# Worcester Polytechnic Institute: Construction Management Services for the new WPI Residence Hall

A Major Qualifying Project
Submitted to the faculty of
Worcester Polytechnic Institute
In partial fulfillment of the requirements for the
**Degree of Bachelor of Science**


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# Abstract

This project presents an alternative design for the foundation wall of the Worcester Polytechnic Institute new residence hall to resist lateral loading during construction. The cost implications of this alternative design were also investigated. A 3-D model of the structure of the building was also constructed using Autdesk Revit software and a quantity takeoff was developed using this model. A cost estimate and takeoff for the structure were also performed and an earned value analysis was developed to access the progress of construction of the exterior walls.

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## Capstone Design Statement

The capstone design requirements for this Major Qualifying Project are being satisfied by investigating the implications of redesigning a foundation wall that would perform its load carrying abilities as a foundation wall as well as act as a temporary retaining wall during construction. If the wall had originally been designed in this matter the effort of re-excavating, installation of tiebacks, and backfilling that the construction management firm was forced to undertake to complete this project safely could have been avoided. These tasks also had scheduling and cost impacts to the project. We compared the actual cost of the solution implimented in the field to the cost and impacts of our new cantilevered wall with counterforts.

Redesigning the wall consisted of a structural analysis of the existing wall, investigating the soil conditions on site to determine the type of retaining wall, and designing the wall to support vertical and lateral loads. Vertical loads on the wall were determined by using calculations prepared by Canon Design as well as being calculated by ourselves. Soil characteristics were used to determine horizontal pressures on the wall.

The proposed solution is a design that is a cantilevered retaining wall with counterforts, due to the fact that counterforts add tremendous strength without making the heel slab of the retaining wall to extremely long. This solution would take up minium space as well as materials and would allow the wall to accept the lateral loads presented by construction.

This project will addressed economic, scheduling, and constructability issues created by a differently designed foundation wall. We examined the increased costs of the project due to a foundation wall designed to carry vertical loads while also being able to resist horizontal loads during the construction process.  Additionally we determined how the scheduling and constructability of the project would have been impacted if the wall was designed as a retaining wall from the beginning and additional time did not have to be dedicated backfilling the wall and then removing the fill at a later time.

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## 1.0 Introduction

Worcester Polytechnic Institute (WPI) has seen an annual growth rate for its student body over the past few years as its undergraduate and graduate programs continue to expand and gain global recognition. This is partly due to WPI's increasing success with its global projects program, which send students all around the world to work on either their Initial (IQP) or Major Qualifying Project (MQP), but more so because of a well thought out master plan for WPI that seeks to eventually connect the main WPI campus with its new satellite campus known as Gateway Park. Because of this there has been a need for more undergraduate housing particularly on campus. Traditionally most students move off campus after their first year into the surrounding apartments, sororities and fraternities. In order to foster the expansion of the university as well as provide much needed upper-classman housing, WPI has begun the construction of a new residence hall and parking garage between Boynton St. and Dean St. By bringing upperclassmen back on campus, Janet Richardson, the Vice President of Student Affairs and Campus Life believes that "the university benefits greatly from the leadership, mentorship, experience and talent of its students being part of the residential community on campus"[1].

[1] http://www.wpi.edu/About/NewResHall/facts.html

In order to attract the aforementioned upper-class students and their qualities, the construction of a new residence hall has begun. The school wants the residence hall to be completed by the fall of 2008 in order that students can move in at that time. Therefore the Project is being performed under a fast-track schedule, meaning that construction began before the design phase of the project is completed. The successful implementation of a fast track schedule requires close collaboration between the designer and the builder. This collaboration can best be obtained by using the Construction Manager approach with a guaranteed maximum price (GMP) contract and the selection of competent and experienced firms. For this reason Gilbane was hired as the Construction Manager and Cannon Design was hired as the Architect. Gilbane is in a construction manager at risk contract with a guaranteed maximum price (GMP). In other words, if there are cost overruns it will either cut into Gilbane's profits or if costly enough, even result in a loss for the company. This type of contract works well for the project as it must be completed in a very tight time frame as the university wishes to use the housing the 2008 school year.

The goal of this project is to observe the construction management process and to apply modern project management concepts and techniques used in cost estimating and project control during the building of the new residence hall. The activities conducted in this project include:

a.) Redesign of the East Foundation Wall of the building to act as a retaining wall during construction.

b.) Creation of a 3-D model of the structure based on the 2-dimensional plans and drawings using Autodesk Revit, a 3-dimensional Building Information Modeling program.

c.) Generation of the material quantities for the structural concrete and steel for the building using the information stored in the Revit Model.

d.) Analysis of the construction progress of the exterior walls of the building using earned value analysis techniques.

e.) Preparation of cost estimates of the steel and concrete packages by doing a quantity takeoff using the drawings and Microsoft Excel as well as by using the 3-D Revit model.

f.) An analysis of the relationships of the different parties involved in the project and how they evolved throughout construction. This is known as a "Player Meeting Analysis" and can be used as a measure of how the relationships between important construction team members either hurt or helped the success of the project. The "Meeting Player Analysis" will describe the roles and attributes of the major players in the project, such as; the Project Manager for Gilbane, Neil Benner, Cannon Design's main liaison Ed Mello, WPI's construction consultant, Brent Arthaud, and WPI's head of plant services, Alfred DiMauro.

## 2.0 Background

Worcester Polytechnic Institute (WPI) has seen an annual growth rate for its student body over the past few years as its undergraduate and graduate programs continue to expand and gain global recognition. This is partly due to WPI's increasing success with its global projects program, which send students all around the world to work on either their Initial (IQP) or Major Qualifying Project (MQP), but more so because of a well thought out master plan for WPI that seeks to eventually connect the main WPI campus with its new satellite campus known as Gateway Park. Because of this there has been a need for more undergraduate housing particularly on campus. Traditionally most students move off campus after their first year into the surrounding apartments, sororities and fraternities. In order to foster the expansion of the university as well as provide much needed upper-classman housing, WPI has begun the construction of a new residence hall and parking garage between Boynton St. and Dean St. By bringing upperclassmen back on campus, Janet Richardson, the Vice President of Student Affairs and Campus Life believes that "the university benefits greatly from the leadership, mentorship, experience and talent of its students being part of the residential community on campus"[2].

To appeal to upperclassmen, the suites are designed as four person apartment style dorms with a full kitchen, living room, compartmentalized bathroom and either single or double bedrooms. The building also offers wireless internet access, air-conditioning, tech suites on each floor, recreation and fitness space and a separate parking garage able to accommodate

[2] http://www.wpi.edu/About/NewResHall/facts.html

the parking demand created by the building. It is these services and conveniences that are hoped to give students incentive to remain on campus throughout their time at WPI.

The architect on the project is Cannon Design whose offices are located in Boston, MA. The company was founded over sixty years ago and "is an international architectural, engineering and interior design firm recognized for design excellence and technological innovation."[3] Currently Cannon Design has offices in Boston, New York, Baltimore, Washington DC, Jacksonville, Albany, Buffalo, Toronto, Chicago, St. Louis, Vancouver, Victoria, San Francisco and Los Angeles. The dormitory (See Figure 1 below) has 232 beds and 103,610 square feet of floor space. Janet Richardson stated that "The building is designed specifically with the students' needs and expectations in mind, including their desire for privacy, independence, safety, and security"[1]. The design program was based a great deal on student feedback along with information provided by neighbors, faculty, and staff. Also incorporated into the design was to obtain LEED gold certification for the building. LEED, or Leadership in Energy and Environmental Design, certification involves incorporating alternative materials, recycling, reducing power consumption, along with many other criteria into the design and construction. This will make the dormitory environmentally friendly, or also known as a green building.

[3] www.canondesign.com

Figure 1: Computer generated image of new WPI dorm

Another one of the main goals for this project is “developing a vibrant lower campus that begins to link WPI's main campus with the downtown area and to Gateway Park, the 11-acre mixed-use life sciences-based campus the university is developing in partnership with the Worcester Business Development Corporation[4]”. This is accompanying the idea of creating an “attractive route for members of the WPI community and neighbors heading to the Worcester Art Museum, Tuckerman Hall, and the other venues in the downtown arts and culture district”. By bringing upperclassmen back onto campus and tying WPI into the surrounding culture, the university can become much more hospitable.

Adjacent to the dormitory is a 189-space parking garage to address the parking issues around campus. This structure will provide parking to the residents, staff, and members. Its location is adjacent to the dormitory as well as the church as can be seen in figure 1.

[4] (http://www.wpi.edu/News/Releases/20078/developers.html, 2006)

## 2.1 Fast Track Process

The new dormitory is being constructed under a fast track schedule. The reason for this is That WPI would like to have the building first occupied before the 2008-09 school. This has led to a tight schedule in which the dorm is to be completed. Starting with demolition of the existing buildings in April 2007 the building must be completed by early August 2008. The fast track construction process takes places when construction begins before design is completed. The design comes out in partial packages that are coordinated with the construction. As the design packages are finalized they are turned over to the contractor who then puts them out to bid. This process allows for a significant decrease in the time between the conceptualization and construction phases of the project, which directly translates into economic benefits in the form of lower financial costs & early occupancy rental costs. Even though overall development time is reduced, there is the always present the need for increased coordination and the risk of miscommunication, delays, and other human error. There is also less time to fix any mistakes or changes made in the design, as the construction is being done before the 100% completion of construction documents.

## 2.2 Construction Management

Project Management is "the art and science of coordinating people, equipment, materials, money and schedules to complete a specified project on time and within approved cost."[5] The major tasks of the management team include organizing different areas of work and working to identify and solve any problems that may arise including interaction of parties,

[5] Oberlander, Garold D. Project Management for Engineering and Construction.

conflict resolution, and scheduling issues. Gilbane, a Providence, R.I. based company, is the general contractor of the project and as such is in control of the project management.

## 2.3 Guaranteed Maximum Price (GMP) Contract

Gilbane is the construction manager at risk for this project and is bound by a Guaranteed Maximum Price contract (GMP). A GMP contract is defined as a form of compensation in a contract where the contractor is paid for actual costs incurred plus a fixed fee and the contractor is responsible for cost overruns above the agreed upon GMP amount. This gives the contractors incentive to keep costs down as they also benefit from the savings[6]. With a fast track design, there needs to be sufficient percentage of the design completed to provide a reasonably accurate cost estimation. The less complete the design is, the higher the contingency allowance is if a GMP is to be given at that point. This means that there is more room for the GMP to move up or down in cost depending on completion of design. As the design develops and more construction packages are bid then the uncertainty about the GMP decreases and the contingency allowance decreases as well.

The GMP for a fast track project is given early on in the project with a higher contingency allowance and is narrowed in on as the different trades for the job are bought out and contracted. This process often takes some time as the design for the building develops and the scope of the different aspects of construction can be determined by the subcontractors. The GMP for the new residence hall was not actually determined until late in the summer 2007,

[6] (Dagostino & Feigenbaum, 2003)

which was about 3-4 months after construction for the new residence hall began. The GMP for this residence hall is $33,479,592.

## 2.4 Cost Estimating

Construction cost estimating is “the determination of probable construction costs of any given project.[7]” Cost estimating is an integral part of the project management process because it provides a means for identifying and organizing materials in terms of quantity and cost value. Cost Estimates are performed on a project multiple times; from its preliminary conception all the way through to its completion. There are four of these types of estimates; the first of which would take place is called a feasibility estimate which is the least accurate. These estimates determine the projected cost of a project which then can be used usually by the architect to develop a cost vs. benefit analysis for the owner. These estimates are usually performed without an actual set of plans or drawings but rather with a general idea and sense of what an owner wants. Sometimes sketches of the facility are also used in the determination. The estimator must then use his expertise, judgement and experience in the construction field to produce the feasibility estimate for that project.

The next type of estimate that would take place is called a pre-construction cost estimate. Pre-construction estimate gives an owner an idea of the general price a project may cost. They are performed when more information about a project is available and they help the owner and architects define the scope of work for the project. They also work well as a basis for

[7] Oberlander, G. D. (1993).

cost comparison for the various designs or modifications a project may include and help the owner reach the best solution while staying within his budget.

A square foot estimate is an estimate which can be performed when the proposed size of the building is known. A typical square foot cost estimate is broken down into different components, a cost is assessed to these components and then a cost per square foot is determined. These estimates also take into consideration geographic area and cost of construction in these areas. The accuracy of these estimates can vary from -20% to +30% of actual costs.

The most precise type of estimate is a unit price detail estimate. This type of estimate requires a full working set of plans and specifications, known as the working drawings, and is typically the type of estimate performed in the bidding process of construction. "It includes determination of the quantities and costs of everything required to complete the project. This includes the materials, labor, equipment, insurance, bonds, and overhead, as well as an estimate of profit." (Dagostino, 2003) From this information unit prices are established for all the different materials and equipment that will be needed to construct the project. These estimates are usually organized by trade and are typically accurate within -5% to +10% of actual project costs. This is the type of estimate that was performed in this project.

All of these types of estimates were performed at various stages during the development of this project. Initially Cannon Design performed a feasibility estimate for the building to help WPI determine the characteristics that they wanted the new residence hall to have. Gilbane also performed a cost estimate during the schematic stage of the development as well as an independent cost consultant.

## 2.5 Project Scheduling

A major task in construction management is the scheduling of a project. "Project scheduling is the process of determining the sequential order of the planned activities, assigning realistic duration to each activity, and determining the start and finish dates for each activity." We created an as-built schedule for the construction of the exterior walls based on the observed progress using Primavera software. After this we observed the actual progress between and conducted an Earned Value Analysis (EVA) of the construction of the exterior walls. The EVA is a method that can be used to determine if the real progress in the construction of an activity in terms of its schedule and/or its cost or both. This essentially discerns if the activity being performed is ahead or behind schedule and whether the cost paid for the construction performed is either more or less than it should be based on the real amount of work performed. The exterior walls for this project were initially behind schedule as problems were encountered from the architectural precast manufacturer. The first few pieces of precast arrived late to the site and an acceptable version of the mock-up curtain wall was not initially agreed upon which also lead to delays. Right now they are catching up to their schedule and are almost on track.

## 2.6 Building Information Modeling

Computer programs that specialize on design have been around for a few decades. Starting with crude two dimensional Computer Aided Design (CAD) systems, programs slowly developed the ability to create crude three dimensional and further improved over the years into more functional programs with more capabilities. Today we no longer have "crude" programs. We have the luxury of Building Information Modeling. "A building information model (BIM) is an object-oriented building development tool that utilizes 5-D modeling concepts, information technology and software interoperability to design, construct and operate a building project, as well as communicate its details"[8]. Programs now have the ability to incorporate nearly every aspect of a project into a three dimensional drawing including cost, time, time of year, location, and link everything together.

Building Information Modeling is becoming an increasingly prominent aspect of design and construction. The ability to visualize a building in three dimensions gives all parties involved a better idea of the overall project. Not only of the outside of the building and its orientation on the site, but all the other aspects of the building including the foundation, structural steel, utilities, floors, walls, ceilings, and essentially every detail of the building. By using the plans to create the model, it is in fact a scaled replica of the actual building. This then allows for changes to be made without having to redraw plans, but by simply clicking a mouse and adjusting the properties or dimensions of an object. BIM Programs even allow the user to create 4D models by linking the entire project to a time schedule, showing the project being completed in a scale of the actual times assigned in the work breakdown structure for the project. Almost everything needed for the entire project can be incorporated into a Building Information Model, potentially making it the only document necessary for linking information from most all aspects of the construction process.

[8] www.BIMForum.org

Coordination between parties is always a challenge, especially when it pertains to changes or discrepancies within a project. "With BIM, architects and engineers, efficiently generate and exchange information, create digital representations of all stages of the building process, and simulate real-world performance – streamlining workflow, increasing productivity, and improving quality"[9]. Any problems can be seen by all parties in an actual representation of the building. If there is a problem with the model, then there would be a problem with the actual building unless it is changed.

BIM is becoming increasingly popular within construction as programs improve, adding features and becoming more user-friendly. There are many pro-BIM groups developing, spreading the word of BIM and its benefits. One example is Associated General Contractors (AGC) BIM Forum, www.BIMForum.org, chaired by John Tocci of Tocci Building Corporation, located in Woburn, MA. Their goal is to "facilitate and accelerate the adoption of building information modeling (BIM) in the AEC industry"[10]. Another example is the National BIM Standard project, which takes information from different phases of their projects and work orders, and calculates an amount that would have been saved, most likely by the owner[11]. Such groups supply information and praise BIM to everyone involved in design, construction, or any other aspect of a project.

Since BIM is becoming ever more useful, it is only a matter of time before more of the world accepts it as a major source of information on a project. Paper drawings and specs are not going to be phased out, but BIM is a extremely helpful in coordinating this information. A

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[9] Autodesk
[10] BIMForum
[11] NBIMS

company bidding on a job is able to display the building developing in real time with exact rendering of the owner's wants and needs, or a construction company that has to make a change can show the owner on a three dimensional model in order to get approval. These characteristics are what make Building Information Modeling popular and potentially the future of the construction industry.

## 2.7 Foundation and Retaining Wall Design

Foundation Engineering is the science of designing a structure that can adequately support the loads transferred to it from the structure above, as well as prevent any sideways movement from the earth's pressure including an overturning moment. The foundation itself is normally designed by a structural engineering firm, while the soil settlement, soil pressure, and other earth material characteristics of the soil below the foundation is evaluated by a geotechnical engineer. Typical foundations designs are spread footings, slab on grade foundations or deep foundations. Most foundations are made of concrete with reinforcing steel inside. Concrete is an extremely strong material when used in compression, while the steel inside helps protect the concrete from cracking when loaded in tension. The two work well together because they expand and contract at a very similar rate.

Retaining walls are structures that hold back rocks, soils, and other materials acting on one side of the wall. They are either made of timbers, rock, generally concrete, brick, masonry, and steel. Retaining walls are also typically designed by structural engineers. One of the main concerns when designing a retaining wall is the internal friction and cohesiveness of the material that is being retained, because depending on the material the pressures are extremely different ranging from saturated clays that can act like a fluid and exert extreme pressures, to dry soils that will exert normal earth pressure's, to dry clays that are very cohesive and will exert hardly any pressure on the walls.  There are a few different types of retaining walls such as a gravity wall, cantilevered wall, counterfort walls and mechanically stabilized walls.

## 3.0 The New WPI Residence Hall Project

In order to completely understand the new dormitory construction project, research was conducted on site as well as in the library. Construction meetings and owner meetings were attended weekly from August 25th, 2007 to February 28th 2008 in order to stay updated as to which tasks have been completed as well as any issues that may have risen. At these meetings weekly meeting minutes were handed out which outlined the relevant topics of discussion and coordination between the parties. Also other various project documents were handed out at these meetings which included product specification sheets, weekly project expenses, and sub-contractor bid comparison sheets. These documents and the discussions at the meetings gave us great insight into the way a building develops as well as the collaboration of different parties and how critical they are to a projects success and ability to stay on schedule. Our research extends across many aspects of the design and construction process in order to gain a more complete understanding of the project.

The main focus of this chapter is to better explain each of main parties involved with this project. The construction manager for the project, the designer, and the owner of the project. The chapter will also help explain how the three main parties interacted with one another during the duration of our project.

Our objective in completing this MQP is to gain important real-life knowledge of how construction takes place. Applying knowledge learned in the classroom and integrating it with a construction project that is taking place at the same time will give us a very hands-on and challenging experience. We hope to gain a more precise understanding of civil engineering practices and potentially some direction in terms of where our careers will take us after graduation.

## 3.1 Owner

The owner of the project is WPI. With 2,861 undergraduates annually enrolled the demand for housing has been an increasing concern. Currently, WPI has 33 major buildings on 80 acres in a residential neighborhood[12] in Worcester, New England's third-largest city. WPI, named the 22nd *"Most Connected Campus"* by *The Princeton Review* for 2006[8], has a goal to begin the process of connecting the main WPI campus with its new satellite campus known as Gateway Park which was completed in 2007. This effort is an attempt to further tie together the campus as well as begin expanding for the future. In the development of the residence hall building there are many individuals representing WPI in the project including Janet Richardson, Philip Clay, Brent Arthaud and Alfredo DiMauro and Jeff Solomon.

Janet Richardson is responsible for the delivery of services to more than 3,600 undergraduate and graduate students and for oversight of the offices of undergraduate admissions, enrollment management, financial aid, and student life, as well as the Career Development Center and the Department of Physical Education, Recreation, and Athletics. Her main role in the project is to help determine and incorporate the important issues that concern student life with the new residence hall.[13]

Philip Clay is the dean of students at WPI. He represents WPI and the needs of students when it came to the design of the new residence hall. Brent Arthaud was hired as a consultant for WPI to act as an owner's representative for WPI. He was hired because of his knowledge

[12] http://www.wpi.edu/About/facts.html
[13] http://www.wpi.edu/News/Transformations/2004Winter/richardson.html

and expertise of construction and his main concerns are making sure that the construction of the new residence hall is completed per plans and specifications within the budget allocated for the construction of this project.

Alfredo DiMauro is the assistant vice president of facilities at WPI. His main concerns for the building revolve around the future safe and efficient operation and maintenance of the new residence hall. Alfredo is responsible for making sure all the systems in the building will be working properly and are constantly maintained. The facilities department also deals with all repairs to the facility due to wear and tear and damages. Many of the issues brought up by Mr. DiMauro during the owner's meetings involved materials and their ability to withstand vandalism and general wear and tear. Ultimately he wants a building that is easy to maintain, very user friendly, very safe for the students, and will stay in good condition for a long time to come.

## 3.2 Architect

Cannon Design is the architect for this project. Established in 1945, Cannon's services include "planning, architecture, engineering, interior design and project delivery"[14]. It is a single firm-multi office practice, employing over 700 people and $102.4 million annual revenue[9]. Working on the project for Cannon are Ed Mello and Lynne Deninger. Lynne Deninger is the main architect for the project who acts as a representative for Cannon at owners meetings. She deals with the selection of many of the furnishings and materials needed in the construction and the design of the building. Ed Mello works with the contracts between

[14] http://cannondesign.com/start_frameset.htm

WPI and Cannon and helps expedite the process of design changes and coordination issues with the design. Coordination issues occur when the plans do not exactly meet up with the way the building is constructed and minor changes must be made in order to complete construction.

