Mile	5.45			5.45	6
1000 Vertical photography, 4 to 6 shots with									
1010 different scales, 1 print each				Set	1,125			1,125	1,225
1500 Time lapse equipment, camera and projector, buy					845			845	930
1550 Rent per month				▼	305			305	335
1700 Cameraman and film, including processing, B.&W.				Day	1,375			1,375	1,525
1720 Color				"	1,375			1,375	1,525

11 Regulatory Requirements

26 – Permit Requirements

01 41 26.50 Permits

	Daily Crew	Labor- Output	Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
01 41 26.50 PERMITS									
0020 Rule of thumb, most cities, minimum				Job					.50%
0100 Maximum				"					2%

01 45 Quality Control

01 45 23 – Testing and Inspecting Services

01 45 23.50 Testing

	Daily Crew	Labor- Output	Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
01 45 23.50 TESTING and Inspecting Services									
0015 For concrete building costing \$1,000,000, minimum				Project				4,725	5,200
0020 Maximum								38,000	41,800
0050 Steel building, minimum								4,725	5,200
0070 Maximum								14,800	16,300
0100 For building costing, \$10,000,000, minimum								30,100	33,100
0150 Maximum								48,200	53,000
0200 Asphalt testing, compressive strength Marshall stability, set of 3				▼	Ea.			145	165
0220 Density, set of 3								86	95
0250 Extraction, individual tests on sample								136	150

01 45 Quality Control

01 45 23 – Testing and Inspecting Services

01 45 23.50 Testing

	Daily Crew	Labor- Output	Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0300 Penetration				Ea.				41	45
0350 Mix design, 5 specimens								182	200
0360 Additional specimen								36	40
0400 Specific gravity								41	45
0420 Swell test								64	70
0450 Water effect and cohesion, set of 6								182	200
0470 Water effect and plastic flow								64	70
0600 Concrete testing, aggregates, abrasion, ASTM C 131								136	150
0650 Absorption, ASTM C 127								42	46
0800 Petrographic analysis, ASTM C 295								775	850
0900 Specific gravity, ASTM C 127								50	55
1000 Sieve analysis, washed, ASTM C 136								59	65
1050 Unwashed								59	65
1200 Sulfate soundness								114	125
1300 Weight per cubic foot								36	40
1500 Cement, physical tests, ASTM C 150								320	350
1600 Chemical tests, ASTM C 150								245	270
1800 Compressive test, cylinder, delivered to lab, ASTM C 39								12	13
1900 Picked up by lab, minimum								14	15
1950 Average								18	20
2000 Maximum								27	30
2200 Compressive strength, cores (not incl. drilling), ASTM C 42								36	40
2250 Core drilling, 4" diameter (plus technician)				▼	Inch			23	25
2260 Technician for core drilling				Hr.				45	50
2300 Patching core holes				Ea.				22	24
2400 Drying shrinkage at 28 days								236	260
2500 Flexural test beams, ASTM C 78								59	65
2600 Mix design, one batch mix								259	285
2650 Added trial batches								120	132
2800 Modulus of elasticity, ASTM C 469								164	180
2900 Tensile test, cylinders, ASTM C 496								45	50
3000 Water-Cement ratio curve, 3 batches								141	155
3100 4 batches								186	205
3300 Masonry testing, absorption, per 5 brick, ASTM C 67								45	50
3350 Chemical resistance, per 2 brick								50	55
3400 Compressive strength, per 5 brick, ASTM C 67								68	75
3420 Efflorescence, per 5 brick, ASTM C 67								68	75
3440 Imperviousness, per 5 brick								87	96
3470 Modulus of rupture, per 5 brick								86	95
3500 Moisture, block only								32	35
3550 Mortar, compressive strength, set of 3								23	25
4100 Reinforcing steel, bend test								55	61
4200 Tensile test, up to #8 bar								36	40
4220 #9 to #11 bar								41	45
4240 #14 bar and larger								64	70
4400 Soil testing, Atterberg limits, liquid and plastic limits								59	65
4510 Hydrometer analysis								109	120
4530 Specific gravity, ASTM D 354								44	48
4600 Sieve analysis, washed, ASTM D 422								55	60
4700 Unwashed, ASTM D 422								59	65
4710 Consolidation test (ASTM D2435), minimum								250	275
4715 Maximum								430	475
4720 Density and classification of undisturbed sample								73	80

01 45 Quality Control

01 45 23 - Testing and Inspecting Services

01 45 23.50 Testing	Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs			Total	Total Incl O&P
						Labor	Equipment	Total		
4735				Ea.					35	38.50
4740									27	30
4750									9	10
4780									500	550
4800									227	250
4850									250	275
4900									123	135
4950									68	75
5100									410	450
5150									545	600
5300									320	350
5350									410	450
5550									320	350
5570									280	310
5650									400	440
5750									480	530
5790									480	530
5820				Day					310	340
5840									310	340
5860									450	495
5880									310	340
6000				Ea.					91	100
6100				"					250	275
7000										
7500				Ea.					435	480
7510				"					615	675
7600				Day					1,375	1,500
7610				"					2,275	2,500
7700				Total					4,550	5,000
7710				"					6,375	7,000
8000				Ea.					182	200
9000				"						500

Temporary Utilities

01 51 13 - Temporary Electricity

01 51 13.80 Temporary Utilities	Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs Labor	2012 Bare Costs Equipment	2012 Bare Costs Total	Total	Total Incl O&P
0010										
0100										
0200										
0350										
0360										
0400										
0430										
0450										
0600										
0650										
0700				Month						
1000										

01 52 Construction Facilities

01 52 13 - Field Offices and Sheds

01 52 13.20 Office and Storage Space	Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs Labor	2012 Bare Costs Equipment	2012 Bare Costs Total	Total	Total Incl O&P
0010										
0020										
0250										
0300										
0350										
0400										
0450										
0500										
0550										
0700										
0800				Mile						
0890				Ea.						
0900										
0910										
0920										
1000				S.F.						
1100				"						
1200				Ea.						
1250										
1300										
1350										
5000										

01 52 13.40 Field Office Expense

01 52 13.40 Field Office Expense	Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs Labor	2012 Bare Costs Equipment	2012 Bare Costs Total	Total	Total Incl O&P
0010										
0100				Month						
0120				"						
0125										
0140				Month						
0160				"						

01 54 Construction Aids

01 54 09 - Protection Equipment

01 54 09.50 Personnel Protective Equipment

01 54 09.50 Personnel Protective Equipment	Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs Labor	2012 Bare Costs Equipment	2012 Bare Costs Total	Total	Total Incl O&P
0010										
0015										
0020				Ea.						
0030										
0040										
0050										
0060										
0100										
0110										
0150										
0160										
0200										
0210										
0300				Pr.						
0310										
0320										
0400										
0410										

01 54 Construction Aids

01 54 09 - Protection Equipment

01 54 09.50 Personnel Protective Equipment		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
0500	Fire protection equipment, shoes/boots				Ea.	255			255	281
0510	Hard-hats					242			242	266
0520	Gloves				↓	54.50			54.50	60

01 54 09.60 Safety Nets

0010 SAFETY NETS		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
0020	No supports, stock sizes, nylon, 4" mesh				S.F.	1.10			1.10	1.21
0100	Polypropylene, 6" mesh				↓	1.59			1.59	1.75
0200	Small mesh debris nets, 1/4" & 3/4" mesh, stock sizes				↓	.74			.74	.81
0220	Combined 4" mesh and 1/4" mesh, stock sizes				↓	2.05			2.05	2.26
0300	Monthly rental, 4" mesh, stock sizes, 1st month				↓	.50			.50	.55
0320	2nd month rental				↓	.25			.25	.28
0340	Maximum rental/year				↓	1.15			1.15	1.27

01 54 16 - Temporary Hoists

01 54 16.50 Weekly Forklift Crew

0010 WEEKLY FORKLIFT CREW		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
0100	Warehouse forklift, 45" lift, 35" mesh, 2000 lb. capacity	3	20	60	Week		1,800	2,400	4,200	5,675

01 54 19 - Temporary Cranes

01 54 19.50 Daily Crane Crews

0010 DAILY CRANE CREWS for small jobs, portal to portal		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
0100	12-ton truck-mounted hydraulic crane	A-3H	1	8	Day		380	825	1,205	1,500
0200	25-ton	A-3I	1	8	↓		380	955	1,335	1,650
	40-ton	A-3J	1	8	↓		380	1,175	1,555	1,900
	55-ton	A-3K	1	16	↓		710	1,625	2,335	2,900
	80-ton	A-3L	1	16	↓		710	2,275	2,985	3,625
	100-ton	A-3M	1	16	↓		710	2,275	2,985	3,625