## 3.3 Construction Manager at Risk

The Construction Manager at risk for this project is Gilbane Building Company. They have 1800 employees nationally and in Puerto Rico and revenue of $3 billion annually. After four generations of owners, Gilbane is “still a privately held, family-run company”[15]. Since 1873 their clientele has expanded to the “life sciences, transportation, healthcare, convention/cultural, government, education, mission-critical, corporate, sports/recreation, and criminal justice markets”[10]. Managing the project for Gilbane is Neil Benner with Don Venerus acting as the project engineer. Neil Benner is the project manager for the new residence hall and is responsible for all the permits, coordinating sub-contractors, and buying out the job among many other things. Don Venerus deals with the engineering issues involved with construction. Assisting them is WPI graduate Melissa Hinton who works for Gilbane on the job site. She works directly with sub contractors on a day to day basis and is involved with the everyday construction tasks such as coordinating sub contractors, ordering materials, and clarifying issues pertaining to construction. Ralph Stukowski is the project superintendent who oversees the day to day operations and coordinates the on-site subcontractors.

[15] http://www.gilbanebuilding.com/inside/about.aspx

## 3.4 Owner, Architect, Contractor Relationship

The WPI dorm project is a fast track design with a guaranteed maximum price (GMP). Because of the fact pace and intense coordination for this style of project, there must be exceptional communication amongst all parties involved. The fast track schedule allows for barely any mistakes to be made in the construction project in order to meet the deadline. The construction manager at risk acts as a middle man, taking the owners demands or the demands imposed by the designer and portraying them to subcontractors in plans and directives. With poor communication, it is extremely difficult to get across what is needed and wanted by the owner. This can cause misunderstandings, which can lead to delays, ordering the wrong materials, or poor coordination. Coordination is necessary to have a smooth flowing project. There needs to be coordination of materials, labor and in the case of a fast track project, the design. Any mistakes that are made, starting at the owner, will most often lead to some type of negative consequence. In the case of construction, this is often depicted in an increase of cost.

The owner, architect, contractor relationship and collaboration for the new residence hall at WPI has been exceptional based on observations from the attendance of weekly meetings. Gilbane has worked for WPI before on the new admissions building that was constructed in 2006. In fact Neil Benner was the project manager for that project as well and his relationships with the entire WPI faculty concerned with the project are very good. He is also very knowledgeable of the city 's regulations and ordinances as well as of the local market conditions. Meetings have run very smoothly and there is little tension or disagreement over issues. There have been no major delays to the project as a result of bad relationships between the contractor, architect or owner, despite many disagreements on different concerns.

One main issue arose at the morning meeting on Wednesday, September 12th 2007. The issue was related to the metal studs for the interior wall, in particular about the way top-track connects the wall to the ceiling, mainly concerning its specs. Cannon had designed it to use a certain Hilti top track that was both a connection and a fire stop. Neil Benner (Gilbane) had found a product that met the all the requirements of the Hilti brand but was less expensive. Ed Mello (Canon) was very fervent in his belief that the substitute could not be used in place of the Hilti top track, and if it was used he tried to say it would note meet the intent expressed by Cannon's Design for the top track as a fire stop. Brent Arthaud (WPI) tried explaining to Ed that it would not be a problem, but Ed was not budging on his stance about the design, and eventually convinced them to go with the Hilti top track.

## 3.5 Project Progress To-date

According to Melissa Hinton, the dormitory is currently 50-55% completed. This figure has been calculated by a program which accounts for the square footage of walls, precast, and other calculable aspects of the project as well as percentage of non calculable portions of the project. These figures then provide an overall percentage completed. However, these figures are not exact, as there are many non quantifiable parts to the project.

## 4.0 Cost Estimating

A cost estimate for the structure of this building was performed by using the working drawings and specifications for the new residence hall as well as Microsoft Excel. The physical drawings for the residence hall were obtained through Melissa Hinton who is assisting the Project Manager Neil Benner. The drawings used to complete the estimate include the foundation plan, the first-floor through fifth-floor framing plans, vertical steel plan and the roof plan. The specifications for this building were also needed to fill in the gaps that the plans left out such as material types and specifications.

Once the materials were quantified from the plans the cost estimate for this building was performed using R.S Mean's method of Building Construction Cost Data[16]. A City Cost Index value was then applied to the prices in order to get a more accurate value for the construction costs in Worcester, MA. Unfortunately Worcester was not listed so the closest city to Worcester listed was Springfield, MA so the value of 1.08 was used.

### 4.1 Definition of Quantities

The quantity used to measure the concrete needed for construction is the Cubic Yard (CY). Often times Cubic Feet (CF) are also used and then converted to Cubic Yards. A volume measurement of 1 cubic yard is equivalent to 27 cubic feet of material.

The measurement used to quantify the steel in the project is the ton. Steel is quantified by its weight and then an associated cost is attached to the weight of the material. One ton is the equivalent to 2000 lbs of material.

[16] RS Means Building Construction Cost Data 2006

## 4.2 Concrete and Steel Quantity Takeoff

The first step for performing a cost estimate involves quantifying the materials needed for construction. Starting with concrete the different elements that comprise the foundation for the new residence hall include spread footings, piers, continuous footings, grade beams, and slab. The spread footings are taken off individually by their volume which is a combination of their length multiplied by width and height. These foundations are located in the ground underneath the building in the various places which are needed to withstand the vertical loads of the building. These are below grade and each of these spread footings is connected to the building structure by a vertical pier that attaches from the spread footing to either the slab or continuous footing of the building. These piers are also taken off by their volume and vary based on the depth of the spread footing.

The continuous footing runs under the perimeter of the building and are sometimes visualized as the foundation wall. In the case of the new residence hall there is no underground basement so the continuous footing runs under the structural foundation wall. The continuous footings are taken off by volume and the main aspect that changes for the continuous footing is its height. In areas where the loads on the building are greatest the continuous footing will go deeper into the ground in order to support the loads. Grade beams are a special kind of continuous footing that connects different spread footings together for improved strength by running a continuous footing between the piers of two or more spread footings. There are only a few grade beams in the new residence hall and they are also taken off by volume.

The structural concrete slab, which is found on every floor starting from the first floor up to the roof top, supports the various loads on each floor and transfers these loads to the structural steel. The slab provides a solid surface to walk on and is taken off by volume. The square footage of each floor is calculated and then multiplied by a uniform depth. In the case of the new residence hall the square footage was calculated by breaking the whole floor plan into separate sections which is a common practice in estimating the square footage of floor slab. Using this method the square footage and concrete calculations for each floor slab were made.

The spreadsheets for the quantification of all the structural concrete activities can be seen in Appendix C. A short table of the concrete volumes for each activity shows that the Concrete Slab for all of the floors and the roof is 1827.84 cubic yards. Each floor slab averages 290 cubic yards. The grade beams that are found under the first floor slab are equal to 20.42 cubic yards. The spread footings which take much of the structural compressive load of the building are equal to 700.39 cubic yards of concrete. The continuous footing and foundation wall is 213.25 CY. The entire volume of the structural concrete found in the building is 2815.79 cubic yards.

Table 1: Concrete Quantity Total

**Concrete Total**

| Activity | Volume (CY) |
|---|---|
| Concrete Slab | 1827.84 |
| Grade Beams | 20.42 |
| Piers | 53.89 |
| Continuous Footings + Walls | 213.25 |
| Spread Footings | 700.39 |
| Subtotal | 2815.79 |

Quantifying the steel in the structure is done by separating the different types of steel beams used in the structure individually. Horizontal beams run across the floors of the building providing a surface for metal decking to lay on which then holds the slab. Columns run vertically from the foundation up to the different floors connecting the frame of the building along with the bracing which reinforces the structure.

The steel beams are broken down by floor and by the columns that connect these floors. Once all of the different types of steel beams were identified they were quantified by taking their linear feet measurements from the working drawings. Once this is done the information for the steel is used to calculate the tonnage of the steel based on the cross-section of the beam and its linear foot measurement. Every specific type of steel beam has a different weight/length measurement. These measurements are given in lbs/feet and then multiplied by linear feet of steel in order to obtain a value for weight.

The spreadsheets for the quantification of structural steel for the building can be found in Appendix E. The second floor framing which is comprised of horizontal steel members weighed 61.21 tons. The third floor through fifth floor had identical steel framing plans and their weight was 60.29 tons each. The roof framing weighed more than the other floors because of the live loads imposed on the roof by the green roof system. The roof framing weighed 72.74 tons. Bracing which connects different floors together to increase the rigidity of the frame weighed 28.4 tons. The columns for the building were 140.81 tons. The total tonnage for the steel frame of the building came out to be 484.03 tons.

Table 2: Steel Quantity Tonnage per Floor

| Steel Tonnage per Floor | |
|---|---|
| Activity | Steel Quantity (Tons) |
| 2nd Floor Framing | 61.21 |
| 3rd Floor Framing | 60.29 |
| 4th Floor Framing | 60.29 |
| 5th Floor Framing | 60.29 |
| Roof Framing | 72.74 |
| Bracing | 28.4 |
| Columns | 140.81 |
| Total Tonnage | 484.03 |

### 4.2.1 Concrete Pricing

Once the structural concrete and steel were quantified the next step in the process of performing the cost estimate is pricing the different activities associated with the construction. RS Means has a few different ways of pricing activities. One way to do this is by breaking down activities into specific tasks that can be priced individually. An example of this would breaking the floor slab activity into the material cost of concrete, the cost of formwork, the cost of placing concrete,  the cost of reinforcing, the cost of curing and the cost of finishing. This method is very specific and in depth thus producing the most accurate estimates for the true price of construction. Another way to price an activity would be to apply a “system” price to the activity. This “system” price explicitly describes what is included in it. An example of this would be a slab system that includes the price of concrete, placement, formwork, and reinforcing all together. The price for this system is the applied to the volume of concrete (CY) of the slab. System pricing is more inaccurate but often times much simpler and leaves less chance of error by the estimator in forgetting to include something in the estimate.

For the concrete pricing combinations of both methods were used. The slab was first broken down by floor and cubic volume. The cubic volume of concrete was the multiplied the cost per CY to obtain the cost of materials. The cost of placing the concrete was then determined by multiplying a cost per CY for each floor. Additions were made for pumping the concrete to higher floors as the placement of concrete is more expensive the higher above the ground it needs to be placed. The cost of formwork was then determined by figuring out the linear feet of formwork needed to place the slab. Given that the floor slabs are almost identical the formwork could be reused for every floor which led to a lower cost per linear feet of formwork. The slabs for the residence hall include fibrous reinforcing which weighs 33 pounds/CY. The unit price for this reinforcing was then determined and multiplied by the volume of cubic yards. The cost of finishing the slabs and curing the slabs were determined based on the square footage of slab multiplied by unit costs for each activity. The average price for each floor was about $56,000. The price for all of the slab activities for the building was $279,975.

The grade beams for the building were priced in the same way that the slab was. The cubic volume of the grade beams were multiplied by different unit price factors to determine the price of concrete, placement and formwork. The cost of reinforcing was done using the cross-section of GB01 from the drawings to determine first the tonnage of reinforcing and then the price. The grade breams for the structure cost \$5,381.

The piers which connect the spread footings to the slab were taken off using the system method. A system cost was found for both the 24” x 24” P24 footings as well as the 30” x 30” P30 footings. The system included forms, concrete, placement as well as reinforcing and the total cost for the concrete piers in the building is \$39,814.52.

The spread footings for the building and foundation walls were also priced using the system method. All of the spread footings for the building are greater than 1CY so they all fit into one unit price category for spread footings which includes formwork, concrete, placement and reinforcing. There are 700.39 CY of spread footings in the building and their cost was determined to be \$202,594.81.

The continuous footings for the building were taken off individually. Their volume of concrete was multiplied by a unit price to determine the cost of concrete. Their placement cost was also figured out using the volume as all of the footings are below grade. The formwork for these footings was determined by figuring out the contact area of the footings and multiplying that by the linear feet of footing. The reinforcing for the continuous footings was determined by multiplying a weight/foot factor to the linear feet and then multiplying that weight by the associated unit cost for steel reinforcing. The total cost for the continuous footings was \$60,306.

The pricing spreadsheets for the structural concrete can be found in Appendix D. Once the price for all of the concrete was determined this price was then multiplied by the City Cost Index rate for Springfield, MA which is 1.08. A brief table of the prices of concrete shows that the total price determined for all of the structural concrete is $635,118.

Table 3: Concrete Total Cost

| **Concrete Total** | | |
|---|---|---|
| Activity | Volume (CY) | Cost |
| Concrete Slab | 1827.84 | $279,975.05 |
| Grade Beams | 20.42 | $5,381.87 |
| Piers | 53.89 | $39,814.52 |
| Continuous Footings | 213.25 | $60,305.99 |
| Spread Footings | 700.39 | $202,594.81 |
| Subtotal | 2815.79 | $588,072.24 |
| Cost Index: Springfield MA | | |
| x1.08 | | $635,118.02 |
| Total | | $635,118.02 |

## 4.2.2 Steel Pricing

The pricing for steel was done using a unit price per ton of steel and applying that to each activity of steel. The unit price for steel for the building was determined by averaging the minimum and maximum values for a school construction project which were $2,222/ton and $3,338/ton which gave a value of $2780/ton. The spreadsheets for steel pricing can be found in

Appendix F. The cost of the structural steel was then multiplied by the city cost index which was 1.08. The total cost of the structural steel for the building was $1,269,474.77. Each floor had an average steel cost of about $168,500 and the columns and bracing cost about $280,000.

**Table 4: Steel Tonnage Cost per Floor**

Steel Tonnage per Floor

| Activity | Steel Quantity (Tons) | Cost |
|---|---|---|
| 2nd Floor Framing | 61.21 | $170,163.80 |
| 3rd Floor Framing | 60.29 | $167,606.20 |
| 4th Floor Framing | 60.29 | $167,606.20 |
| 5th Floor Framing | 60.29 | $167,606.20 |
| Roof Framing | 72.74 | $202,217.20 |
| Bracing | 28.4 | $78,952.00 |
| Columns | 140.81 | $391,451.80 |
| Total Tonnage Cost | 484.03 | $1,175,439.60 |
| x City Cost Index Springfield MA: 1.08 | | $1,269,474.77 |

## 5.0 Scheduling and Control

"Project Scheduling is the process of identifying all the activities necessary to successfully complete the project. Project Scheduling is the process of determining the sequential order of the planned activities, assigning realistic durations to each activity, and determining the start and finish dates for each activity."[17] In order to successfully schedule a project, it must first be completely planned out. The omission of any activity would be detrimental to any schedule developed including the omission. It is the goal of construction project management to thoroughly plan and schedule a project. This information is then used to coordinate all activities performed by all parties on the construction project in an effort to improve efficiency, decrease delays, and increase profits.

### 5.1 Project Scheduling

A schedule was created using Primavera software as well as acquiring information from the schedule reports acquired from Gilbane, such as the one shown in Appendix B: Gilbane Construction Schedule. Primavera is a computer program that allows for inputs of scheduled starts, durations, and finishes as well as the development of a schedule based on the critical path method (CPM). Further, it allows the users to input labor units and cost in order to track cost over the duration of the project. A simplified version of the construction schedule, shown in Appendix T: Simplified Gilbane Construction Schedule, was created in order to gain a better understanding of the scheduling involved in a construction project. Examination of the project schedules developed by Gilbane allowed for the creation of a schedule containing roughly 90

[17] Oberlander, Garold D. Project Management for Engineering and Construction.

activities opposed to the hundreds present in a fully detailed schedule. Using this simplified version it was determined that the critical path of the project was through the following activities: Site work & Foundations→Steel Erection→Floor Construction. This is not the path for the entire project as the simplified schedule, shown in Appendix T: Simplified Gilbane Construction Schedule , does not include all activities in the project.

## 5.2 Exterior Walls

Although a simplified scheduled was used for most project activities, a fully detailed schedule of the exterior walls was created using Microsoft Project. Project was chosen because of its simplified input format that more closely matched the less complex values calculated for the Exterior Wall Section. This allowed for the input of estimated costs per activity as opposed to a more complex resource breakdown by labor crew, material, and equipment. However, all of these factors were taken into account as shown in **Error! Reference source not found.**.

The main purpose of this schedule was to allow for an Earned Value analysis of the work package. The schedule was broken down by section of the building. The sections were Architectural Pre-cast, Exterior Sheathing, North Pod, and South Pod. Each section was then further broken down according to location such as East, West, North and/or South Elevations. Activities for the North and South Pod include Veneer Ties, Spray foam and membrane, Staging erection, Brick Veneer, Washdown and Staging Removal, Punch Windows, Curtain Wall, and Curtain Wall trim and seal. The activities are assigned to each façade they will be performed on by location such as East or West.

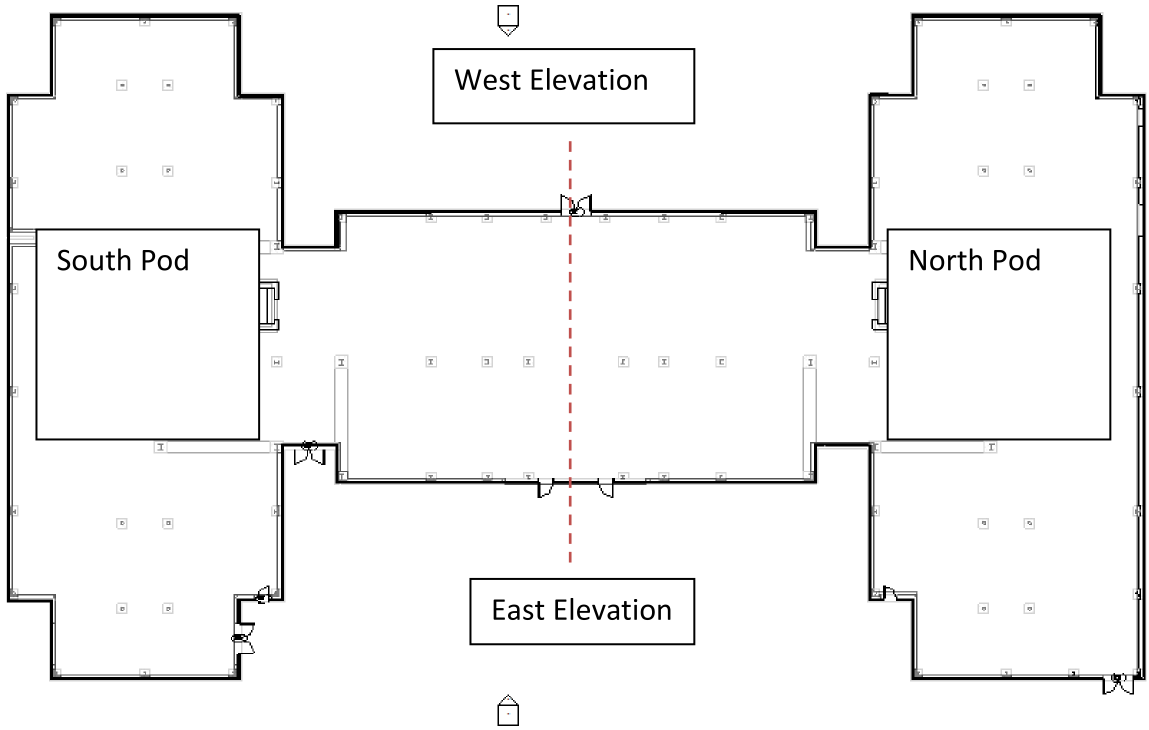


Figure 2: Plan View

## 5.3 Earned Value Analysis

An earned value analysis was performed on the construction of the exterior walls during the project. Photographs were taken at two separate times, once on December 12th, 2007 and again on January 30th, of 2008, that captured the process of the exterior wall construction.


Figure 3: Photograph Taken on December 12th, 2007

Using these pictures, estimates were made as to the percent completion of the work performed for each particular activity as categorized in **Error! Reference source not found.**.

### 5.3.1 Methodology

The initial step of the analysis was to determine the total amount of work planned to be completed on the building, known as Budgeted-Work Hours. In order to do so, the Total Labor Hours were calculated. The Total Labor Hours is simply the amount of time it takes a trade to complete one unit multiplied by the total number of units per activity. An example calculation of the Total Labor Hours for the East Elevation/North Pod: Brick Veneer activity is provided for clarity.

Table 5: Sample Total Labor Hour and Cost Calculations

| Activity | Unit | Labor | Material | Labor | Cost/Unit | # of | Total | Total Cost |
|---|---|---|---|---|---|---|---|---|

| | | Hours | | | | Unit | Labor Hours | |
|---|---|---|---|---|---|---|---|---|
| East Elevation/North Pod: Brick Veneer | M | 26.667 | 470.000 | 880.000 | 1350.000 | 34.425 | 918.011 | $46,473.75 |

In this example, the unit M is for every 1000 bricks. There are two types of bonding patterns used for the veneer of the building. A running bond constitutes most of the veneer while a double soldier course is used to separate the floors of the building, as depicted in Figure 4: Running Bond and Solider Course. Conveniently, both bond patterns use 6.75 bricks per square foot of wall place. The total area for the East Elevation/North Pod Brick was 5100 S.F.

.

**Figure 4: Running Bond and Solider Course**

The following equation was used to calculate the total number of bricks placed during the East Elevation/North Pod: Brick Veneer activity: $(6.75 \frac{Bricks}{S.F.} * 5100\ S.F.)/1000 = 34.425$ M.

Next, the Total Labor Hours was calculated as the product of Labor Hours and the total quantity of the unit. Continuing with the previous example, the calculation would be performed as follows: $26.667 \frac{Labor\ \ Hrs}{M} * 34.24\ M = 918.011\ Labor\ Hrs.$ The total numbers of Labor Hours for all activities were calculated in a similar manner and may be viewed, in addition to all other calculations performed in this section, in **Error! Reference source not found.**. The same quantity unit was used to determine to determine the total cost of the activity as shown in this calculation taken from the same example: $34.24\ M * \frac{\$1350.00}{M} = \$46{,}473.75$. Again, the total costs for all activities were calculated in a similar manner.