01 54 19.60 Monthly Tower Crane Crew

0010 MONTHLY TOWER CRANE CREW, excludes concrete footing		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
0100	Static tower crane, 130' high, 106' jib, 6200 lb. capacity	A-3N	.05	176	Month		8,425	22,100	30,525	37,600

01 54 23 - Temporary Scaffolding and Platforms

01 54 23.60 Pump Staging

0010 PUMP STAGING, Aluminum R015423-20		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
0200	24' long pole section, buy				Ea.	330			330	365
0300	18' long pole section, buy				↓	257			257	282
0400	12' long pole section, buy				↓	173			173	190
0500	6' long pole section, buy				↓	91.50			91.50	100
0600	6' long splice joint section, buy				↓	67.50			67.50	74.50
0700	Pump jack, buy				↓	136			136	149
0900	Foldable brace, buy				↓	55			55	60.50
1000	Workbench/back safety rail support, buy				↓	71.50			71.50	78.50
1100	Scaffolding planks/workbench, 14" wide x 24' long, buy				↓	665			665	735
1200	Plank end safety rail, buy				↓	288			288	315
1250	Safety net, 22' long, buy				↓	320			320	355
1300	System in place, 50' working height, per use based on 50 uses	2 Carp	84.80	.189	C.S.F.	5.70	8.30		14	19.95
1400	100 uses	↓	84.80	.189	↓	2.86	8.30		11.16	16.80
1500	150 uses	↓	84.80	.189	↓	1.92	8.30		10.22	15.75

01 54 23.70 Scaffolding

SCAFFOLDING R015423-10		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
Steel tube, regular, no plank, labor only to erect & dismantle										
	Building exterior, wall face, 1 to 5 stories, 6'-4" x 5' frames	3 Carp	8	3	C.S.F.		132		132	217
0200	6 to 12 stories	4 Carp	8	4			176		176	289

01 54 Construction Aids

01 54 23 - Temporary Scaffolding and Platforms

01 54 23.70 Scaffolding		Crew	Daily Output	Labor-Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
							Labor	Equipment		
0301	13 to 20 stories	5 Clab	8	5	C.S.F.		176		176	288
0460	Building interior, wall face area, up to 16' high	3 Carp	12	2	↓		88		88	145
0560	16' to 40' high	↓	10	2.400	↓		106		106	174
0800	Building interior floor area, up to 30' high	↓	150	.160	C.C.F.		7.05		7.05	11.55
0900	Over 30' high	4 Carp	160	.200	"		8.80		8.80	14.45
0906	Complete system for face of walls, no plank, material only rent/mo				C.S.F.	36			36	39.50
0908	Interior spaces, no plank, material only rent/mo				C.C.F.	3.42			3.42	3.76
0910	Steel tubular, heavy duty shoring, buy									
0920	Frames 5' high 2' wide				Ea.	81.50			81.50	90
0925	5' high 4' wide				↓	93			93	102
0930	6' high 2' wide				↓	93.50			93.50	103
0935	6' high 4' wide				↓	109			109	120
0940	Accessories									
0945	Cross braces				Ea.	15.85			15.85	17.40
0950	U-head, 8" x 8"				↓	19.10			19.10	21
0955	J-head, 4" x 8"				↓	13.90			13.90	15.30
0960	Base plate, 8" x 8"				↓	15.50			15.50	17.05
0965	Leveling jack				↓	33.50			33.50	36.50
1000	Steel tubular, regular, buy									
1100	Frames 3' high 5' wide				Ea.	75			75	82.50
1150	5' high 5' wide				↓	88			88	96.50
1200	6'-4" high 5' wide				↓	118			118	129
1350	7'-6" high 6' wide				↓	158			158	173
1500	Accessories cross braces				↓	15.50			15.50	17.05
1550	Guardrail post				↓	16.40			16.40	18.05
1600	Guardrail 7' section				↓	6.30			6.30	6.95
1650	Screw jacks & plates				↓	21.50			21.50	24
1700	Sidearm brackets				↓	25.50			25.50	28.50
1750	8" casters				↓	31			31	34
1800	Plank 2" x 10" x 16'-0"				↓	24.50			24.50	27
1900	Stairway section				↓	275			275	305
1910	Stairway starter bar				↓	32			32	35
1920	Stairway inside handrail				↓	53			53	58
1930	Stairway outside handrail				↓	81.50			81.50	90
1940	Walk-thru frame guardrail				↓	41.50			41.50	46
2000	Steel tubular, regular, rent/mo.									
2100	Frames 3' high 5' wide				Ea.	5			5	5.50
2150	5' high 5' wide				↓	5			5	5.50
2200	6'-4" high 5' wide				↓	5.15			5.15	5.65
2250	7'-6" high 6' wide				↓	7			7	7.70
2500	Accessories, cross braces				↓	1			1	1.10
2550	Guardrail post				↓	1			1	1.10
2600	Guardrail 7' section				↓	1			1	1.10
2650	Screw jacks & plates				↓	2			2	2.20
2700	Sidearm brackets				↓	2			2	2.20
2750	8" casters				↓	8			8	8.80
2800	Outrigger for rolling tower				↓	3			3	3.30
2850	Plank 2" x 10" x 16'-0"				↓	6			6	6.60
2900	Stairway section				↓	40			40	44
2940	Walk-thru frame guardrail				↓	2.50			2.50	2.75
3000	Steel tubular, heavy duty shoring, rent/mo.									
3250	5' high 2' & 4' wide				Ea.	5			5	5.50
3300	6' high 2' & 4' wide				↓	5			5	5.50

01 54 Construction Aids

01 54 36 - Equipment Mobilization

01 54 36.50 Mobilization	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs			Total Incl O&P
						Labor	Equipment	Total	
0020 Dozer, loader, backhoe, excav., grader, paver, roller, 70 to 150 H.P.	B-34N	4	2	Ea.		70.50	126	196.50	253
0100 Above 150 HP	B-34K	3	2.667			94	283	377	460
0300 Scraper, towed type (incl. tractor), 6 C.Y. capacity		3	2.667			94	283	377	460
0400 10 C.Y.		2.50	3.200			113	340	453	560
0600 Self-propelled scraper, 15 C.Y.		2.50	3.200			113	340	453	560
0700 24 C.Y.		2	4			141	425	566	695
0900 Shovel or dragline, 3/4 C.Y.		3.60	2.222			78.50	236	314.50	385
1000 1-1/2 C.Y.		3	2.667			94	283	377	460
1100 Small equipment, placed in rear of, or towed by pickup truck	A-3A	8	1			34.50	17.40	51.90	74.50
1150 Equip. up to 70 HP, on flatbed trailer behind pickup truck	A-3D	4	2			68.50	62	130.50	179
2000 Crane, truck-mounted, up to 75 ton, (driver only, one-way)	1 Eqhv	7.20	1.111			53		53	84
Crane, truck-mounted, over 75 ton	A-3E	2.50	6.400			266	55.50	321.50	485
Crane, crawler-mounted, up to 75 ton	A-3F	2	8			330	435	765	1,000
Over 75 ton	A-3G	1.50	10.667			445	660	1,105	1,425
2500 For each additional 5 miles haul distance, add						10%	10%		
3000 For large pieces of equipment, allow for assembly/knockdown									
3001 For mob/demob of vibrofloatation equip, see Section 31 45 13.10									
3100 For mob/demob of micro-tunneling equip, see Section 33 05 23.19									
3200 For mob/demob of pile driving equip, see Section 31 62 19.10									
3300 For mob/demob of caisson drilling equip, see Section 31 63 26.13									

01 54 39 - Construction Equipment

01 54 39.10	% of contractor's base bid cost for project, maximum	Total	50%
0110	Maximum		7%

01 55 Vehicular Access and Parking

01 55 23 - Temporary Roads

01 55 23.50 Roads and Sidewalks

ROADS AND SIDEWALKS Temporary										
0100	Roads, gravel fill, no surfacing, 4" gravel depth	B-14	715	.067	S.Y.	4.15	2.49	.47	7.11	9.10
0100	8" gravel depth	"	615	.078	"	8.30	2.89	.54	11.73	14.45
1000	Ramp, 3/4" plywood on 2" x 6" joists, 16" O.C.	2 Carp	300	.053	S.F.	1.23	2.35		3.58	5.20
1100	On 2" x 10" joists, 16" O.C.	"	275	.058	"	1.70	2.57		4.27	6.10