The calculations of the Actual Labor hours and Scheduled Labor hours were simply a matter of multiplying the estimated actual percentage of work complete and the scheduled percent completion by the Total Labor hours, respectively. A sample of the spreadsheet used for these calculations is shown in Table 6: Sample Spreadsheet for Actual and Scheduled Labor Hours Complete. The Actual Cost of Work Performed (ACWP) and Budgeted Cost of Work Performed (BCWP) were calculated in a similar manner as depicted in Table 7: Sample Spreadsheet for ACWP and BCWP. Similar calculations were made for all exterior wall activities.

**Table 6: Sample Spreadsheet for Actual and Scheduled Labor Hours Complete**

| | Actual Percent Completed | | Scheduled Complete | | | Actual Labor Hours | | Scheduled Labor Hours | |
|---|---|---|---|---|---|---|---|---|---|
| **Activity** | **Dec. 12** | **Jan. 30th** | **Dec. 12** | **Jan. 30th** | **Total Labor Hours** | **Dec. 12** | **January 30th** | **Dec. 12** | **Jan. 30th** |
| East Elevation/North Pod: Brick Veneer | 50.00% | 100.00% | 100.00% | 100.00% | 918.011 | 459.01 | 688.51 | 918.01 | 918.01 |

**Table 7: Sample Spreadsheet for ACWP and BCWP**

| | Actual Percent Completed | | Scheduled Complete | | | ACWP | | BCWP | |
|---|---|---|---|---|---|---|---|---|---|
| **Activity** | **Dec. 12** | **Jan. 30th** | **Dec. 12** | **Jan. 30th** | **Total Cost** | **Dec. 12** | **Jan. 30th** | **Dec. 12** | **Jan. 30th** |
| East Elevation/North Pod: Brick Veneer | 50% | 100.% | 100% | 100% | \$46,473.75 | \$23,236.88 | \$46,473.75 | \$46,473.75 | \$46,473.75 |

## 5.3.2 Results

The earned-value system was used to monitor the progress of work and compare accomplished work with planned work.[18] This was accomplished using a Microsoft Project

[18] Oberlander, Garold D. Project Management for Engineering and Construction.

feature that allows for the exportation of time-scaled data into Microsoft Excel for graphical analysis. This project lacked access to the Actual Costs of Work Performed (ACWP) therefore ACWP was set equal to BCWP in an attempt to illustrate the methods used in an earned value analysis. However, all scheduling information is believed to be accurate.

The first graph created was Figure 5: Integrated Cost/Schedule/Work Graph which is more commonly referred to as a “Lazy-S Curve” because of its consistent resemblance as can be seen.

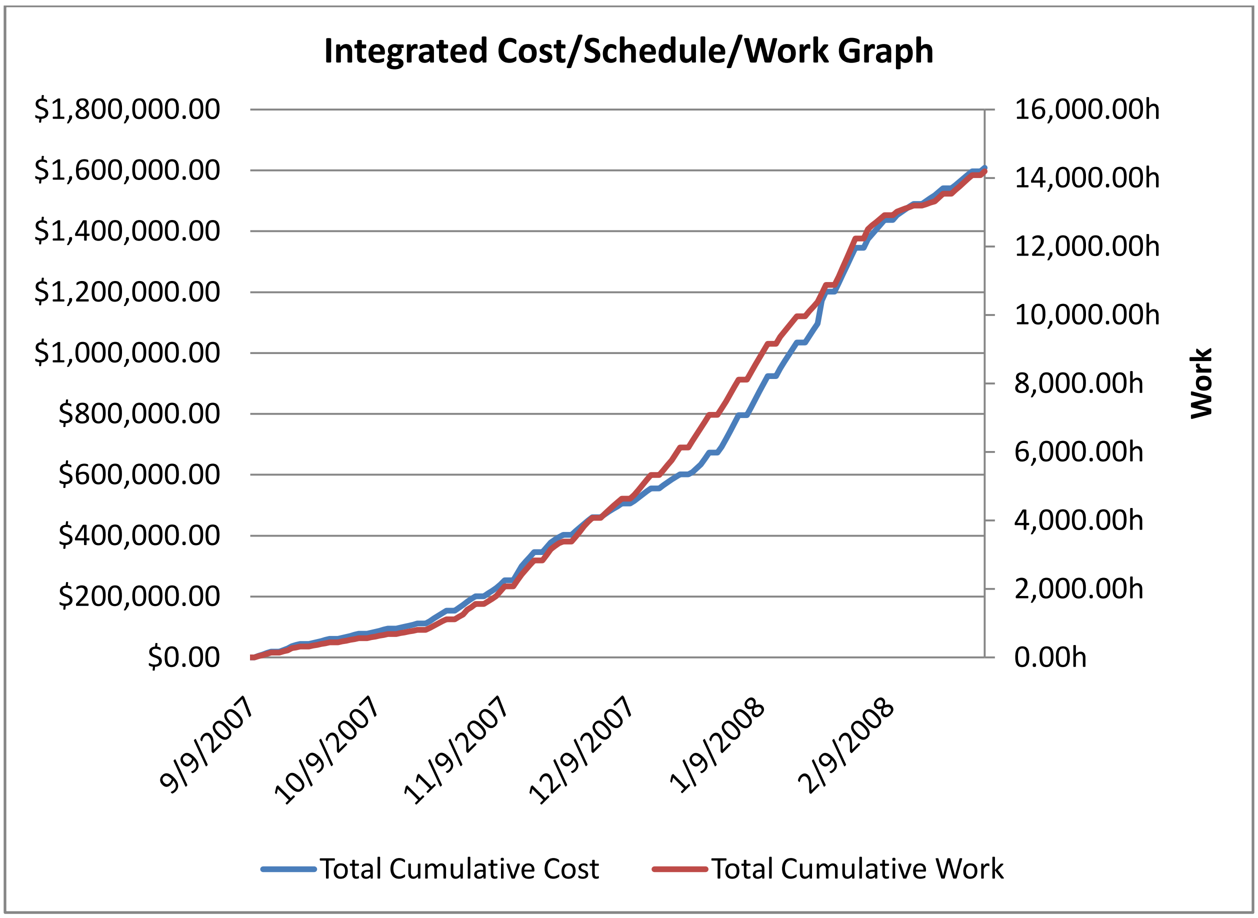


Figure 5: Integrated Cost/Schedule/Work Graph

This graph is created simply using the cumulative cost and work scheduled over the course of a project vs. time. As is shown, the projected amount of work for the exterior walls is 14019.207

Total Labor hours accumulating a Total Cost of $1,608,858.61. The input of the ACWP and the Actual Work Completed on any date along the X-axis results in the determination of the current status of the project with respect to the baseline schedule. This is known as the Percent Complete Matrix Method. Using this method, it was determined that as of December 12th, 2008 the exterior wall activities were 1387.94 labor-hours behind schedule and $143,712.69 under budget. As of January 30th, 2008 the activities were 1804.79 labor-hours behind schedule and $46,487.29 under budget. The ACWP is considered equal to the BCWP in this analysis and because the actual work was behind the crews were not being overpaid. However, further analysis must be performed to interpret the true trends of the project.

The Cost Variance (CV) and Schedule Variance (SV) were calculated using the following equations: $CV = BCWP - ACWP \quad SV = BCWP - BCWS$. The Cost Variances for both dates were equal to zero due to the equality of BCWP and ACWP. The Schedule Variances for the two dates were, -143,712.69 and -46487.29, respectively. This reduction in variance indicates that the activities have gained time on the schedule between December 12th, 2007 and January 30th, 2008.

In addition to the variances, the Cost Performance Index (CPI) and the Schedule Performance Index (SPI) were then used to track the trends of the current project using the BCWP, ACWP, and Budgeted Cost of Work Schedule (BCWS). The equations for these indices are show here: $CPI = \frac{BCWP}{ACWP} \qquad SPI = \frac{BCWP}{BCWS}$. Both Indices give a value greater than one for favorable performance, i.e. under budget and ahead of schedule.

The CPI was equal to one because BCWP is equal to ACWP for the project without actual costs. The SPI, however, was equal to .75 on this date showing the project was behind schedule.  This is displayed in **Error! Reference source not found.**.  Similar calculations produced a CPI equal to one and an SPI of .85 for January 30th, 2008 and are illustrated in Figure 7: Cost and Schedule Variance Graph for Jan. 30th.  The increase of the SPI by .10 confirms the fact that the progress of the activities has gained time on the schedule.  This is further illustrated in Figure 8: Cost Performance Index (CPI) vs. Schedule Performance Index (SPI) as the movement toward 1.0 is shown graphically.

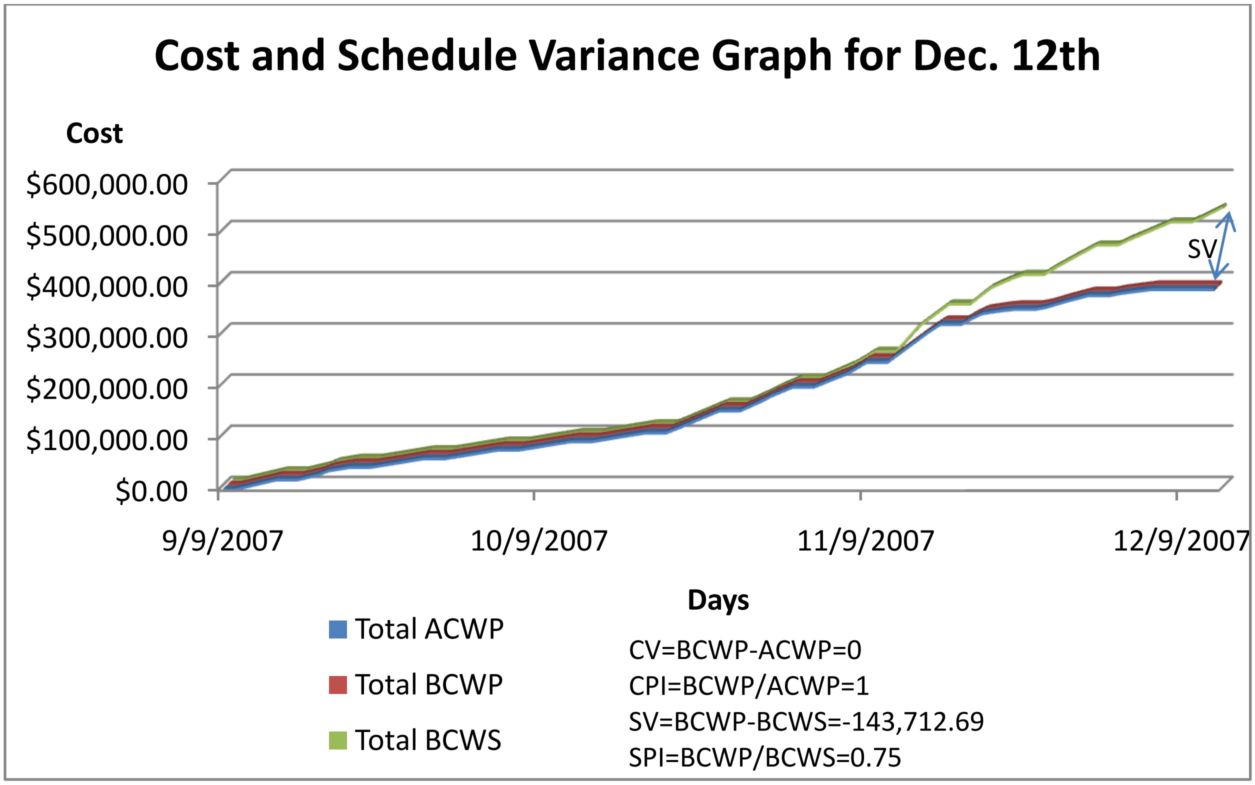


**Figure 6: Cost and Schedule Variance Graph for Dec. 12th**

The Percent Complete of the exterior wall activities were calculated for both dates and determined to be 33% and 89%, respectively.  Percent complete is equal to the Budgeted Units minus the Units to Complete divided by Budgeted Units.  The values were calculated using Microsoft Project as shown in Appendix M: Microsoft Project Screenshot December 12th, 2008 and Appendix N: Microsoft Project Screenshot January 30th, 2008

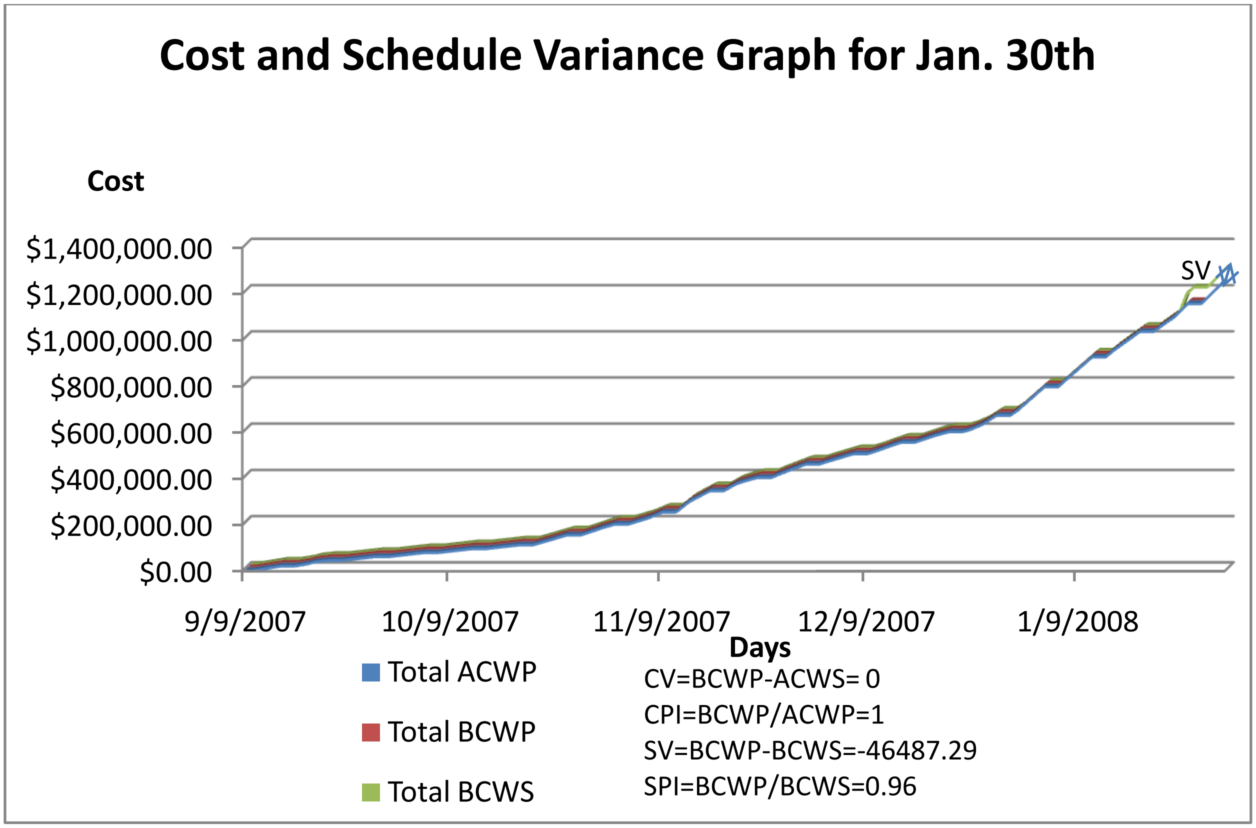


Figure 7: Cost and Schedule Variance Graph for Jan. 30th

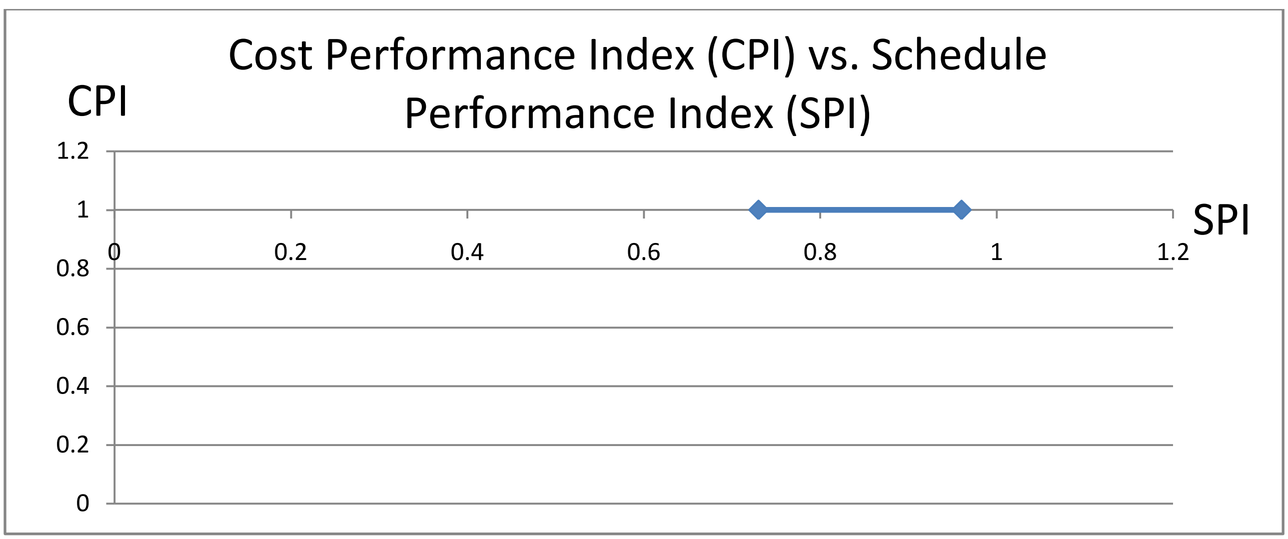


Figure 8: Cost Performance Index (CPI) vs. Schedule Performance Index (SPI)

## 6.0 Building Information Model – Revit

The program which we are using to create our Building Information Model is Revit Building 9.1 by Autodesk. Published in 2006, the program has since been replaced by Revit Architecture 2008, but it is still applicable to most any current construction project. It has many useful features of design, a vast library of materials, styles, furniture, and various other components. Revit also has the capability to import other design program files, such as AutoCAD. This can be useful to convert a 2 dimensional layout and turn it into a multi story structure. It can also export data from the drawing, eliminating the need to quantify by hand as well as DWG format into AutoCAD. Autodesk is a prominent name in CAD and BIM, with Revit being its major architectural BIM-based design program.

## 6.1 Model Design

Going by the drawings and specifications, our model was developed over the past three terms. With little background in Building Information Modeling, our group was somewhat nervous approaching the Revit design of the dormitory. At first, it was a bit frustrating, learning the program and its properties, not knowing commands or how to approach the design. However, with time, we became fairly proficient with Revit. Much like an education, we started at the foundation, doing what we thought was right, and learning from our mistakes along the way. However, as the building went up, so did our understanding of the program. By the time we had the structure done, we were able to make the building much more accurate and realistic.

### 6.1.1 Getting Started

Opening Revit, it seems as if you have far too many options (See Figure 9: Revit Menu**Error! Reference source not found.**). The left side of the screen has 10 main tabs, each with numerous options within them. Right next to the tab there are expandable views from different viewpoints as well as legends, sheets, families, and other options. At the top of the screen are countless options, ranging from an eyeball (dynamically modify view), to a hammer (demolish). These are very confusing at first, but each option has some benefit which gets discovered later and what once seemed like too many options becomes much more comfortable to navigate.

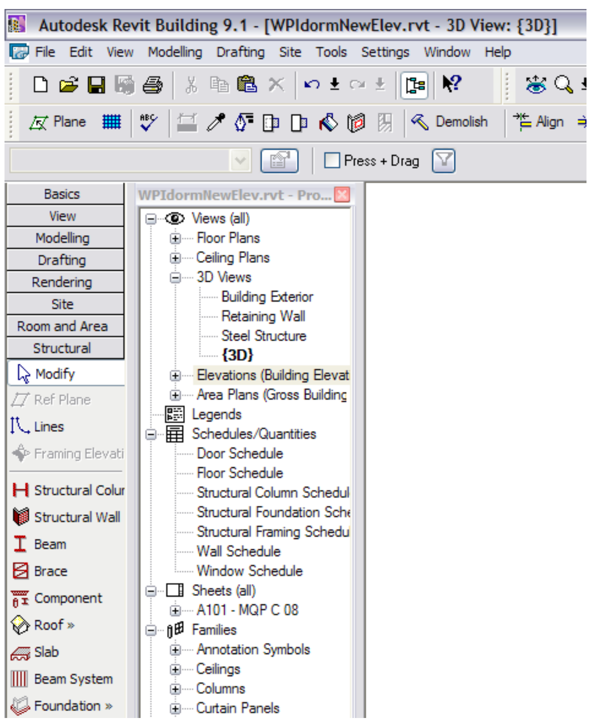


Figure 9: Revit Menu

Once we got our bearings straight, our model began by creating the levels of the building. These levels start with the foundation and go all the way up to the top of the screen wall. Levels are represented by dashed lines in the Building Elevation views (See Figure 10: Revit Elevations). The views that these levels are visible in are the North, South, East, and West and appear as if looking directly at the associated side of the building. Our model was oriented the same way as in the plans. The levels which we created were based on the first floor elevation being 0'. The actual elevation of the first floor in the project starts at 502.60' works up or down from this. We thought it would simplify the calculations by using a base of 0', when in reality it may have made it more difficult.

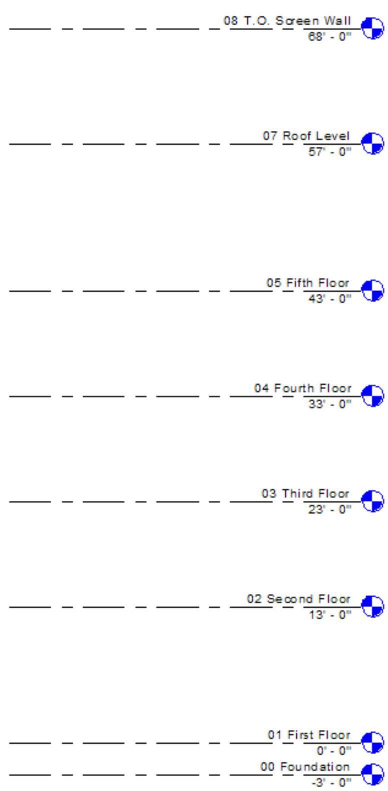


Figure 10: Revit Elevations

Next, we created a grid, exactly like the plans for the building. This grid is spaced at positions where the framing steel follows, making it easier to follow. The grid is again represented by dotted lines, but used in the Floor Plan views (See Figure 11: Floor Plan Grid).