01 56 Temporary Barriers and Enclosures

01 56 13 - Temporary Air Barriers

01 56 13.60 Tarpaulins

TARPAULINS										
0020	Cotton duck, 10 oz. to 13.13 oz. per S.Y., minimum				S.F.	.78			.78	.86
0050	Maximum					.80			.80	.88
0100	Polyvinyl coated nylon, 14 oz. to 18 oz., minimum					.48			.48	.53
0150	Maximum					.68			.68	.75
0200	Reinforced polyethylene 3 mils thick, white					.15			.15	.17
0300	4 mils thick, white, clear or black					.20			.20	.22
0400	5.5 mils thick, clear					.23			.23	.25
0500	White, fire retardant					.35			.35	.39
0600	12 mils, oil resistant, fire retardant					.28			.28	.31
0700	8.5 mils, black					.57			.57	.63

01 56 Temporary Barriers and Enclosures

01 56 13 - Temporary Air Barriers

01 56 13.60 Tarpaulins

01 56 13.60 Tarpaulins	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs			Total Incl O&P
						Labor	Equipment	Total	
0710 Woven polyethylene, 6 mils thick									
0720 Steel reinforced polyethylene, 4 mils thick				S.F.	.35			.35	.39
0730 Polyester reinforced w/integral fastening system 11 mils thick					.53			.53	.58
0740 Mylar polyester, non-reinforced, 7 mils thick					1.07			1.07	1.18
					1.17			1.17	1.29

01 56 13.90 Winter Protection

WINTER PROTECTION									
0100 Framing to close openings									
0200 Tarpaulins hung over scaffolding, 8 uses, not incl. scaffolding	2 Clab	750	.021	S.F.	.39		.75	1.14	1.64
0250 Tarpaulin polyester reinf. w/integral fastening system 11 mils thick		1500	.011		.25		.37	.62	.89
0300 Prefab fiberglass panels, steel frame, 8 uses		1600	.010		.80		.35	1.15	1.46
		1200	.013		.85		.47	1.32	1.71

01 56 16 - Temporary Dust Barriers

01 56 16.10 Dust Barriers, Temporary

DUST BARRIERS, TEMPORARY									
0020 Spring loaded telescoping pole & head, to 12', erect and dismantle	1 Clab	240	.033	Ea.			1.17	1.17	1.92
0025 Cost per day (based upon 250 days)				Day	.24			.24	.26
0030 To 21', erect and dismantle	1 Clab	240	.033	Ea.			1.17	1.17	1.92
0035 Cost per day (based upon 250 days)				Day	.39		.59	.59	.96
0040 Accessories, caution tape reel, erect and dismantle	1 Clab	480	.017	Ea.			.05	.05	.05
0045 Cost per day (based upon 250 days)				Day					
0060 Foam rail and connector, erect and dismantle	1 Clab	240	.033	Ea.			1.17	1.17	1.92
0065 Cost per day (based upon 250 days)				Day	.10			.10	.11
0070 Caution tape	1 Clab	384	.021	C.L.F.	2.65	.73		3.38	4.11
0080 Zipper, standard duty		60	.133	Ea.	8	4.68		12.68	16.45
0090 Heavy duty		48	.167	"	9.50	5.85		15.35	20
0100 Polyethylene sheet, 4 mil		37	.216	Sq.	3.23	7.60		10.83	16
0110 6 mil		37	.216	"	4.54	7.60		12.14	17.45
1000 Dust partition, 6 mil polyethylene, 1" x 3" frame	2 Carp	2000	.008	S.F.	.27	.35		.62	.88
1080 2" x 4" frame	"	2000	.008	"	.29	.35		.64	.90

01 56 23 - Temporary Barricades

01 56 23.10 Barricades

BARRICADES									
0020 5' high, 3 rail @ 2" x 8", fixed	2 Carp	20	.800	L.F.	5.30	35.50		40.80	64
0150 Movable	"	30	.533	"	4.35	23.50		27.85	43.50
0300 Stock units, 6' high, 8' wide, plain, buy				Ea.	475			475	520
0350 With reflective tape, buy				"	540			540	595
0400 Break-a-way 3" PVC pipe barricade									
0410 with 3 ea. 1' x 4' reflectorized panels, buy				Ea.	160			160	176
0500 Plywood with steel legs, 32" wide					99.50			99.50	109
0600 Warning signal flag tree, 11' high, 2 flags, buy					330			330	365
0800 Traffic cones, PVC, 18" high					10			10	11
0850 28" high					11.60			11.60	12.80
1000 Guardrail, wooden, 3' high, 1" x 6", on 2" x 4" posts	2 Carp	200	.080	L.F.	1.15	3.53		4.68	7.05
1100 2" x 6", on 4" x 4" posts	"	165	.097		2.26	4.28		6.54	9.50
1200 Portable metal with base pads, buy					15.25			15.25	16.75
1250 Typical installation, assume 10 reuses					2.50	1.18		3.68	4.68
1300 Barricade tape, polyethylene, 7 mil, 3" wide x 500' long roll	2 Carp	600	.027					25	27.50
5000 Barricades, see Section 01 54 33.40				Ea.					

01 56 26 - Temporary Fencing

01 56 26.50 Temporary Fencing

TEMPORARY FENCING									
0020 Chain link, 11 ga, 5' high	2 Clab	400	.040	L.F.	4.50	1.40		5.90	7.25

01 56 Temporary Barriers and Enclosures

01 56 26 - Temporary Fencing

01 56 26.50 Temporary Fencing

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
6' high	2 Clab	300	.053	L.F.	5.30	1.87		7.17	8.90
Rented chain link, 6' high, to 1000' (up to 12 mo.)		400	.040		6.30	1.40		7.70	9.25
Over 1000' (up to 12 mo.)		300	.053		3.29	1.87		5.16	6.70
Plywood, painted, 2" x 4" frame, 4' high	A-4	135	.178		5.45	7.50		12.95	18.20
4" x 4" frame, 8' high	"	110	.218		10.20	9.20		19.40	26
Wire mesh on 4" x 4" posts, 4' high	2 Carp	100	.160		9.25	7.05		16.30	22
8' high	"	80	.200		13.90	8.80		22.70	30

01 56 29 - Temporary Protective Walkways

01 56 29.50 Protection

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 PROTECTION									
0020 Stair tread, 2" x 12" planks, 1 use	1 Carp	75	.107	Tread	3.83	4.70		8.53	11.90
0100 Exterior plywood, 1/2" thick, 1 use		65	.123		1.41	5.45		6.86	10.45
0200 3/4" thick, 1 use		60	.133		2.10	5.90		8	11.95
2200 Sidewalks, 2" x 12" planks, 2 uses		350	.023	S.F.	.64	1.01		1.65	2.35
2300 Exterior plywood, 2 uses, 1/2" thick		750	.011		.24	.47		.71	1.03
2500 3/4" thick		600	.013		.35	.59		.94	1.35

01 56 32 - Temporary Security

01 56 32.50 Watchman

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 WATCHMAN									
0020 Service, monthly basis, uniformed person, minimum				Hr.				25	27.50
0100 Maximum								45.50	50
0200 Person and command dog, minimum								31	34
0300 Maximum								54.50	60
0500 Sentry dog, leased, with job patrol (yard dog), 1 dog				Week				290	320
0600 2 dogs				"				390	430
0800 Purchase, trained sentry dog, minimum				Ea.				1,375	1,500
0900 Maximum				"				2,725	3,000

01 58 Project Identification

01 58 13 - Temporary Project Signage

01 58 13.50 Signs

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 SIGNS									
0020 High intensity reflectorized, no posts, buy				S.F.	34			34	37.50

01 71 Examination and Preparation

01 71 23 - Field Engineering

01 71 23.13 Construction Layout

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 CONSTRUCTION LAYOUT									
1100 Crew for layout of building, trenching or pipe laying, 2 person crew	A-6	1	16	Day		705	78.50	783.50	1,225
1200 3 person crew	A-7	1	24			1,150	78.50	1,228.50	1,925
1400 Crew for roadway layout, 4 person crew	A-8	1	32			1,500	78.50	1,578.50	2,500

01 71 23.19 Surveyor Stakes

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 SURVEYOR STAKES									
0020 Hardwood, 1" x 1" x 48" long				C	66			66	72.50
0100 2" x 2" x 18" long					74			74	81.50
0150 2" x 2" x 24" long					130			130	143