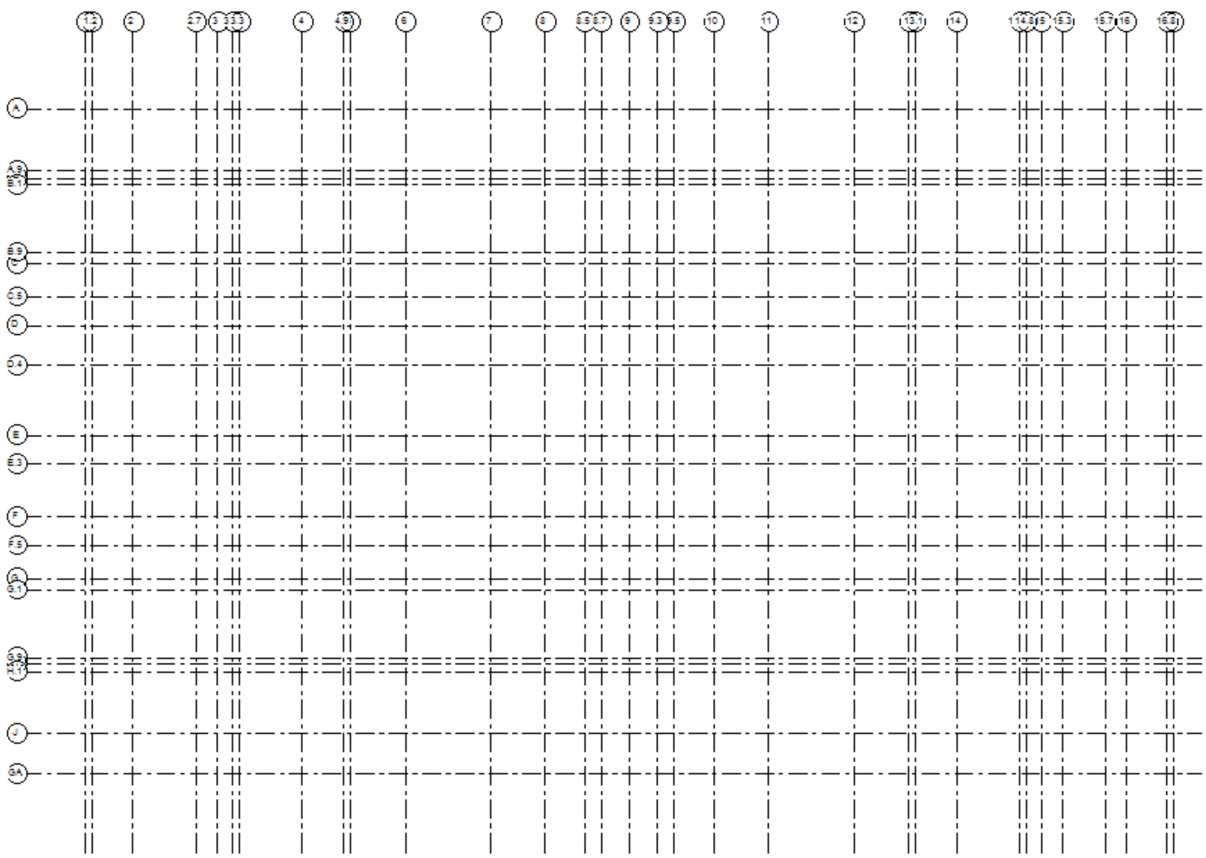

**Figure 11: Floor Plan Grid**

This grid can be appear to be a bit overwhelming at first, but in fact is extremely useful. Most of the dimensions are taken from these gridlines, so it would be even more confusing not having them. When they get in the way, Revit has a useful feature that lets you hide selected objects, or an entire category of objects. Once the grid was created, we could start creating the footprint of the building.

### 6.1.2 Foundation

At first, the foundation was somewhat complicated because this was the true starting point of the actual building, and again, we have had little experience with Revit at this point and limited exposure to foundation design. However Revit does make most general operations relatively simple to its user. You are able to select footings from the structural tab by selecting the components option and selecting a footing. A drop down menu becomes active, and you are able to select footings of certain dimensions. When a footing, for example, a type F8 8'0" x 8'0" x 1'10" spread footing, is not available, you can load it from the library, or create it by duplicating, renaming, and adjusting properties of other spread footings. Early on during the design of the model, we relied mostly on creating our own because we were not sure how to utilize the library. Once you have the footing loaded, you can select a level and offset from that level to place it. This is how we placed our spread footings at their appropriate levels (See Figure 12: Foundation).

With the footings in place, the foundation walls and piers can be drawn and set at the appropriate base depth. While the top of the foundation is constant, the depth varies from 3' up to over 10' on the South East corner (Figure 12: Foundation), which is the focus of our structural analysis. We are focusing on this wall because of the fact that it had to be redesigned due to overturning moment.

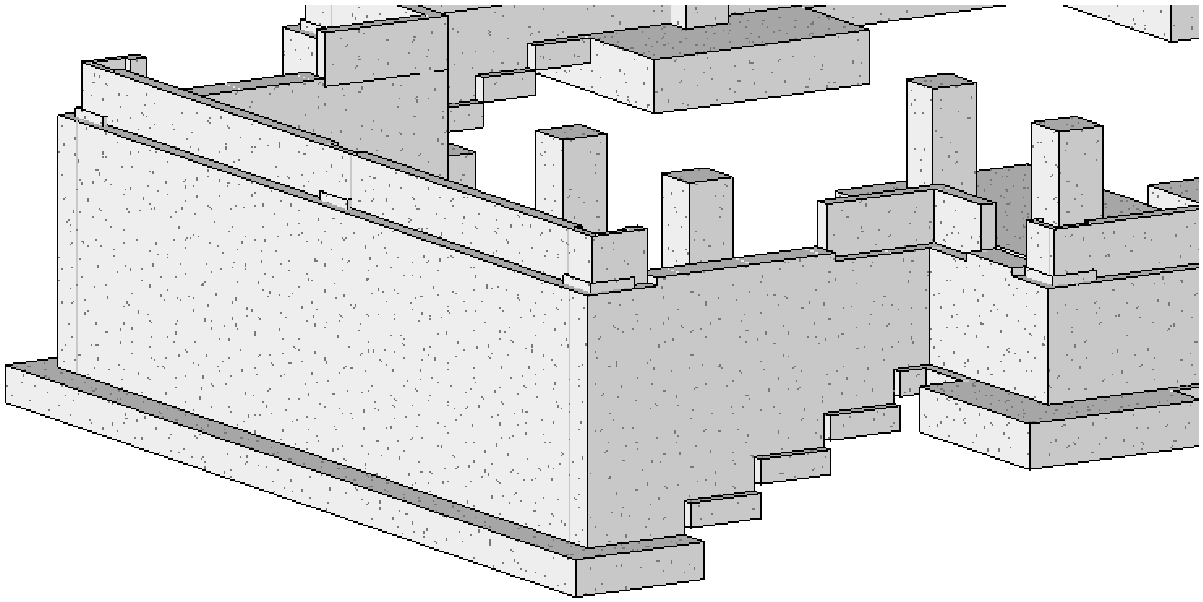

Figure 12: Foundation

### 6.1.3 Steel Frame

Once the foundation was completed, we were able to start building our model up. Starting with the vertical steel, the columns were set in place by simply selecting structural column and a beam size, then centering them on the piers. The columns were given a base and top constraint, reaching up to various heights, but mainly to the roof level. With the vertical steel columns in place, we were able to utilize the levels that we had created. Because the steel is not on the same level as the floor, a separate layer for the steel was created by offsetting the second floor level downwards. On the new level we followed the structural plans for the second floor steel. To draw a beam, you click the structural the tab on the left, and then select beam. Again, you can select different beams from the drop down menu, or load new ones. Once you have the beam you are putting in place, it is as simple as drawing a line. One issue we encountered in drawing the structural framing is that no connections are displayed between beams (See Figure 13: Steel Connections). We searched meticulously for what the problem was, learning later that it was merely a characteristic of the program. The program is Revit Building 9.1, but it is architectural. In order to create and view connections, you must use Revit Structural. With our software, the connections are made even though they cannot be visualized.

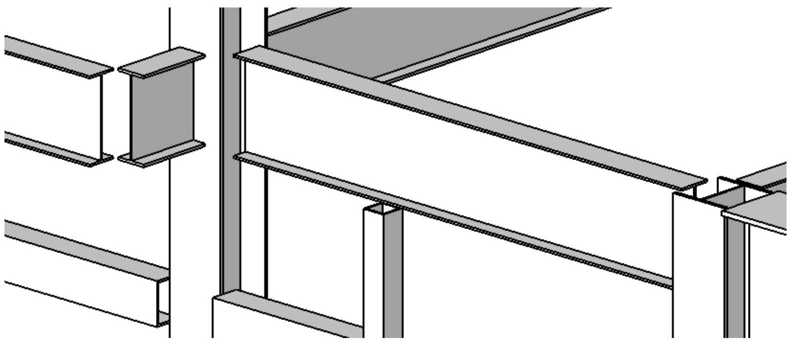

Figure 13: Steel Connections

After creating the structural frame, the model progressed quickly. For the most part, each level was very similar, with the steel framing for the roof being the only one with different size beams. This allowed us to copy and paste the framing from one level aligned to multiple levels at once. The result is a complete steel skeleton of the building (See Figure 14: Steel Frame), which allows us to begin wrapping the building.

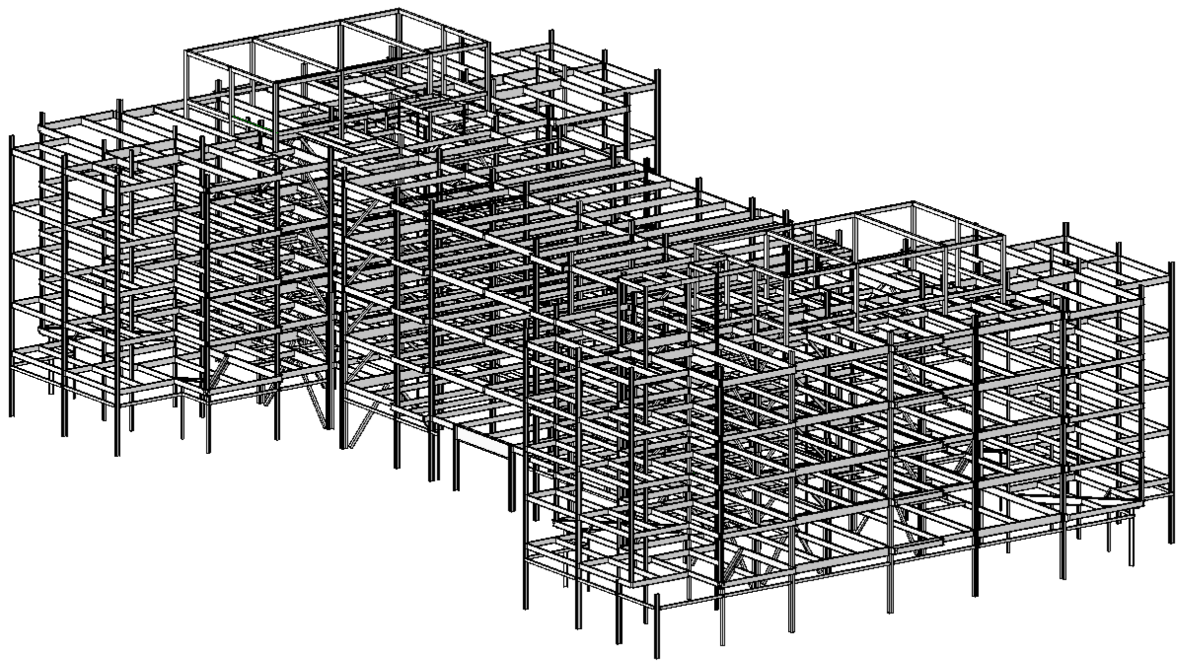

Figure 14: Steel Frame

## 6.1.4 Outer Walls

With the steel frame complete, walls could then be constructed. This is done by selecting wall from the basic tab. There are several options for wall types, including brick, concrete, glass, and aluminum. There are also different backings such as insulation, air barriers, and studs, which can be altered in the properties menu. Again, Revit makes it simple, with the ability to place a wall by offsetting it from a beam or other object by a specified distance or by simply drawing it.

The first floor is wrapped mainly in precast, which was fairly easy to put in place. One alteration made to the precast are the decorative reveals, giving it a more textured look, which were created by changing the properties of the wall. Also on the first floor is a glass curtain wall at the West and East entrances, as well as four other locations. This went in place just like the other walls, and had to connect with the brick. For the second floor and up, the walls were more of a challenge. The majority of the wall space is brick, backed by insulation and metal studs. The wall also includes a soldier course at the base, which again was added by changing the walls properties. Also on all floors after the first floor is glass curtain wall. Aluminum trim was added between each level of the glass curtain wall and extending from the fifth floor to the roof level. Again, once one floors walls were in place, we were able to copy and paste aligned to the other floors, saving us from having to repeat the process three more times. At the top of the fifth floor brick wall is more precast concrete reaching up to the roof level.

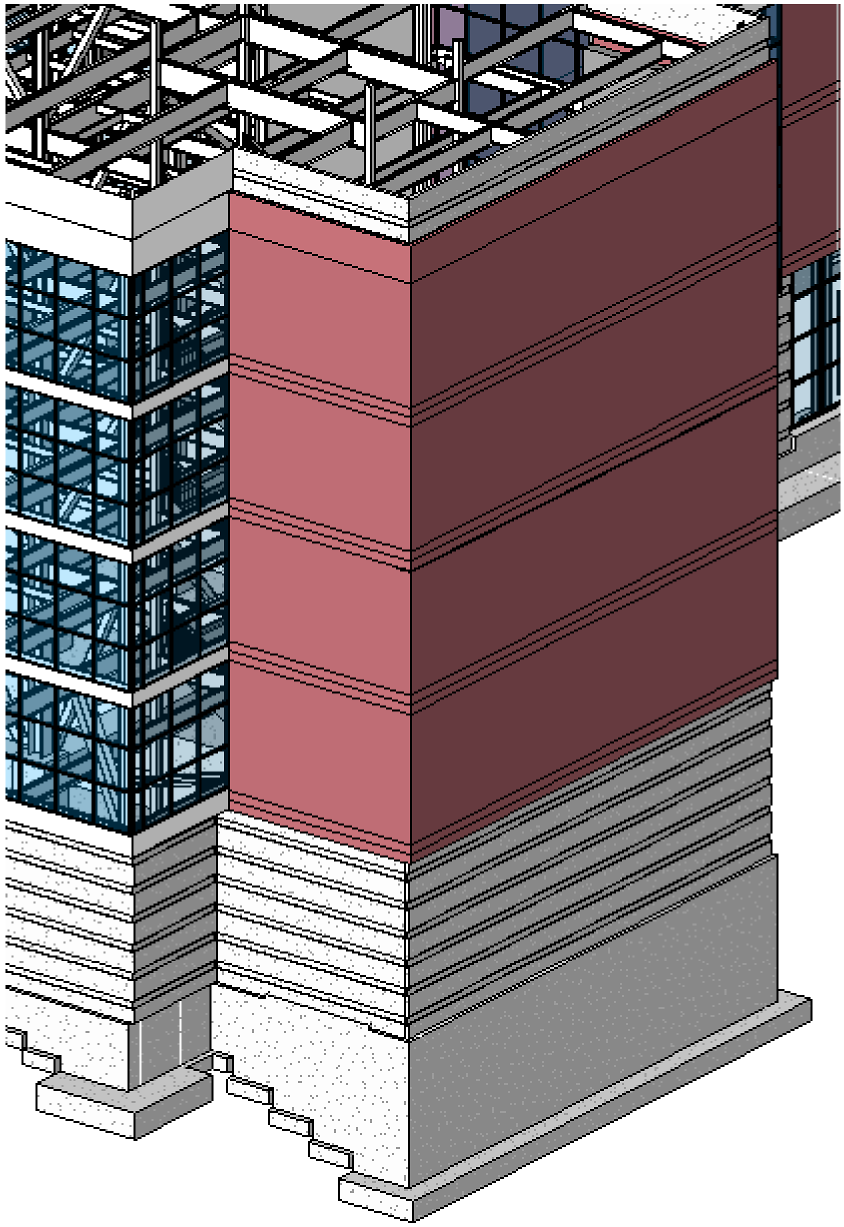

Figure 15: Wrapped Building

### 6.1.5 Slabs

The next step once the walls were in place was to place the slabs. This operation is located again in the structural tab under slab. For the most part, the slab is poured to the edge of the wall, but many places, mainly around openings, the slab will extend a certain distance past the steel or edge.  This is done by simply offsetting the desired line a certain distance.  Also with the slab command you can draw the lines you want and leaving out openings in the floor. Once the slab is drawn, the desired thickness can be assigned, and it is set.  Again, the second through fifth floor slabs are the same, so again we copied and pasted aligned to the desired level.  This then gives us set floors within the building, and essentially, completing the concrete for the building.

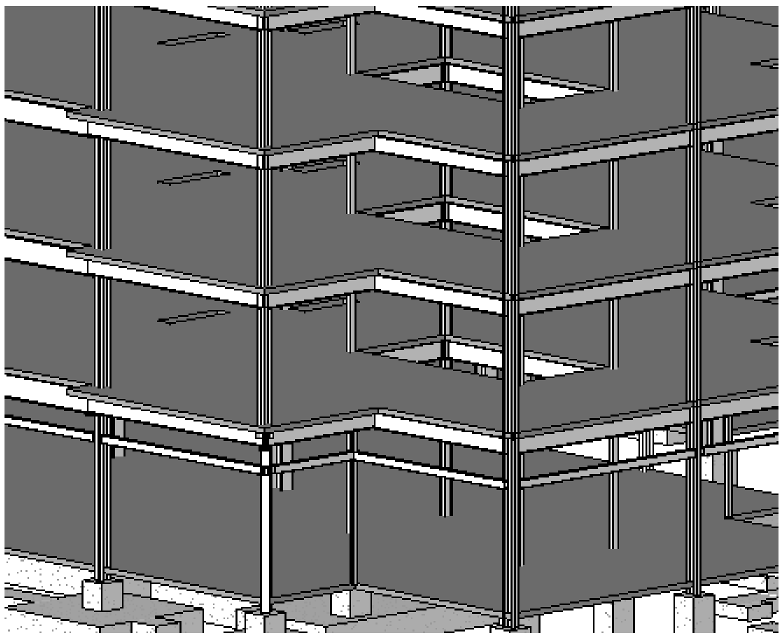

Figure 16: Slabs

### 6.1.6 Finishes

Once the slabs were placed, windows and doors were put in place.  By selecting door or window in the modeling tab, then specifying types and sizes, doors and windows go in extremely easy.  It is just a matter of selecting the wall it is to be placed on, its location, and for doors, the direction of their swing.  When put in place, it automatically cuts out the wall and it is set.  They can be easily moved and changed if necessary.

To finish the building off, we wrapped the chiller housing on the roof with “ribbed steel”, which for our project was just a thin aluminum wall and the canopy over the West entrance was covered. Also, we put the panel roof caps over the glass curtain walls as well as stairs on the interior. This was more for aesthetics purposes, as it served no purpose for the structure of the building. With some minor adjustments and fixing mistakes that became noticeable further along in the design, the dormitory was finished and we could then utilize our hard work to simplify our quantities and takeoffs.

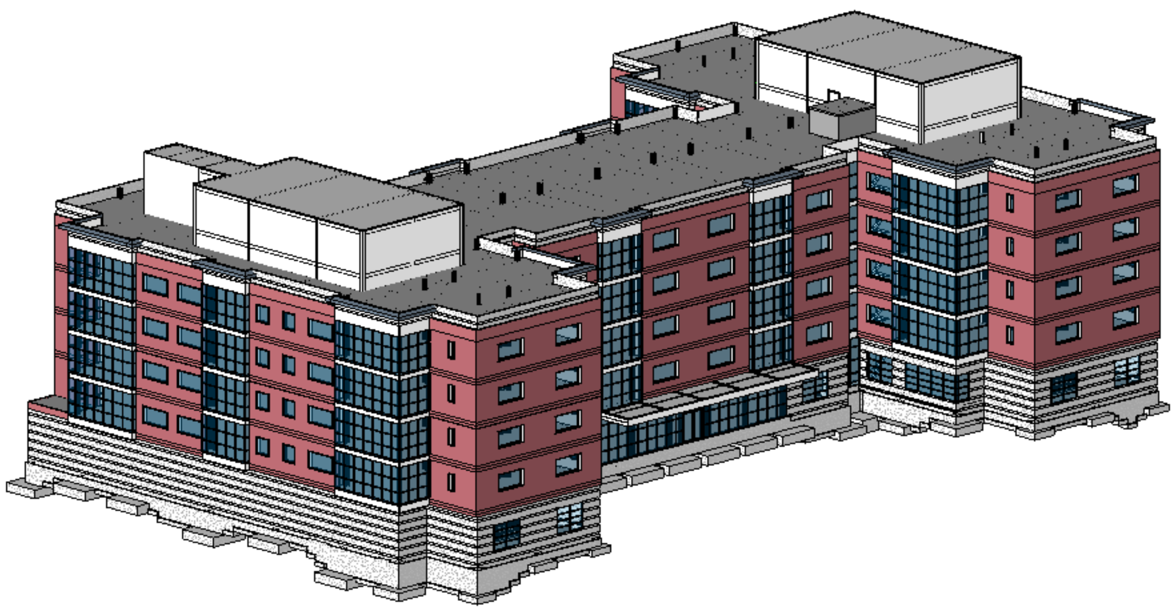

Figure 17: Exterior of Building

## 6.2 Summary of Design

Although it was a learning experience using Revit, we believe that it helped us get a better understanding of the building. It was a challenge to create the model; much like a big three dimensional puzzle on the computer. We learned about the design of the foundation, vertical steel and steel frame within the building as well as the overall orientation of the building and all of its internal structural components. Although we did not develop the architectural floors, including interior walls, bathrooms, utilities or finishes, these elements can be added to the model at any point in the future.

Most people will only see the final product, a furnished dormitory with a roof, walls, windows and doors. However, we learned how much actually goes into supporting the building, the types and quantities of the materials used and the overall design of such a structure. Even though it was frustrating at times, the Revit model proved to be a very valuable aspect of our project.

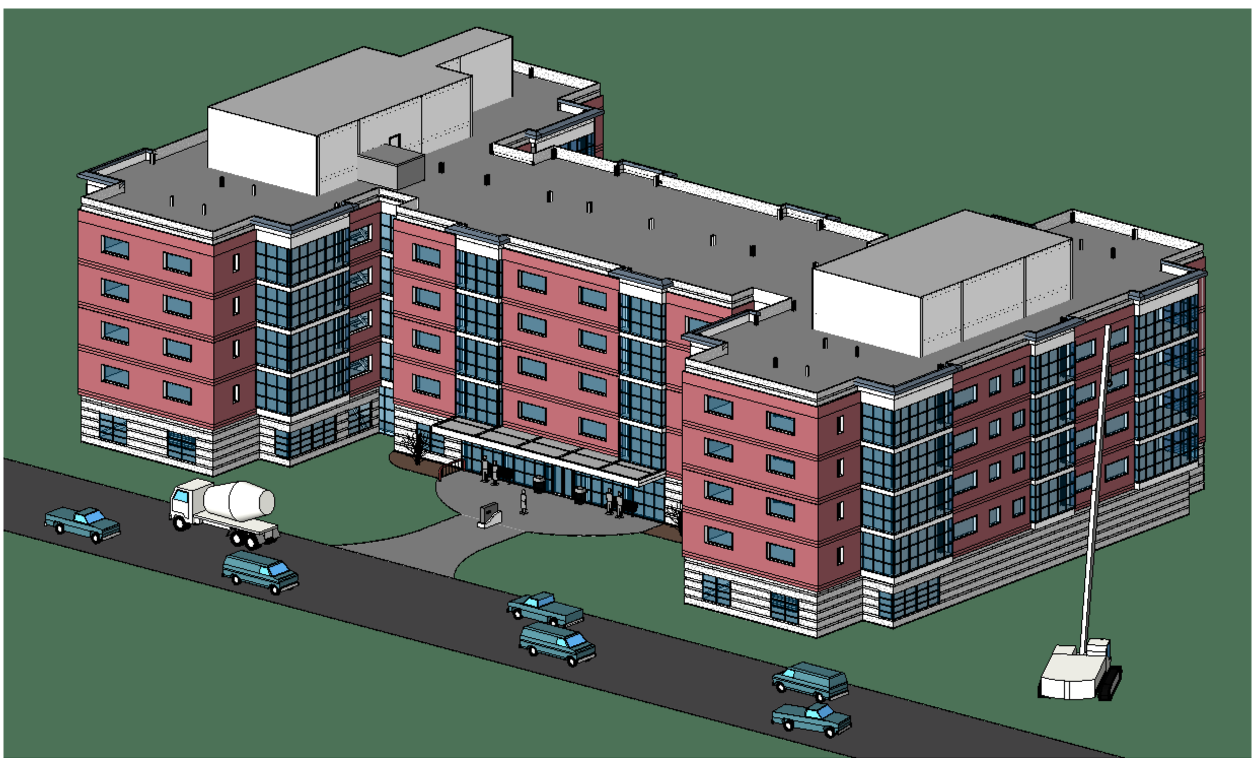

**Figure 18: Final Building Design**

## 6.3 Estimating Using Revit

An extremely useful aspect of Revit is the ability to extract quantities from the model. By adding the correct materials and dimensions, the building becomes a scaled replica of the actual building. With this, all the information can be obtained with a few clicks of the mouse. At any point during the design, a schedule can be created. Options are given as to which category to create the schedule for, such as doors, windows, rooms, electrical, and even such categories as gutters. For our project, we focused on the structural columns, structural foundation, and structural framing categories. Within the categories are the options to which fields are to be included in the schedule. The schedules which we created included fields such as Family and Type, Length, Volume, and Level. At any point, these fields can be added or removed to display other pertinent information. As the project develops, the schedule is automatically updated. Cost can also be incorporated as long as each object and material is given a price per unit.

Structural Framing Schedule 2

| Family and Type | Reference Level | Length | Volume |
|---|---|---|---|
| | | | |
| C-Channel: C8X11.5 | 02 Second floor Steel | 2' - 4" | 0.05 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 2' - 4" | 0.05 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 2' - 4" | 0.05 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 2' - 4" | 0.05 CF |
| C-Channel: C8X11.5 | 06 Roof Steel | 2' - 4" | 0.05 CF |
| 0.05 CF: 5 | | 11' - 8" | 0.27 CF |
| C-Channel: C8X11.5 | 07 Top of Elevator | 2' - 7 5/8" | 0.06 CF |
| C-Channel: C8X11.5 | 07 Top of Elevator | 2' - 7 5/8" | 0.06 CF |
| C-Channel: C8X11.5 | 07 Top of Elevator | 2' - 7 5/8" | 0.06 CF |
| C-Channel: C8X11.5 | 07 Top of Elevator | 2' - 7 5/8" | 0.06 CF |
| 0.06 CF: 4 | | 10' - 6 1/2" | 0.25 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 1" | 0.08 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 1" | 0.08 CF |
| 0.08 CF: 16 | | 49' - 4" | 1.25 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 03 Third floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 05 Fifth floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 6 1/2" | 0.09 CF |
| C-Channel: C8X11.5 | 04 Fourth Floor Steel | 3' - 6 1/2" | 0.09 CF |
| 0.09 CF: 16 | | 56' - 8" | 1.40 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 4' - 9 1/4" | 0.12 CF |
| C-Channel: C8X11.5 | 02 Second floor Steel | 4' - 9 1/4" | 0.12 CF |

Figure 19: Schedule

When the model is completed, the schedules can be extracted, easily going into a spreadsheet. Totals can be given by changing some options, but additional calculations were necessary for our project. For example, the tonnage of steel was not given, but the linear footage was. By multiplying the linear footage by the beams weight per foot, we get a weight in feet, and then dividing by 2000 gives us the tonnage. The spreadsheets are rather large, including hundreds and hundreds of beams, footings, and walls of different sizes, weights, and volumes (Figure 19: Schedule). Even though it is time consuming and tedious to calculate the totals from the spreadsheets, it is much easier than reviewing each floors structural drawing and measuring and adding beams by hand.

After extracting the structural columns, structural foundation, and structural framing schedules, we were able to calculate total cubic yards of concrete and tonnage of steel. This allowed us to compare the results obtained by Revit to the ones calculated by hand. These figures can be viewed in Section 8.2 Hand Estimate vs. Revit Estimate on page 76.

## 7.0 Structural Design and Analysis of Retaining Wall

As a requirement for our MQP we were required to complete a capstone design that related to the project. For the WPI residence hall we decided to redesign the southeast foundation wall. We chose this because it was not designed originally to act as both a load bearing foundation wall and a soil retaining wall. The original design was for strictly a vertical load bearing foundation wall in the southeast corner of the building. Early on in the planning of the project but after the design it was determined that Gilbane would begin construction of the parking garage during construction of the dormitory. In order to do this the front face of the southeast foundation wall would not be covered with soil in order to have enough room to construct forms for the parking garage retaining wall and facilitate equipment movement around the new dormitory.

This task would prove to be very interesting because time was lost early on in the project when excavation had to be performed so that field changes could be made to the foundation wall so it could act as both retaining and foundation wall. To fulfill our capstone requirement we designed the wall to both prevent the overturning moment of the earth as well as to support the weight of the building. Next we compared the difference in price for the original design, including costs to go back and install the tieback system, and the new design of the wall. Finally we compared how much of a difference it could have made in terms of scheduling to use this design in the first place, compared to having gone back and lost time to excavate, install the solution, and backfill again. A redesign of the wall was definitely needed in order to construct the parking garage while the front face of the foundation wall was not covered with soil to help counteract the overturning moment.

## 7.1 Analysis of Original Design

The first step in completing the wall redesign was to analyze the original design of the wall to determine the deficiencies in the wall. To do so we had to first obtain the geo-mechanical properties of the soil on site that would be acting against the wall in the horizontal direction. Once the properties were gathered we began our investigation into whether or not the southeast foundation wall of the new WPI Residence hall could resist the overturning moment created from the soil. Using formula's from Arthur Nilson's book we could determined the pressure caused by the earth as follows:

$$P=.5C_{ah}wh(h+2h')$$

$$=.5*.333*130*11.65*(11.65+2(17))$$

$$=11{,}511.3 \text{ lbs.}$$

$C_{ah}$ is the coefficent of active earth pressure

*w* is the unit weight of the soil

h is the height of the wall

h' is the surcharge converted to feet created by the building

The overturning moment that the pressure created was then calculated by multiplying the pressure from the earth with the distance at which it acts, the moment arm.

Moment Arm Distance

$$y=(h^2+3hh')/3(h+2h')$$

$$=[11.65^2+3(11.65)(17)]/3[11.65+(2*17)]$$

$$=5.33 \text{ ft.}$$

Overturning moment

$$M_o=P*y$$

$$=11,511.3*5.33$$

$$=61,354 \text{ ft-lbs.}$$

Once this was done we then determined how much counteracting force was generated by the weight of the concrete in the wall and the soil resting on the heel of the spread footing. It was found that the overturning moment created by the earth's pressure was 61,354 ft-lbs while the resisting force from the weight of the wall and soil resting on the heel was a mere 27,714 ft-lbs. Calculations for the resisting force can be found in Appendix Q.

## 7.2 Design of Combined Retaining and Foundation Wall.

The first step in the process was to decide what type of design would be best suited for the application and size constraints since the wall was less than 10' away from where the parking garage would be constructed. Due to this fact, a buttress wall could not be constructed since as much free space as possible was need on the front face of the wall to facilitate construction of the wall forms for the parking garage.  Possible choices were now narrowed to a gravity wall, a cantilevered retaining wall, or a cantilevered wall with counterforts.

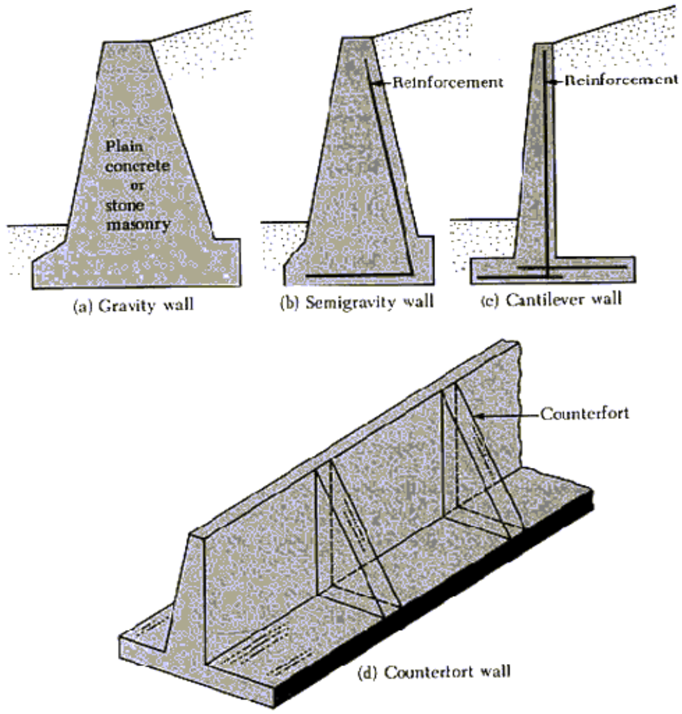


Figure 20: Possible solutions for the wall design

Counterforts are basically concrete [19]stiffeners that connect the slab to the arm by triangulation and increase the walls ability to hold back material and resist overturning moment.

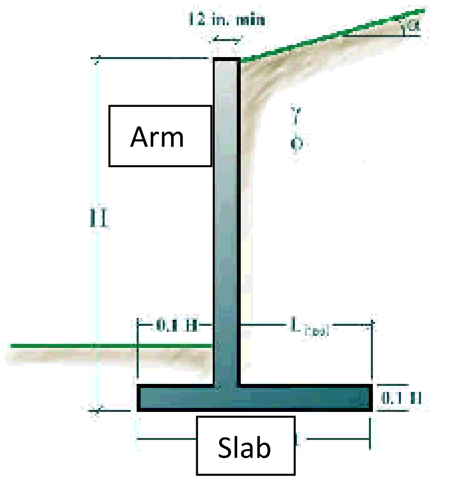


Figure 21: Simple cantilevered wall

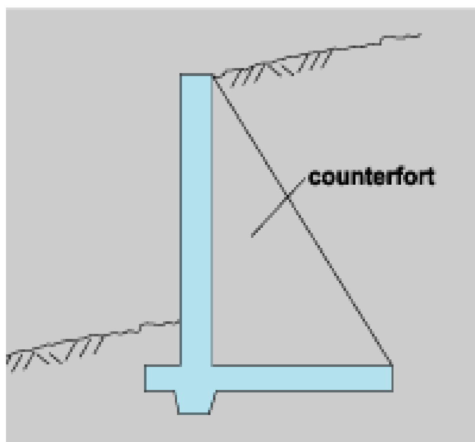


Figure 22: Retaining wall showing counterfort connecting the heel to the arm

The choice was made to design the cantilevered retaining wall with counterforts, due to the fact that counterforts add tremendous strength without making the heel slab of the retaining wall to extremely long. The heel is the slab located on the horizontal plane extending backwards from the arm of the wall.

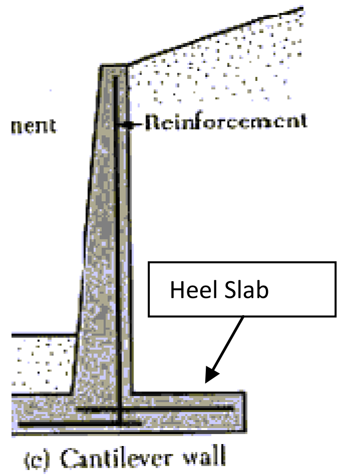


Figure 23: View of heel slab

Soil resting on top of the heel helps to resist the overturning moment, so the longer the heel, the more weight acting downwards on the slab and preventing the wall from rotating about the bottom corner of the toe. The one problem with this is that an extremely long heel can become costly in terms of the concrete and time to construct the vast forms. This was another reason why a counterfort design was chosen, to hopefully limit costs of the wall.

Not only would the wall have to resist the overturning moments and the inkling to slide if enough friction was not created between the slab and the soil, it must also be able to carry the large dead and live loads transmitted through the columns of the building down into the earth. The two combined would lead to an interesting challenge for the design.

The next step taken in the process was determining the vertical loads that would be acting on the wall in accordance with ACI code, because they would act as a surcharge, or an additional amount of soil, pressing against the wall. Dead loads for the steel and concrete that would be in place at the time of the construction of the parking garage retaining wall. Additional loads were factored in for tradesman and tools that might be transmitted to the foundation during the period that the front face would be exposed. The loads were determined by calculating how much steel would be erected at the time construction of the garage would have started as well as the amount of concrete that would be adding to the total weight of the building in terms of the poured floor slabs.  The surcharge was calculated by determing the weight on one column of the building multyplying it by three, the number of columns on the southeast wall, and dividing by the total length of the wall.  The new pressure could be calculated using the same formula as earlier stated.  Next the moment arm, distance at which the resultant pressure was acting, was calculated as follows:

$$y=(h^2+3hh')/3(h+2h')$$

$$=[(12.15^2)+(3*2.15*17)]/[3*(12.15+(2*17))]$$

$$=5.54 \text{ ft.}$$

h' being the additional height of soil created by the surcharge.

With the two calculated values we then determined the overturning moment acting on the wall from the soil and the surcharge, plus a design factor that would increase the moment, to make sure the final design could handle an enhanced overturning moment in case the pressure was ever increased due to the soil becoming saturated with water and changing the characteristics.  Preliminary design could now begin with the acquisition of the values.

The first order of business in the preliminary design was to use the moment and other known values to determine a possible dimension for the width of the arm and key, d, at the base of the slab, even though this would not be the actually distance of d.  The arm is the vertical component that the soil pushes against, while the key is on the bottom side of the slab and helps or create friction to prevent sliding.

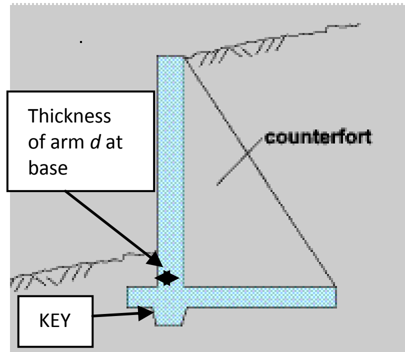


Figure 24: Diagram of Arm thickness and Key

The reason this could not be the actual thickness is because 2 inches had to be added to the distance to account for a concrete cover over the reinforcing steel as well as .5in for ½ the diameter of a typical piece of reinforcing steel. In the case of our design a thickness, d, was found to be 14.7 in. plus the 2in. cover, plus .5in. for the rebar thickness equaling a value of 17.2in. Refer to Appendix Q for the calculation of distance *d*. It was then rounded up to 2ft. because our group had wanted our design to be very conservative in case of the event that construction of the garage was delayed and additional loads were added to the wall from the surcharge. Shear at the base of the wall was also checked to make sure there would be no failures along a shear plane.

The next step was to make an assumption about the thickness of the slab, being that the slab is usual the same thickness or slightly thicker than the arm and key, followed by determining the width of the arm at the top of the wall. Normally the width decreases at the top of the arm to half the width at the base, but since this would be a foundation wall as well as a retaining wall, it was decided to leave the width of the arm stay constant at 2ft. from top to bottom to prevent any cracking or crushing damage that could be created from over loading to small an area at the top of the wall from the load bearing columns.

Our dimensions were starting to come together now with a 2ft. wide arm and key, as well as a 2ft. thick slab and the arm being 14.15 ft. tall from the bottom of the slab to the top of the ledge.

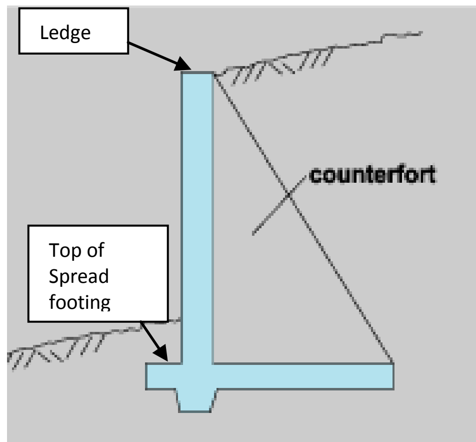


Figure 25: View of Ledge

The original distance from the top of the spread footing to the ledge was 10.15ft., but it was not designed to be exposed to the elements since it was thought that the distance from grade to the top of the footing would be well below 4ft. and would prevent any movement due to frost.  Therefore the new design had to go 4 ft. below 10.15 ft. to prevent frost action since the full 10.15 ft. would be exposed and that would leave only 18" which is far too little and the foundation could have been affected by frost.

An educated guess was then made to have a starting point for the length of the toe and heel slab for the retaining wall.  Next computations were done to some the weights and moments about the front edge of the toe.  A few trials were made with different length heels and toes to determine what dimensions would work best to satisfy external stability of the wall. The final dimensions of a 2ft. toe, 8ft. long heel and 2ft. by 2ft., were chosen because they provided enough weight and resisting moment to prevent overturning with a factor of safety of

1.48, as well as resist sliding. 1.5 is the accepted factor of safety, but being that the safety factor was within 1% of the accepted, it would work. It was also kept because weight of the counterforts were not in the calculations and they would provide quite a bit more weight and resisting moment and increase the factor of safety. The factor of safety for resisting overturning moment is calculated by taking the resisting moment created by the weight multiplied by the distance from center of mass to the front edge of the toe, and dividing it by the overturning moment created by the earth's pressure at the resultant distance.

F.S=(Resisting Moment)/(Earth's Overturning Moment)

=139,543 ft-lbs./94067 ft-lbs.

=1.48

So as one could imagine the counterforts would certainly provide the added moment to resist overturning with a factor of safety greater than 1.5 and closer to 1.55.

Next the walls ability to resist sliding was checked using Reynold's formulas, to combine the resistance created by the toe with the soil, the resistance created by the key jutting below the slab, resistance from friction between the slab and soil, and finally the small amount of passive earth pressure created in front of the wall. The friction created between the toe and heel is much different, not due to the length, but because of the pressure gradient created from the non uniform loading of the arm. What this means is that the most pressure is located almost directly under the front edge of the toe and goes to practically zero at the back edge of the heel. The combined forces resisting sliding were 22,889 lbs, as opposed to the 14,744 lbs if sliding force created by earth pressures. The factor of safety was found by dividing the resisting sliding force by the sliding force created by earth, (22889)/(14744) equaling 1.55, therefore external stability of the retaining wall was found.

F.S.=(Sliding Resisting Force)/(Earth's Sliding Force)

=22889/14744

=1.55

Next the reinforcing steel in the footing, wall and counterforts had to be determined. First we determined the horizontal steel for the counterfort by calculating the moment using the formula,

$$M_u = pl^2/10,$$

$$= [14,744*(9.375*12)^2]/10$$

$$=18,660,375 \text{ in}^2\text{-lbs.}$$

p is the earth's pressure

l is the distance from the center of one counterfort to the center of the next counterfort

to determine the moment acting on the two lower most 1 ft. tall horizontal strips on the wall between two counterforts. Once the moment was determined in $\text{in.}^2$-lbs. we could plug the moment into the formula used to determine the area of steel that would be necessary in a given 1ft. section,

$$A_s = M_u / \phi f_y (jd).$$

$$=18,660,375/[.9(60,000)(.875)(8.5)(12)]$$

$$=3.51 \text{ in}^2$$

$A_s$, being the area of the steel required,

$M_u$ being the moment,

$\phi f_y$ being the tensile strength of steel times a limiting factor of .9 for concrete, and

jd being the distance from where the arm meets the slab and the center of the bottom section of the wall.

Once $A_s$ is calculated the correct reinforcing bar can be selected and spacing can be determined. Spacing is determined by making sure that the amount of steel in a 1ft. section. That could be by either having bigger bar spaced further apart or smaller bar closer together. So if required steel area was .59 you could use no. 7 bar spaced 1ft. O.C. (on center),or no. 8 bar spaced 16" O.C., since in 4ft, you would have .79*3 or 2.37 $in^2$ in 4ft. of length and you would have 2.4 $in^2$ in 4ft. with the no. 7 bars 12" O.C.. Our calculations provide us with no. 18 reinforcing steel spaced 8" apart for the first 32" of the counterfort then decreasing to no.16 bar spaced at 8" for the next 40", and no.16 bar spaced 16" O.C. for the rest of the height, due to decreased bending moment.

Next, the vertical steel size and spacing must be determined. This is done by dividing a factored shear value by the tensile strength of steel multiplied by phi for steel and the distance from the back of the arm to the edge of the slab.

$$A_v=V_1/\phi f_y d$$

$$=85,450/.85(60,000)(8)$$

$$=.209 \text{ in.}^2$$

$V_1$ is the factored shear load

$f_y$ is the steel strength in tension

d is the distance from the base of the arm to the end of the slab

$\phi$ is the limiting factor for steel

Our vertical reinforcing steel ended up coming out to be no. 5 bars spaced 8” O.C for the entire counterfort. After horizontal and vertical steel was designed for the counterfort we moved on to determining the steel needed to reinforce the arm, key, toe, and heel.

After using some of the same formulas and a few different formulas from Reynold’s*, Reinforce Concrete Design Handbook,* we designed all the reinforcing steel for the rest of the retaining wall. Refer to, Appendix Q:Design Computations, Notes, and Diagrams, for all steel design computations.

At this point in time our wall had been designed including, necessary dimensions, and all reinforcing steel design. We were able to simply compare the dimensions of our new design and reinforcing steel to realize that our design would be more than capable to car the vertical loads transmitted to the foundation from the columns since our footing and wall was thicker and more reinforced than the original design. It was now time to complete the next part of the design, which was to complete a concrete takeoff for our newly designed retaining and foundation wall, so we could determine and compare costs to the original design plus the tieback solution.

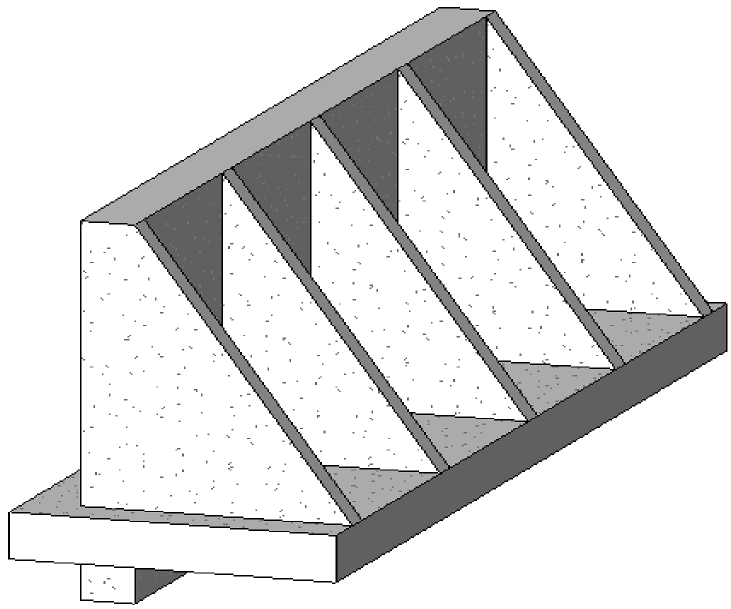

Figure 26: Redesigned Retaining and Foundation Wall

## 7.3 Concrete Takeoff and Estimate

To perform our takeoff and cost estimate we used the dimensions of our new wall and convert it into cubic yards of concrete. Calculations are in **Error! Reference source not found.**. We found that our design contained approximately 60 more cubic yards of concrete than the original design without the tieback and was about 47 cubic yards larger than the original design plus the tieback solution. The new design contained about twice as much concrete than the original specifications plus the tieback deadman. The final value for the concrete formed and poured in place was about 48,752 dollars as opposed to 28,100 dollars for the cost of the original foundation plus the cost to install the tiebacks. At first glance the price difference seems quite substantial but that does not take into account the amount of time that was lost to move ahead in construction due to having to stop work to go back and fix the problem.

## 8.0 Conclusions

The results garnered through our project work have led us to several conclusions. These conclusions have been outlined in four sections. The Earned Value Analysis Benefits, Hand Estimate vs. REVIT Estimate, Hand Estimate vs. REVIT **Estimate**

One portion of our project was to compare the quantities acquire by Revit to the ones done by hand. Originally we had predicted that there would be a substantial discrepancy in the quantities, but the results were much better than we had guessed. The differences that exist in the quantities are due to human error. Even though the Revit output exact quantities, any flaws in the model will have a direct effect on the schedule, for example any deviation of wall dimensions creates error.

Our concrete volumes were as follows:

| **Concrete Volume (CY)** | Revit | Hand Calculations |
|---|---|---|
| **Footings** | 714.73 | 700.39 |
| **Piers** | 53.26 | 53.89 |
| **Grade Beams** | 31.91 | 20.42 |
| **Cont. Footings** | 352.75 | 280.23 |
| **Slabs** | 1766.28 | 1827.84 |
| | | |
| **Total** | 2918.93 | 2882.77 |
| | Difference | 36.16 |

Table 8: Concrete Volume

With a difference of only 36.16 Cubic Yards, our two methods were relatively close. The largest discrepancy was with the slabs. This main reason for this is most likely the Revit model. In Revit, when pouring a slab, the outer edges are usually walls, unless offset elsewhere. In some places in the model, there were some variations between the drawings and what actually was done. A small offset in a wall of even just a few inches could create a surplus of concrete.

For example, the West wall is about 230 feet long. If the wall was off by just 2 inches, with a 5 inch slab, this would result in an extra 8.5 cubic yards of concrete for one slab, and there are 6 slabs. That means that a 2 inch discrepancy would be the cause for an extra 51 cubic yards of concrete. Such errors do exist in the model, so it is inevitable that the Revit schedule does not exactly reflect the exact quantities. Another means of error is simple calculation mistakes. The drawings can be confusing in certain areas, and can create problems in accurately measuring and quantifying. However, we believe our difference of 36.16 cubic yards of concrete is acceptable, and both the Revit quantities and those obtained by hand were done with a fairly high degree of accuracy.

Our steel volumes were as follows:

| **Steel (Tons)** | Revit | Hand Calculations |
|---|---|---|
| **Vertical** | 137.31 | 140.81 |
| **Framing** | 345.53 | 314.82 |
| **Bracing** | 28.95 | 28.4 |
| | | |
| | 511.80 | 484.03 |
| | Difference | 27.77 |

**Table 9: Steel Tonnage**

Again, our two methods were respectably close. However, unlike the concrete volumes, the difference was most likely due to error in hand calculations. Quantifying steel by hand can be extremely difficult because of the number of beams, difference in sizes and location. There are many beams on different levels, and in small spaces. Human error here plays a big part, because by missing only a few beams, the total can be off. For example, by missing just one 11’10” W27x84 beam would result in a half ton difference. Or one vertical HSS7X7X.500 column that stretched from the foundation to the top of the screen wall would result in over one and a half ton difference. It is errors like these, along with incorrect measuring that could lead in such variation. Also, with Revit, if a structural beam is not connected correctly and extends to the wrong column, it will result in a small over calculation in the framing steel. Certain structural BIM software is more accurate, for example that used by steel fabricators, will automatically adjust the beam to fix this issue, but we used an Architectural program and this is not a feature. However, with Revit, such issues are often easily recognizable, and you have the luxury of going back and fixing the error. Usually these errors are spotted with oddities in the model, or error messages when something is placed incorrectly. Although there is a difference of 27.77 tons of steel, the difference was less that our group had expected. With such a complex matrix of structural beams and columns, we predicted a much higher margin of error, so once again, were satisfied with our steel quantities

**Feasibility of Retaining Wall Design**, and Gilbane Owner/Architect Meetings. The Earned Value Analysis Benefits section describes the uses and benefits of earned value methods for construction management. The Hand Estimate vs. REVIT Estimate compares and contrasts the quantities obtained using the different methods and possible reasons for discrepancies. The Feasibility of Retaining Wall Design will discuss the impact the redesigned wall would have on the schedule and overall cost of the project. Finally, the Gilbane Owner/Architect Meetings will contain observations and impressions made by attendance at weekly construction and owner meetings.

## 8.1 Earned Value Analysis Benefits

This project served as an example of how earned-value analysis can be used to track the trends of a project. As was discussed in Gilbane site construction meetings, the exterior walls are indeed behind schedule mainly due to issues with discolored and poorly fabricated Pre-cast concrete segments in the beginning of the project. Project manager Neil Benner stated this as fact, but there was little concern as the activities remained out of the Critical Path of the project and as such was not in a position to affect the completion date. It has been shown that the exterior wall activities are indeed behind schedule, however, they are making up ground on the schedule.

The final information to be gained from analysis is the forecasting of project completion. The information gather from this analysis include the Estimate to Complete (ETC) and the Estimate at Completion (EAC). The following equations were used in the analysis:

$ETC = \frac{BAC - BCWP}{CPI}$ $EAC = (ACWP + ETC)$ where BAC= Budget at Completion = Original Estimate. As of January 30th, 2008, the most recent date of analysis, the ETC is equal to \$367,026.06 and the EAC is equal to \$1,609,395.93. The Estimate at Completion is equal to the Original project estimate as a result of the lack of actual cost values in our data. However, this is where the forecasting of cost at completion would show budget overruns or savings. If there were budget overruns they would be absorbed by the CM at-risk unless they were able to then pass the costs on to responsible subcontractors. Almost all construction projects stray from the schedule. The benefits of Earned Value methods allow construction managers to keep track of the trends of their project.

## 8.2 Hand Estimate vs. REVIT Estimate

One portion of our project was to compare the quantities acquire by Revit to the ones done by hand. Originally we had predicted that there would be a substantial discrepancy in the quantities, but the results were much better than we had guessed. The differences that exist in the quantities are due to human error. Even though the Revit output exact quantities, any flaws in the model will have a direct effect on the schedule, for example any deviation of wall dimensions creates error.

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## 8.3 Feasibility of Retaining Wall Design

The capstone project allowed our group to experience designing something that is not just used to get practice from, but instead we had to determine an alternative way to come up with an effective design that could perform as designed as well as think economically so that we could minimize cost. Our design seems very feasible for a multitude of reasons, including the fact that no time would be lost re-excavating and installing the tieback, no additional costs for engineering a new design and purchasing the materials for it, and no change in the critical path of the project.

First being that before installing the tieback system our design would have cost approximately 34,000 dollars more. When looking at that number quickly it seems very high, but as you take a deeper look at the situation, you realize there were quite a few more costs that would have to be added to the original price that would close that gap. The first thing that closes the price gap is that concrete alone for the tieback system costs roughly 6,000 dollars, which closes the gap to a 28,000 dollar difference. The next thing that must be looked at is the price to install the tieback system, 7,600 dollars, which includes excavation, machines costs, installation and backfilling once installed. This closes the gap now to just over 20,000 dollars, which does not include any of the fees from the engineering firm that had to design the restraint system on short notice. Now we are probably looking at just over a 15,000 dollar difference. What it does not factor into the difference is the amount of time lost to go back and install this, the cost to have a professional engineer design a support system that could handle the loads, time spent by project engineers and project managers to reschedule work plan, or the increase to the General Condition costs of the project.

The lost time to go back over work that has already done to re-work a problem is very great in even the smallest of projects. Three days lost to excavate, install, and backfill could translate in a week or more of delay in other jobs that could be getting done. The week delay that was created by an oversight in planning as to whether or not to construct the garage and dorm simultaneously could lead to a penalty of 20,000$ dollars or more if stipulations are in the contract to finish on a certain date, and no later than that. In this case, the penalty could be much more than 20,000 dollars because if the dormitory is not finished by the completion date it could possibly lead to 300 or more students not being able to move into their rooms which could lead to a lawsuit from the owner against the CM for lost revenue if some of the students who could not move in decide to not go to WPI because they were mistreated the first day they arrived there or because WPI would have to spend additional money to temporarily accommodate the students in hotels or other housing until the dormitory was completed.

So our group feels this is a very feasible design because what started out costing the owner almost 30,000 dollars could lead to a lot more than that lost by the CM in the long run.
Any time there is a problem like this in the construction of a project there is always more than what one sees the first time that look at a problem. In today's fast paced construction industry, time is money, therefore lost time can very often be more detrimental than a few thousand dollars difference in the design of part of the project involved in the critical path of the project.

## 8.4 Gilbane Owner/Architect Meetings

Over the duration of our project we attended weekly construction meetings between the Construction Manager At-Risk, Gilbane, the Architect, Canon Design, and the Owner, WPI. Through these meetings we gained perspective on the type of discussions made both in a construction meeting and in owner meetings. In both cases, a representative is usually on hand for all three parties. However, in a construction meeting the main focus is on scheduling, the progress of the sub-contractors, RFI's, and change orders, and the determination of GMP line items. Owner meetings mainly focused on sub-contract bids and awards, as well as architectural decisions. Attending these meetings also displayed the types of conflicts that often arise on a construction project.


Figure 27: CM/Owner/Architect Meeting

A major topic at the meeting was the type of chiller that would be purchased for the new dormitory. If a Smardt chiller was chosen, WPI would be eligible to receive a discount of $46,000, but not if they purchased a York chiller. They were trying to determine which chiller would be quieter, and if either of them had a substantially lower operating and maintenance cost than the other. The Smardt chiller was more expensive up front, but offered a much larger rebate than the York chiller. The plan was to present what they thought would be the best chiller at the 1pm owners meeting later that day. They also discussed possible MEP coordination problems that they might be facing above the 5$^{th}$ floor and below the roof due to low clearance.  By the second meeting they had informally decided on the Smardt chiller because of its overall cost and efficiency.


**Figure 28: CM/Owner/Architect Meeting II**

These are merely two examples of the myriad number of issues that must be dealt with over the course of a project.  The necessity of these meetings on a timely basis, in this case weekly, is utterly apparent as they quickly quell any issues that arise.  This prevents conflicts that could strain working relationships, prolong the project, and ultimately increase the overall cost.  The three parties worked particularly well throughout the meetings we attended although issues arose over the course of this project and there was tension at times.

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# Appendix A: Proposal

**1.0 Introduction**

Worcester Polytechnic Institute (WPI) has seen an annual growth rate for its student body over the past few years as its undergraduate and graduate programs continue to expand and gain global recognition. Because of this there has been a need for more undergraduate housing particularly on campus. Traditionally most students move off campus after their first year into the surrounding apartments, sororities and fraternities. In order to foster the expansion of the university as well as provide much needed upper-classman housing, WPI has begun the construction of a new residence hall and parking garage between Boynton St. and Dean St. By bringing upperclassmen back on campus, Janet Richardson, the Vice President of Student Affairs and Campus Life believes that "the university benefits greatly from the leadership, mentorship, experience and talent of its students being part of the residential community on campus"[20].

The goal of this project will be to examine and perform project management techniques that are common in construction and will be used during the building process of the new residence hall. The project will also include the redesign of the East Foundation wall of the parking garage to a retaining wall as the Capstone Design. A 3-D model of the residence hall will be created using REVIT and will be used for its feature of obtaining material quantities.

We will do this by performing an earned value analysis for the interior and exterior walls while tracking the scheduling of their construction with respect to percent scheduled versus percent complete using practices learned at WPI. We will also perform a cost estimate of the steel and concrete packages by doing a quantity take-off using excel as well as by using our 3-D REVIT model. An analysis of the relationships between the different parties and how they changed throughout construction will also be done to help understand how essential

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[20] http://www.wpi.edu/About/NewResHall/facts.html

communication is in the construction industry. The foundation wall will be redesigned using hand calculations.

The deliverables of this project will include the following. The first deliverable will be an estimate of the concrete and steel used in the project. The exterior and interior wall construction will be tracked and scheduled using Primavera. Also, there will be a REVIT building model of the concrete, steel, and walls. The capstone design project will include the analysis and design of the foundation wall. A cost-benefit analysis of the wall will be completed with a determination of the potential benefits of building the wall so there would no longer be a need to backfill the parking garage area. At the conclusion of the project a “Meeting Player Analysis” will describe the roles and attributes of the major players in the project.

## 2.0 Literature Review

### 2.1 General Construction and Design

The new residence hall was designed to appeal to upperclassmen and in order to accomplish these suite-style rooms were chosen. The suites have been designed as four person apartment style dorms with a full kitchen, living room, compartmentalized bathroom and either single or double bedrooms. The building also offers wireless internet access, air-conditioning, tech suites on each floor, and recreation and fitness space. Adjacent to the dormitory will also be a parking garage, allowing upper classmen to have their vehicles on campus. It is these services and conveniences that will give students incentive to remain on campus throughout their time at WPI.

Designed by Cannon Design, the dormitory (Figure 29: A computer-generated view of WPI's future residence hall) has 232 beds and 103,610 square feet of space.

Figure 29: A computer-generated view of WPI's future residence hall

Janet Richardson stated that "The building is designed specifically with the students' needs and expectations in mind, including their desire for privacy, independence, safety, and security"[1]. The design was based a great deal on student feedback along with information provided by neighbors, faculty, and staff. Also incorporated into the design was to obtain LEED gold certification for the building. LEED, or Leadership in Energy and Environmental Design, certification involves incorporating alternative materials, recycling, reducing power consumption, along with many other criteria into the design and construction. This will make the dormitory environmentally friendly, or also known as a green building.

Another one of the main goals for this project is "developing a vibrant lower campus that begins to link WPI's main campus with the downtown area and to Gateway Park, the 11-acre mixed-use life sciences-based campus the university is developing in partnership with the Worcester Business Development Corporation". This is accompanying the idea of creating an "attractive route for members of the WPI community and neighbors heading to the Worcester Art Museum, Tuckerman Hall, and the other venues in the downtown arts and culture district"[21]. By bringing upperclassmen back onto campus and tying WPI into the surrounding culture, the university can become much more hospitable.

Accompanying the dormitory is a 189-space parking garage to address the parking issues around campus. This structure will provide parking to the residents, staff, and even the adjacent church members.

### 2.2 Project Management

Project Management is "the art and science of coordinating people, equipment, materials, money and schedules to complete a specified project on time and within approved cost."[22] The major tasks of the management team include organizing different areas of work and working to identify and solve any problems that may arise including interaction of parties, conflict resolution, and scheduling issues. Gilbane is the general contractor of the project and as such is in control of the project management.

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[21] http://www.wpi.edu/About/NewResHall/facts.html

[22] Oberlander, Garold D. Project Management for Engineering and Construction.

### 2.3 Fast Track Process

The new dormitory is being constructed under a fast track schedule. The fast track construction process takes places when construction begins before design is completed. Often in such cases design work is done concurrently with construction. The design comes out in packages that work with the schedule of the contractor. As the design packages are finalized they are turned over to the contractor who then puts them out to bid. This process allows for a significant decrease in the time between the conceptualization and construction phases of the project, which directly translates into cost savings. Even though time is conserved, there is the always present risk of miscommunication, delays, and other human error. There is also less time to fix any mistakes or changes made in the design, as the construction is being done as the plans are made.

### 2.4 Guaranteed Maximum Price (GMP) Contract

Gilbane is the general contractor for WPI and is bound by a guaranteed maximum price contract. A guaranteed Maximum Price contract is defined as a contract where the contractor is compensated for actual costs incurred plus a fixed fee and the contractor is responsible for cost overruns. This gives the contractors incentive to keep costs down as they also benefit from the savings[23]. With a fast track design, there needs to be sufficient design completed in order to provide accurate cost estimation.

### 2.5 Cost Estimating

Construction cost estimating is "the determination of probable construction costs of any given project." Cost estimating is an integral part of the project management process because it provides a means for identifying and organizing materials in terms of quantity and cost value. Cost Estimates are performed on a project multiple times from its preliminary conception all the way through to its completion. There are four of these types of estimates; the first of which would take place is called a feasibility estimate which is the least accurate. These estimates demonstrate the projected cost of a project which then can be used to develop a cost vs. benefit analysis. These estimates are usually performed without an actual set of plans or drawings but rather with a general idea and sense of what an owner wants. The estimator must

[23] (Dagostino & Feigenbaum, 2003)

then use his expertise and experience in the construction field to produce the feasibility estimate for that project.

The next type of estimate that would take place is called a pre-construction cost estimate. Pre-construction estimate gives an owner an idea of the general price a project may cost. They are performed once more information about a project is available and they help the owner and architects define the scope of work for the project. They also work well as a basis for cost comparison for the various designs or modifications a project may include and help the owner reach the best solution while staying within his budget.

A square foot estimate is an estimate which can be performed when the proposed size of the building is known. A typical square foot cost estimate is broken down into different components, a cost is assessed to these components and then a cost per square foot is determined. These estimates also take into consideration geographic area and cost of construction in these areas. The accuracy of these estimates can vary from -20% to +30% of actual costs.

The most precise type of estimate is a unit price detail estimate. This type of estimate requires a full working set of plans and specifications and is typically the type of estimate performed in the bidding process of construction. "It includes determination of the quantities and costs of everything required to complete the project. This includes the materials, labor, equipment, insurance, bonds, and overhead, as well as an estimate of profit." (Dagostino, 2003) From this information unit prices are established for all the different materials and equipment that will be needed to construct the project. These estimates are usually organized by trade and are typically accurate within -5% to +10% of actual project costs. This is the type of estimate to be performed during this project.

### 2.6 Project Scheduling

A major task in construction management is the scheduling of a project. "Project scheduling is the process of determining the sequential order of the planned activities, assigning realistic duration to each activity, and determining the start and finish dates for each activity." We will look at and analyze the schedule of activities for the construction of the interior and exterior walls.

### 2.7 Building Information Modeling

Building information modeling is the application of a software program to create a 3-Dimensional representation of a building allowing for model reviews, virtual huddles, and electronic CAVES (computer-aided virtual environments) that allow for change to the environment, duration, nature, and results of the construction process. Further, this software can be used to track the entire design-construction process from beginning to end. This technology is in its infancy and a new tool for architects, engineers, and contractors alike. Currently the Institute of Building Sciences (NBIS) and the International Alliance of Interoperability (IAI) have begun to work together as buildingSMART to create the first National Standard for Building Information Modeling (NSBIMS).

One hope for BIM is that it will move away from the common mistakes seen when using CAD. Such problems include missing or generating inconsistent information, difficulties in collaboration, and mistakes detected at the construction site. These mistakes can end up being very substantial in terms of time, labor, and equipment. Whenever any of these resources are wasted it shows up in terms of money whether at the cost of the contractor, architect, or owner.

The model will also help with the coordination of the project between the owner, architect, and contractor and subsequently any subcontractors. Each discipline within the development of a facility including planning, design, construction, and management look only at their 12-18 month view and lack much concern about anything outside their window. "The loser is the owner—to the tune of $15.8B annually according to the National Institute of Standards and Technology (NIST)." The cooperation and understanding gained through the use of a building information model could substantially decrease that number.

## 3.0 Methodology

This project will take three terms to complete and will include a Capstone Design aspect as well as a comparative cost analysis between using this design and the cost of construction in the field.

### 3.1 Earned Value Analysis of interior and Exterior Walls

The construction of the interior and exterior walls will be tracked throughout their construction as well as scheduled using Primavera software. This information will be compared to the amount paid to the subcontractors performing said work. The payment information will be obtained through the representatives of Gilbane, Co. The amount paid and the amount of work completed will be compared to create an earned value analysis.

### 3.2 3-D REVIT Model

A REVIT model of the concrete and steel frame of the building will be created using acquired drawings and specifications. This model will be examined and used in an estimate as well as being studied to determine the possible benefits of using this technology.

### 3.3 Steel and Concrete Estimate

The steel and concrete estimates will be calculated in two manners. One will be done conventionally as a takeoff of quantities multiplied by the pricing of those units found in the means. A second approach will use a program that will perform a quantity takeoff from the REVIT model. We will then compare the two approaches and perform an analysis of them.

### 3.4 Player Meeting Analysis

Weekly construction and owner meeting will be attended. Notes will be taken from these meetings as well as their minutes and any other pertinent information that is provided. Throughout the course of the project, people who play key roles will be studied ultimately compiling information for an analysis. This analysis will look at the relationships between those who attended the meetings as well as their roles in the project.

## 4.0 Project Specifications

In order to complete our project we have four goals. The first is to track the construction of the interior and exterior walls. Using this information we will perform an earned value analysis. We will then be able to evaluate the performance of Gilbane in terms of budget, scheduling, and completion of the scope of work. Our second goal is to provide a cost estimate of the concrete and steel frame of the building using both hand calculations and computer software. Through the determination of quantities and pricing using means we will create a detailed cost estimate of these work packages. The third goal of our project is to create a 3D model of the structural frame of the building, composed of steel and concrete, using REVIT. The final goal of our project will be to redesign and analyze the east foundation wall of the parking garage to act as a retaining wall as well as a foundation wall.

**4.1 Capstone Design**

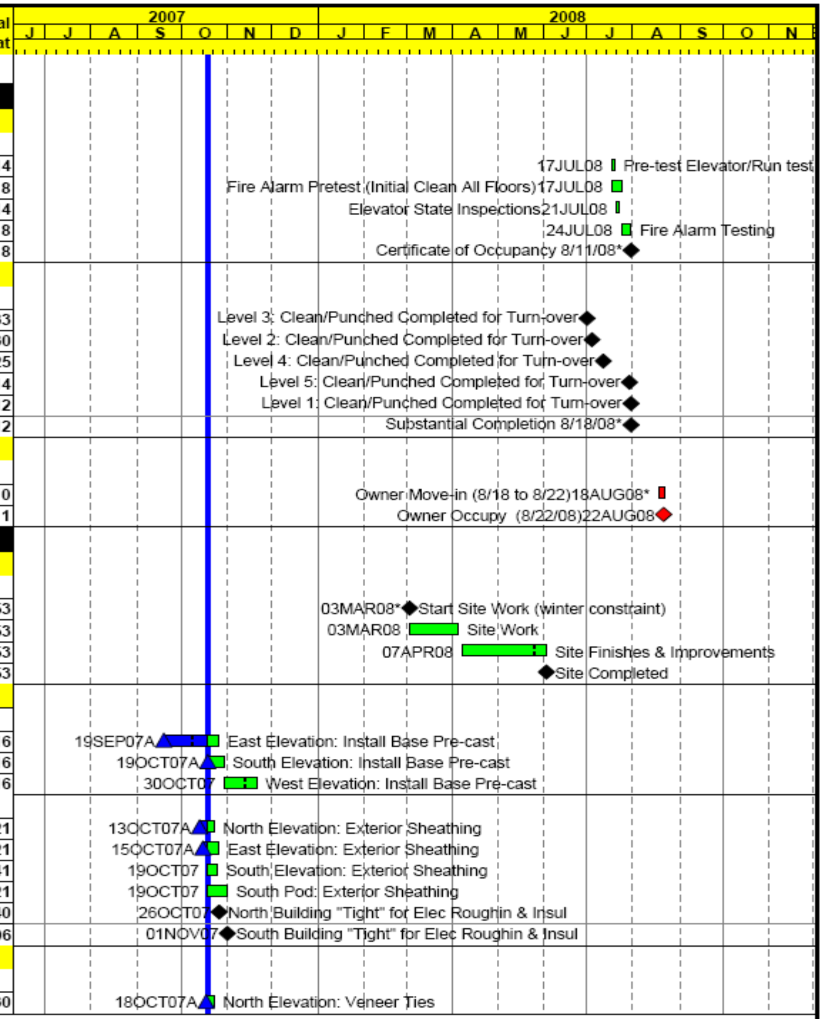
The capstone design requirements for this Major Qualifying Project will be satisfied by investigating the implications of redesigning a foundation wall that would perform its load carrying abilities as a foundation wall as well as act as a temporary retaining wall during construction. If the wall had originally been designed in this matter the effort of re-excavating and backfilling that Gilbane was forced to undertake to complete this project safely could have been avoided. These tasks also had scheduling and cost impacts to the project. We will look at these and evaluate them compared to the cost and impacts of our new design.

Re-design of the wall will consist of a structural analysis of the existing wall, investigating the soil conditions on site to be used in determining the type of retaining wall, and designing the wall to satisfy both of the walls needs. Vertical loads on the wall will be determined by using calculations prepared by Canon Design as well as being calculated by ourselves. Soil characteristics will be used to determine horizontal pressures on the wall using the according foundation engineering formulas.

This project will address economic, scheduling, and constructability issues created by a differently designed foundation wall. We will examine the increased costs of the project due to a foundation wall designed to carry vertical loads while also being able to resist horizontal loads during the construction process. Additionally we intend to determine how scheduling and constructability of the project would have been impacted if the wall was designed as a retaining wall from the beginning and time did not have to be wasted backfilling the wall and then removing the fill at a later time.

# Appendix B: Gilbane Construction Schedule

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| **CONSTRUCTION** | | | | | | |
| **Project Milestones** | | | | | | |
| **Certificate of Occupancy** | | | | | | |
| 9025 | Pre-test Elevator/Run test | 2 | 2 | 17JUL08 | 18JUL08 | 14 |
| MS1 | Fire Alarm Pretest (Initial Clean All Floors) | 5 | 5 | 17JUL08 | 23JUL08 | 8 |
| 9035 | Elevator State Inspections | 2 | 2 | 21JUL08 | 22JUL08 | 14 |
| MS2 | Fire Alarm Testing | 5 | 5 | 24JUL08 | 30JUL08 | 8 |
| MS3 | Certificate of Occupancy 8/11/08* | 0 | 0 | | 30JUL08 | 8 |
| **Substantial Completion** | | | | | | |
| MS23 | Level 3: Clean/Punched Completed for Turn-over | 0 | 0 | | 30JUN08 | 33 |
| MS20 | Level 2: Clean/Punched Completed for Turn-over | 0 | 0 | | 03JUL08 | 30 |
| MS24 | Level 4: Clean/Punched Completed for Turn-over | 0 | 0 | | 11JUL08 | 25 |
| MS25 | Level 5: Clean/Punched Completed for Turn-over | 0 | 0 | | 28JUL08 | 14 |
| MS21 | Level 1: Clean/Punched Completed for Turn-over | 0 | 0 | | 30JUL08 | 12 |
| MS30 | Substantial Completion 8/18/08* | 0 | 0 | | 30JUL08 | 12 |
| **Owner Move-in** | | | | | | |
| 6240 | Owner Move-in (8/18 to 8/22) | 5 | 5 | 18AUG08* | 22AUG08 | 0 |
| 6250 | Owner Occupy (8/22/08) | 0 | 0 | 22AUG08 | | 1 |
| **Residence Hall** | | | | | | |
| **Site Finishes** | | | | | | |
| 7400 | Start Site Work (winter constraint) | 0 | 0 | 03MAR08* | | 53 |
| 7410 | Site Work | 25 | 25 | 03MAR08 | 04APR08 | 53 |
| 7420 | Site Finishes & Improvements | 30 | 40 | 07APR08 | 02JUN08 | 53 |
| 7430 | Site Completed | 0 | 0 | | 02JUN08 | 53 |
| **All Building Elevations** | | | | | | |
| **Architectural Pre-Cast** | | | | | | |
| 7312 | East Elevation: Install Base Pre-cast | 15 | 5 | 19SEP07A | 25OCT07 | 16 |
| 7324 | South Elevation: Install Base Pre-cast | 7 | 7 | 19OCT07A | 29OCT07 | 16 |
| 7336 | West Elevation: Install Base Pre-cast | 15 | 15 | 30OCT07 | 20NOV07 | 16 |
| **Exterior Sheathing** | | | | | | |
| 7143 | North Elevation: Exterior Sheathing | 4 | 2 | 13OCT07A | 22OCT07 | 21 |
| 7145 | East Elevation: Exterior Sheathing | 8 | 5 | 15OCT07A | 25OCT07 | 21 |
| 7146 | South Elevation: Exterior Sheathing | 4 | 4 | 19OCT07 | 24OCT07 | 41 |
| 7148 | South Pod: Exterior Sheathing | 9 | 9 | 19OCT07 | 31OCT07 | 21 |
| MS5 | North Building "Tight" for Elec Roughin & Insul | 0 | 0 | 26OCT07 | | 40 |
| MS5.S | South Building "Tight" for Elec Roughin & Insul | 0 | 0 | 01NOV07 | | 206 |
| **North Pod** | | | | | | |
| **North Facade** | | | | | | |
| 7325 | North Elevation: Veneer Ties | 4 | 2 | 18OCT07A | 22OCT07 | 30 |




| | |
|---|---|
| Start Date | 30OCT06 |
| Finish Date | 22AUG08 |
| Data Date | 19OCT07 |
| Run Date | 19OCT07 13:38 |

Current Schedule
Progress Bar
Critical Activity

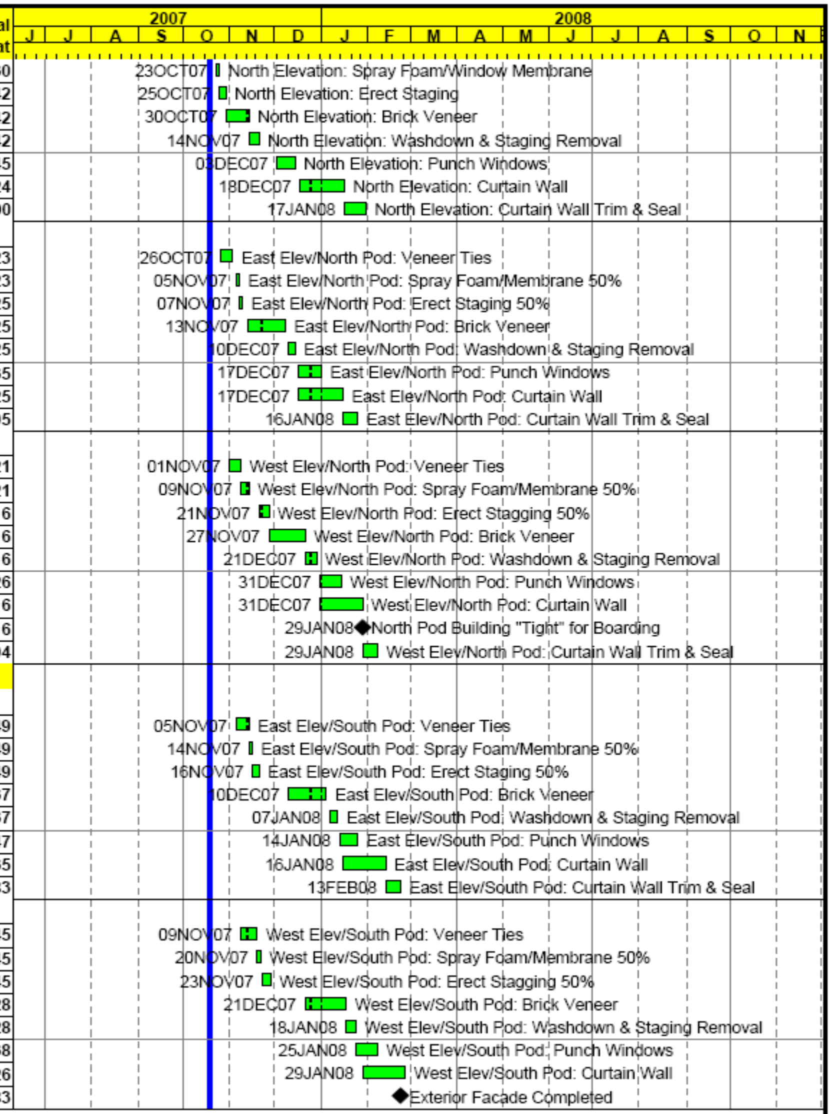
WP31

Sheet 1 of 14

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| 7323 | North Elevation: Spray Foam/Window Membrane | 2 | 2 | 23OCT07 | 24OCT07 | 30 |
| 7350 | North Elevation: Erect Staging | 3 | 3 | 25OCT07 | 29OCT07 | 42 |
| 7360 | North Elevation: Brick Veneer | 10 | 10 | 30OCT07 | 13NOV07 | 42 |
| 7392 | North Elevation: Washdown & Staging Removal | 5 | 5 | 14NOV07 | 20NOV07 | 42 |
| 7365 | North Elevation: Punch Windows | 10 | 10 | 03DEC07 | 14DEC07 | 45 |
| 7310 | North Elevation: Curtain Wall | 20 | 20 | 18DEC07 | 16JAN08 | 24 |
| 7311 | North Elevation: Curtain Wall Trim & Seal | 10 | 10 | 17JAN08 | 30JAN08 | 100 |
| **East Facade** | | | | | | |
| 7329 | East Elev/North Pod: Veneer Ties | 6 | 6 | 26OCT07 | 02NOV07 | 23 |
| 7315 | East Elev/North Pod: Spray Foam/Membrane 50% | 2 | 2 | 05NOV07 | 06NOV07 | 23 |
| 7314 | East Elev/North Pod: Erect Staging 50% | 3 | 3 | 07NOV07 | 09NOV07 | 25 |
| 7316 | East Elev/North Pod: Brick Veneer | 18 | 18 | 13NOV07 | 07DEC07 | 25 |
| 7318 | East Elev/North Pod: Washdown & Staging Removal | 5 | 5 | 10DEC07 | 14DEC07 | 25 |
| 7333 | East Elev/North Pod: Punch Windows | 10 | 10 | 17DEC07 | 31DEC07 | 35 |
| 7322 | East Elev/North Pod: Curtain Wall | 20 | 20 | 17DEC07 | 15JAN08 | 25 |
| 7347 | East Elev/North Pod: Curtain Wall Trim & Seal | 8 | 8 | 16JAN08 | 25JAN08 | 95 |
| **West Facade** | | | | | | |
| 7331 | West Elev/North Pod: Veneer Ties | 6 | 6 | 01NOV07 | 08NOV07 | 21 |
| 7339 | West Elev/North Pod: Spray Foam/Membrane 50% | 2 | 2 | 09NOV07 | 13NOV07 | 21 |
| 7338 | West Elev/North Pod: Erect Stagging 50% | 3 | 3 | 21NOV07 | 26NOV07 | 16 |
| 7340 | West Elev/North Pod: Brick Veneer | 18 | 18 | 27NOV07 | 20DEC07 | 16 |
| 7342 | West Elev/North Pod: Washdown & Staging Removal | 5 | 5 | 21DEC07 | 28DEC07 | 16 |
| 7343 | West Elev/North Pod: Punch Windows | 10 | 10 | 31DEC07 | 14JAN08 | 26 |
| 7345 | West Elev/North Pod: Curtain Wall | 20 | 20 | 31DEC07 | 28JAN08 | 16 |
| MS6 | North Pod Building "Tight" for Boarding | 0 | 0 | 29JAN08 | | 16 |
| 7346 | West Elev/North Pod: Curtain Wall Trim & Seal | 8 | 8 | 29JAN08 | 07FEB08 | 94 |
| **South Pod** | | | | | | |
| **East Facade** | | | | | | |
| 7329.1 | East Elev/South Pod: Veneer Ties | 6 | 6 | 05NOV07 | 13NOV07 | 49 |
| 7315.1 | East Elev/South Pod: Spray Foam/Membrane 50% | 2 | 2 | 14NOV07 | 15NOV07 | 49 |
| 7314.1 | East Elev/South Pod: Erect Staging 50% | 3 | 3 | 16NOV07 | 20NOV07 | 49 |
| 7316.S | East Elev/South Pod: Brick Veneer | 18 | 18 | 10DEC07 | 04JAN08 | 37 |
| 7318.S | East Elev/South Pod: Washdown & Staging Removal | 5 | 5 | 07JAN08 | 11JAN08 | 37 |
| 7333.S | East Elev/South Pod: Punch Windows | 10 | 10 | 14JAN08 | 25JAN08 | 47 |
| 7322.S | East Elev/South Pod: Curtain Wall | 20 | 20 | 16JAN08 | 12FEB08 | 35 |
| 7347.S | East Elev/South Pod: Curtain Wall Trim & Seal | 8 | 8 | 13FEB08 | 22FEB08 | 83 |
| **West Facade** | | | | | | |
| 7331.1 | West Elev/South Pod: Veneer Ties | 6 | 6 | 09NOV07 | 19NOV07 | 45 |
| 7339.1 | West Elev/South Pod: Spray Foam/Membrane 50% | 2 | 2 | 20NOV07 | 21NOV07 | 45 |
| 7338.1 | West Elev/South Pod: Erect Stagging 50% | 3 | 3 | 23NOV07 | 27NOV07 | 45 |
| 7340.S | West Elev/South Pod: Brick Veneer | 18 | 18 | 21DEC07 | 17JAN08 | 28 |
| 7342.S | West Elev/South Pod: Washdown & Staging Removal | 5 | 5 | 18JAN08 | 24JAN08 | 28 |
| 7343.S | West Elev/South Pod: Punch Windows | 10 | 10 | 25JAN08 | 07FEB08 | 38 |
| 7345.S | West Elev/South Pod: Curtain Wall | 20 | 20 | 29JAN08 | 25FEB08 | 26 |
| 7356 | Exterior Facade Completed | 0 | 0 | | 22FEB08 | 83 |




Start Date 30OCT06
Finish Date 22AUG08
Data Date 19OCT07
Run Date 19OCT07 13:38

Current Schedule
Progress Bar
Critical Activity



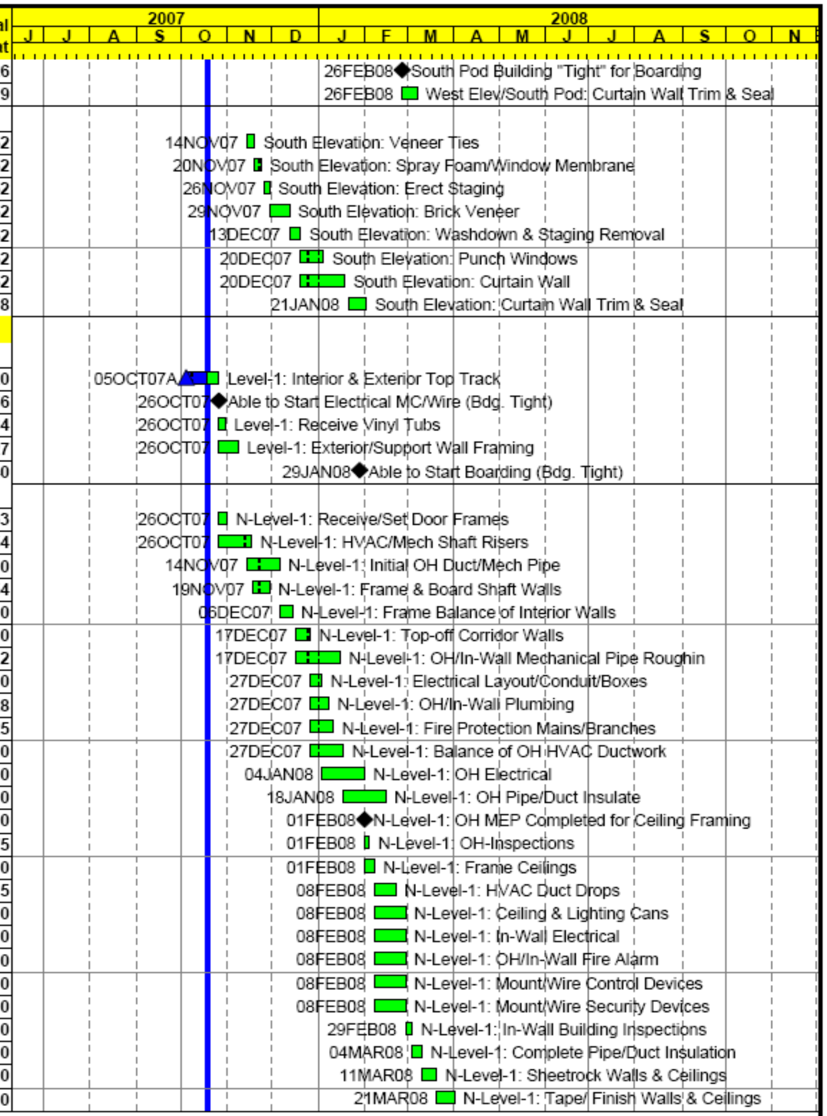
WP31

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

Sheet 2 of 14

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| MS6.S | South Pod Building "Tight" for Boarding | 0 | 0 | 26FEB08 | | 26 |
| 7346.S | West Elev/South Pod: Curtain Wall Trim & Seal | 8 | 8 | 26FEB08 | 06MAR08 | 119 |
| **South Facade** | | | | | | |
| 7352 | South Elevation: Veneer Ties | 4 | 4 | 14NOV07 | 19NOV07 | 52 |
| 7327 | South Elevation: Spray Foam/Window Membrane | 3 | 3 | 20NOV07 | 23NOV07 | 52 |
| 7326 | South Elevation: Erect Staging | 3 | 3 | 26NOV07 | 28NOV07 | 52 |
| 7328 | South Elevation: Brick Veneer | 10 | 10 | 29NOV07 | 12DEC07 | 52 |
| 7332 | South Elevation: Washdown & Staging Removal | 5 | 5 | 13DEC07 | 19DEC07 | 52 |
| 7348 | South Elevation: Punch Windows | 10 | 10 | 20DEC07 | 04JAN08 | 62 |
| 7349 | South Elevation: Curtain Wall | 20 | 20 | 20DEC07 | 18JAN08 | 52 |
| 7351 | South Elevation: Curtain Wall Trim & Seal | 10 | 10 | 21JAN08 | 01FEB08 | 98 |
| **Level 1** | | | | | | |
| **General Floor Area** | | | | | | |
| 612-0 | Level-1: Interior & Exterior Top Track | 10 | 5 | 05OCT07A | 25OCT07 | 20 |
| 745-0 | Able to Start Electrical MC/Wire (Bdg. Tight) | 0 | 0 | 26OCT07 | | 56 |
| 675-0 | Level-1: Receive Vinyl Tubs | 3 | 3 | 26OCT07 | 30OCT07 | 34 |
| 635-0 | Level-1: Exterior/Support Wall Framing | 10 | 10 | 26OCT07 | 08NOV07 | 27 |
| 980-0 | Able to Start Boarding (Bdg. Tight) | 0 | 0 | 29JAN08 | | 40 |
| **North Pod** | | | | | | |
| 730-0 | N-Level-1: Receive/Set Door Frames | 4 | 4 | 26OCT07 | 31OCT07 | 33 |
| 645-0 | N-Level-1: HVAC/Mech Shaft Risers | 15 | 15 | 26OCT07 | 16NOV07 | 54 |
| 646-0 | N-Level-1: Initial OH Duct/Mech Pipe | 15 | 15 | 14NOV07 | 05DEC07 | 10 |
| 654-0 | N-Level-1: Frame & Board Shaft Walls | 7 | 7 | 19NOV07 | 28NOV07 | 54 |
| 652-0 | N-Level-1: Frame Balance of Interior Walls | 7 | 7 | 06DEC07 | 14DEC07 | 10 |
| 650-0 | N-Level-1: Top-off Corridor Walls | 7 | 7 | 17DEC07 | 26DEC07 | 10 |
| 690-0 | N-Level-1: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 17DEC07 | 15JAN08 | 12 |
| 700-0 | N-Level-1: Electrical Layout/Conduit/Boxes | 5 | 5 | 27DEC07 | 03JAN08 | 10 |
| 750-0 | N-Level-1: OH/In-Wall Plumbing | 7 | 7 | 27DEC07 | 07JAN08 | 28 |
| 670-0 | N-Level-1: Fire Protection Mains/Branches | 10 | 10 | 27DEC07 | 10JAN08 | 25 |
| 680-0 | N-Level-1: Balance of OH HVAC Ductwork | 15 | 15 | 27DEC07 | 17JAN08 | 10 |
| 708-0 | N-Level-1: OH Electrical | 20 | 20 | 04JAN08 | 31JAN08 | 10 |
| 710-0 | N-Level-1: OH Pipe/Duct Insulate | 20 | 20 | 18JAN08 | 14FEB08 | 10 |
| 720-0 | N-Level-1: OH MEP Completed for Ceiling Framing | 0 | 0 | 01FEB08 | | 10 |
| 705-0 | N-Level-1: OH-Inspections | 2 | 2 | 01FEB08 | 04FEB08 | 75 |
| 740-0 | N-Level-1: Frame Ceilings | 5 | 5 | 01FEB08 | 07FEB08 | 10 |
| 800-0 | N-Level-1: HVAC Duct Drops | 10 | 10 | 08FEB08 | 21FEB08 | 15 |
| 760-0 | N-Level-1: Ceiling & Lighting Cans | 15 | 15 | 08FEB08 | 28FEB08 | 10 |
| 765-0 | N-Level-1: In-Wall Electrical | 15 | 15 | 08FEB08 | 28FEB08 | 10 |
| 770-0 | N-Level-1: OH/In-Wall Fire Alarm | 15 | 15 | 08FEB08 | 28FEB08 | 10 |
| 780-0 | N-Level-1: Mount/Wire Control Devices | 15 | 15 | 08FEB08 | 28FEB08 | 10 |
| 790-0 | N-Level-1: Mount/Wire Security Devices | 15 | 15 | 08FEB08 | 28FEB08 | 10 |
| 810-0 | N-Level-1: In-Wall Building Inspections | 2 | 2 | 29FEB08 | 03MAR08 | 10 |
| 820-0 | N-Level-1: Complete Pipe/Duct Insulation | 5 | 5 | 04MAR08 | 10MAR08 | 10 |
| 830-0 | N-Level-1: Sheetrock Walls & Ceilings | 8 | 8 | 11MAR08 | 20MAR08 | 10 |
| 840-0 | N-Level-1: Tape/ Finish Walls & Ceilings | 8 | 8 | 21MAR08 | 01APR08 | 10 |




| | | |
|---|---|---|
| Start Date | 30OCT06 | Current Schedule |
| Finish Date | 22AUG08 | Progress Bar |
| Data Date | 19OCT07 | Critical Activity |
| Run Date | 19OCT07 13:38 | |

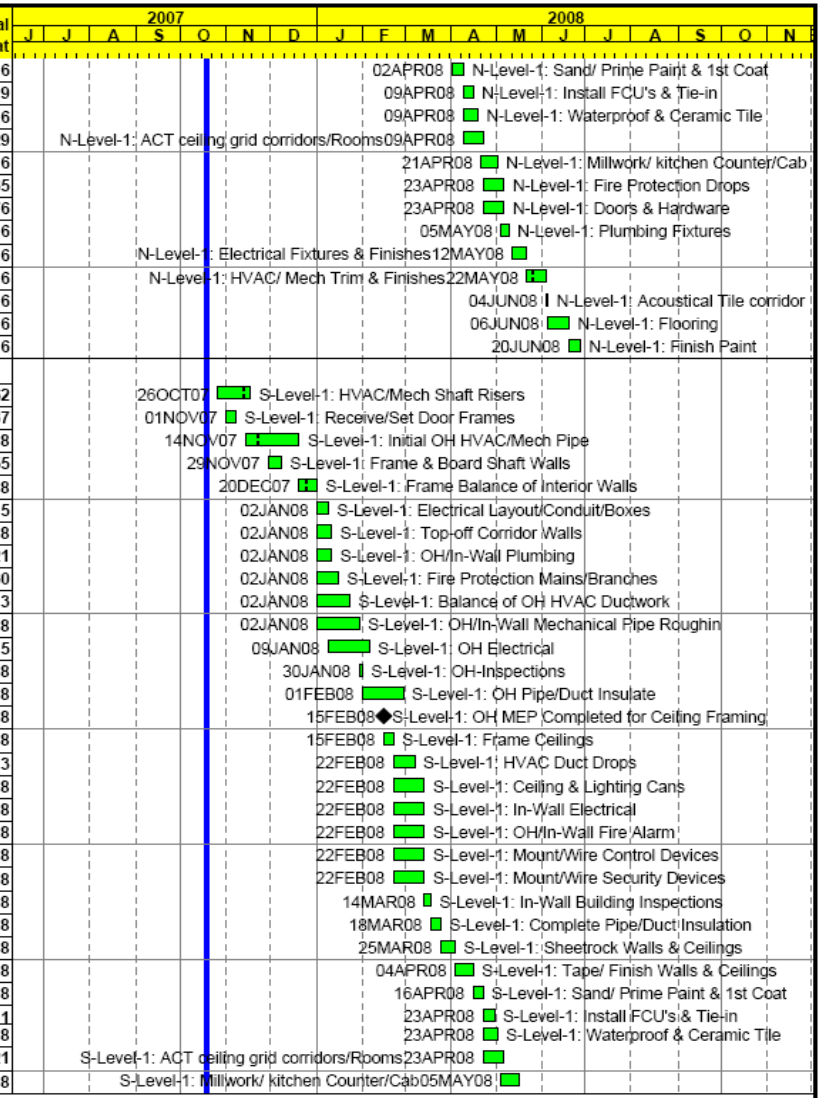
WP31

Sheet 3 of 14

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

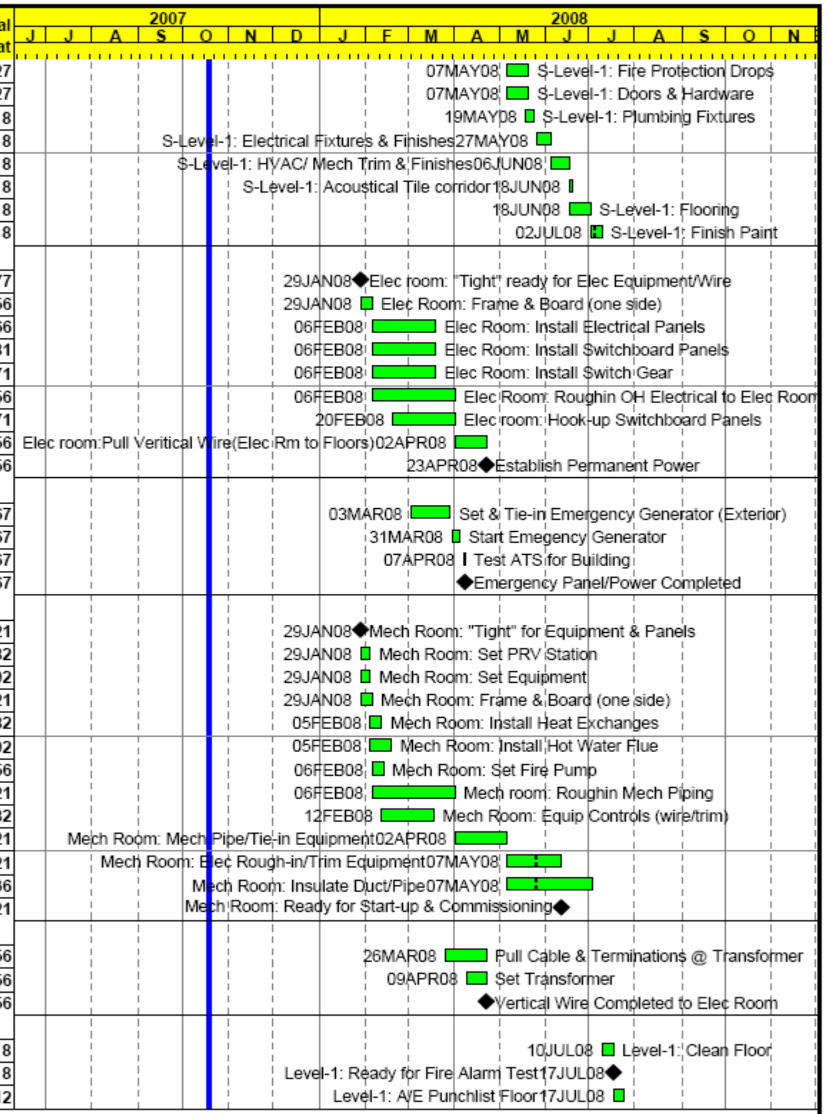
**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| 850-0 | N-Level-1: Sand/ Prime Paint & 1st Coat | 5 | 5 | 02APR08 | 08APR08 | 16 |
| 942-0 | N-Level-1: Install FCU's & Tie-in | 5 | 5 | 09APR08 | 15APR08 | 19 |
| 880-0 | N-Level-1: Waterproof & Ceramic Tile | 8 | 8 | 09APR08 | 18APR08 | 16 |
| 870-0 | N-Level-1: ACT ceiling grid corridors/Rooms | 10 | 10 | 09APR08 | 22APR08 | 29 |
| 910-0 | N-Level-1: Millwork/ kitchen Counter/Cab | 10 | 10 | 21APR08 | 02MAY08 | 16 |
| 890-0 | N-Level-1: Fire Protection Drops | 10 | 10 | 23APR08 | 06MAY08 | 35 |
| 900-0 | N-Level-1: Doors & Hardware | 10 | 10 | 23APR08 | 06MAY08 | 76 |
| 920-0 | N-Level-1: Plumbing Fixtures | 5 | 5 | 05MAY08 | 09MAY08 | 16 |
| 930-0 | N-Level-1: Electrical Fixtures & Finishes | 8 | 8 | 12MAY08 | 21MAY08 | 16 |
| 940-0 | N-Level-1: HVAC/ Mech Trim & Finishes | 8 | 8 | 22MAY08 | 03JUN08 | 16 |
| 950-0 | N-Level-1: Acoustical Tile corridor | 2 | 2 | 04JUN08 | 05JUN08 | 16 |
| 960-0 | N-Level-1: Flooring | 10 | 10 | 06JUN08 | 19JUN08 | 16 |
| 970-0 | N-Level-1: Finish Paint | 5 | 5 | 20JUN08 | 26JUN08 | 16 |
| **South Pod** | | | | | | |
| S-645-0 | S-Level-1: HVAC/Mech Shaft Risers | 15 | 15 | 26OCT07 | 16NOV07 | 62 |
| S-730-0 | S-Level-1: Receive/Set Door Frames | 4 | 4 | 01NOV07 | 06NOV07 | 37 |
| S-646-0 | S-Level-1: Initial OH HVAC/Mech Pipe | 25 | 25 | 14NOV07 | 19DEC07 | 8 |
| S-654-0 | S-Level-1: Frame & Board Shaft Walls | 7 | 7 | 29NOV07 | 07DEC07 | 55 |
| S-652-0 | S-Level-1: Frame Balance of Interior Walls | 7 | 7 | 20DEC07 | 31DEC07 | 8 |
| S-700-0 | S-Level-1: Electrical Layout/Conduit/Boxes | 5 | 5 | 02JAN08 | 08JAN08 | 15 |
| S-650-0 | S-Level-1: Top-off Corridor Walls | 7 | 7 | 02JAN08 | 10JAN08 | 8 |
| S-750-0 | S-Level-1: OH/In-Wall Plumbing | 7 | 7 | 02JAN08 | 10JAN08 | 21 |
| S-670-0 | S-Level-1: Fire Protection Mains/Branches | 10 | 10 | 02JAN08 | 15JAN08 | 30 |
| S-680-0 | S-Level-1: Balance of OH HVAC Ductwork | 15 | 15 | 02JAN08 | 22JAN08 | 13 |
| S-690-0 | S-Level-1: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 02JAN08 | 29JAN08 | 8 |
| S-708-0 | S-Level-1: OH Electrical | 20 | 20 | 09JAN08 | 05FEB08 | 15 |
| S-705-0 | S-Level-1: OH-Inspections | 2 | 2 | 30JAN08 | 31JAN08 | 8 |
| S-710-0 | S-Level-1: OH Pipe/Duct Insulate | 20 | 20 | 01FEB08 | 28FEB08 | 8 |
| S-720-0 | S-Level-1: OH MEP Completed for Ceiling Framing | 0 | 0 | 15FEB08 | | 8 |
| S-740-0 | S-Level-1: Frame Ceilings | 5 | 5 | 15FEB08 | 21FEB08 | 8 |
| S-800-0 | S-Level-1: HVAC Duct Drops | 10 | 10 | 22FEB08 | 06MAR08 | 13 |
| S-760-0 | S-Level-1: Ceiling & Lighting Cans | 15 | 15 | 22FEB08 | 13MAR08 | 8 |
| S-765-0 | S-Level-1: In-Wall Electrical | 15 | 15 | 22FEB08 | 13MAR08 | 8 |
| S-770-0 | S-Level-1: OH/In-Wall Fire Alarm | 15 | 15 | 22FEB08 | 13MAR08 | 8 |
| S-780-0 | S-Level-1: Mount/Wire Control Devices | 15 | 15 | 22FEB08 | 13MAR08 | 8 |
| S-790-0 | S-Level-1: Mount/Wire Security Devices | 15 | 15 | 22FEB08 | 13MAR08 | 8 |
| S-810-0 | S-Level-1: In-Wall Building Inspections | 2 | 2 | 14MAR08 | 17MAR08 | 8 |
| S-820-0 | S-Level-1: Complete Pipe/Duct Insulation | 5 | 5 | 18MAR08 | 24MAR08 | 8 |
| S-830-0 | S-Level-1: Sheetrock Walls & Ceilings | 8 | 8 | 25MAR08 | 03APR08 | 8 |
| S-840-0 | S-Level-1: Tape/ Finish Walls & Ceilings | 8 | 8 | 04APR08 | 15APR08 | 8 |
| S-850-0 | S-Level-1: Sand/ Prime Paint & 1st Coat | 5 | 5 | 16APR08 | 22APR08 | 8 |
| S-942-0 | S-Level-1: Install FCU's & Tie-in | 5 | 5 | 23APR08 | 29APR08 | 11 |
| S-880-0 | S-Level-1: Waterproof & Ceramic Tile | 8 | 8 | 23APR08 | 02MAY08 | 8 |
| S-870-0 | S-Level-1: ACT ceiling grid corridors/Rooms | 10 | 10 | 23APR08 | 06MAY08 | 21 |
| S-910-0 | S-Level-1: Millwork/ kitchen Counter/Cab | 10 | 10 | 05MAY08 | 16MAY08 | 8 |




| | | | | |
|---|---|---|---|---|
| Start Date 30OCT06<br>Finish Date 22AUG08<br>Data Date 19OCT07<br>Run Date 19OCT07 13:38 | Current Schedule<br>Progress Bar<br>Critical Activity | WP31<br>GILBANE BUILDING COMPANY<br>Constuction Activities<br>WPI RESIDENCE HALL | Sheet 4 of 14 | **Baseline Schedule Rev#0 Progress Update (WP31)**<br>**Constuction Schedule**<br>**Updated 19OCT07** |

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| S-890-0 | S-Level-1: Fire Protection Drops | 10 | 10 | 07MAY08 | 20MAY08 | 27 |
| S-900-0 | S-Level-1: Doors & Hardware | 10 | 10 | 07MAY08 | 20MAY08 | 27 |
| S-920-0 | S-Level-1: Plumbing Fixtures | 5 | 5 | 19MAY08 | 23MAY08 | 8 |
| S-930-0 | S-Level-1: Electrical Fixtures & Finishes | 8 | 8 | 27MAY08 | 05JUN08 | 8 |
| S-940-0 | S-Level-1: HVAC/ Mech Trim & Finishes | 8 | 8 | 06JUN08 | 17JUN08 | 8 |
| S-950-0 | S-Level-1: Acoustical Tile corridor | 2 | 2 | 18JUN08 | 19JUN08 | 8 |
| S-960-0 | S-Level-1: Flooring | 10 | 10 | 18JUN08 | 01JUL08 | 8 |
| S-970-0 | S-Level-1: Finish Paint | 5 | 5 | 02JUL08 | 09JUL08 | 8 |
| **Electrical Room** | | | | | | |
| 8490 | Elec room: "Tight" ready for Elec Equipment/Wire | 0 | 0 | 29JAN08 | | 77 |
| 8470 | Elec Room: Frame & Board (one side) | 6 | 6 | 29JAN08 | 05FEB08 | 56 |
| 8480 | Elec Room: Install Electrical Panels | 30 | 30 | 06FEB08 | 18MAR08 | 66 |
| 8500 | Elec Room: Install Switchboard Panels | 30 | 30 | 06FEB08 | 18MAR08 | 81 |
| 8502 | Elec Room: Install Switch Gear | 30 | 30 | 06FEB08 | 18MAR08 | 71 |
| 8460 | Elec Room: Roughin OH Electrical to Elec Room | 40 | 40 | 06FEB08 | 01APR08 | 56 |
| 8510 | Elec room: Hook-up Switchboard Panels | 30 | 30 | 20FEB08 | 01APR08 | 71 |
| 8520 | Elec room:Pull Veritical Wire(Elec Rm to Floors) | 15 | 15 | 02APR08 | 22APR08 | 56 |
| 8530 | Establish Permanent Power | 0 | 0 | 23APR08 | | 56 |
| **Emergency Generator** | | | | | | |
| 9080 | Set & Tie-in Emergency Generator (Exterior) | 20 | 20 | 03MAR08 | 28MAR08 | 67 |
| 8012 | Start Emegency Generator | 5 | 5 | 31MAR08 | 04APR08 | 67 |
| 8014 | Test ATS for Building | 1 | 1 | 07APR08 | 07APR08 | 67 |
| 9004 | Emergency Panel/Power Completed | 0 | 0 | | 07APR08 | 67 |
| **Mechanical Room** | | | | | | |
| 8580 | Mech Room: "Tight" for Equipment & Panels | 0 | 0 | 29JAN08 | | 21 |
| 8570 | Mech Room: Set PRV Station | 5 | 5 | 29JAN08 | 04FEB08 | 82 |
| 8590 | Mech Room: Set Equipment | 5 | 5 | 29JAN08 | 04FEB08 | 92 |
| 8582 | Mech Room: Frame & Board (one side) | 6 | 6 | 29JAN08 | 05FEB08 | 21 |
| 8620 | Mech Room: Install Heat Exchanges | 5 | 5 | 05FEB08 | 11FEB08 | 82 |
| 8670 | Mech Room: Install Hot Water Flue | 10 | 10 | 05FEB08 | 18FEB08 | 92 |
| 8600 | Mech Room: Set Fire Pump | 5 | 5 | 06FEB08 | 12FEB08 | 56 |
| 8560 | Mech room: Roughin Mech Piping | 40 | 40 | 06FEB08 | 01APR08 | 21 |
| 8630 | Mech Room: Equip Controls (wire/trim) | 25 | 25 | 12FEB08 | 17MAR08 | 82 |
| 8610 | Mech Room: Mech Pipe/Tie-in Equipment | 25 | 25 | 02APR08 | 06MAY08 | 21 |
| 8640 | Mech Room: Elec