01 74 Cleaning and Waste Management

01 74 13 - Progress Cleaning

01 74 13.20 Cleaning Up

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 CLEANING UP									
0020 After job completion, allow, minimum				Job					.30%
0040 Maximum				"					1%
0042 Rubbish removal, see Section 02 41 19.23									
0052 Cleanup of floor area, continuous, per day, during const.	A-5	16	1.125	M.S.F.	1.75	39.50	3.30	44.55	70
0100 Final by GC at end of job	"	11.50	1.565	"	2.78	55	4.59	62.37	97.50

01 76 Protecting Installed Construction

01 76 13 - Temporary Protection of Installed Construction

01 76 13.20 Temporary Protection

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 TEMPORARY PROTECTION									
0020 Flooring, 1/8" tempered hardboard, taped seams	2 Carp	1500	.011	S.F.	.38	.47		.85	1.19
0030 Peel away carpet protection	1 Clab	3200	.003	"	.11	.09		.20	.26

01 91 Commissioning

01 91 13 - General Commissioning Requirements

01 91 13.50 Building Commissioning

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 BUILDING COMMISSIONING									
0100 Basic building commissioning, minimum				%					.25%
0150 Maximum									.50%
0200 Enhanced building commissioning, minimum									.50%
0250 Maximum									1%

01 93 Facility Maintenance

01 93 08 - Facility Maintenance Equipment

01 93 08.50 Equipment

	Crew	Daily Output	Labor Hours	Unit	Material	2012 Bare Costs		Total	Total Incl O&P
						Labor	Equipment		
0010 EQUIPMENT, Purchase									
0090 Carpet care equipment									
0110 Dual motor vac, 1 H.P., 16" brush				Ea.	980			980	1,075
0120 Upright vacuum, 12" brush					335			335	365
0130 14" brush					380			380	420
0140 Soil extractor, hot water 5' wand, 12" head					2,075			2,075	2,300
0150 Dry foam, 13" brush					1,575			1,575	1,725
0160 24" brush					2,150			2,150	2,350
0240 Floor care equipment									
0260 Polishing, buffing, waxing machine, 175 RPM									
0270 .33 H.P., 11" dia. brush				Ea.	600			600	660
0280 1 H.P., 16" dia. brush					970			970	1,075
0290 18" dia. brush					1,125			1,125	1,225
0300 1.5 H.P., 20" dia. brush					1,275			1,275	1,400
0310 24" dia. brush					1,375			1,375	1,525
0330 Scrubber, automatic, 2 stage 1 H.P. vacuum motor									
0340 20" dia. brush				Ea.	9,350			9,350	10,300
0350 28" dia. brush				"	13,600			13,600	15,000
1200 Plumbing maintenance equipment									
1220 Kinetic water ram				Ea.	203			203	223
1240 Cable pipe snake, 104 ft., self feed, electric, .5 H.P.				"	2,250			2,250	2,500

01 93 Facility Maintenance

01 93 08 - Facility Maintenance Equipment

Table listing equipment items for Facility Maintenance (01 93 08). Includes categories like 'Specialty equipment' and '01 93 09.50 Moving Equipment'. Columns include Item, Crew, Daily Output, Labor Hours, Unit, Material, 2012 Bare Costs (Labor, Equipment, Total), and Total Incl O&P.

01 93 09 - Facility Equipment

01 93 09.50 Moving Equipment

Detailed table for Moving Equipment (01 93 09.50). Items include 'MOVING EQUIPMENT, Remove and reset, 100' distance', 'Annealing furnace, 24' overall', 'Band saw, small', 'Blue print copy machine', etc. Columns include Item, Crew, Daily Output, Labor Hours, Unit, Material, 2012 Bare Costs (Labor, Equipment, Total), and Total Incl O&P.

01 93 Facility Maintenance

01 93 09 - Facility Equipment

01 93 09.50 Moving Equipment

Detailed table for Moving Equipment (01 93 09.50) from page 27. Items include 'Drafting table', 'Drill press, bench top', 'Floor mounted', 'Industrial radial', 'Dust collector, portable', etc. Columns include Item, Crew, Daily Output, Labor Hours, Unit, Material, 2012 Bare Costs (Labor, Equipment, Total), and Total Incl O&P.

APPENDIX D

LEVEL 1 BIM EXECUTION MAP

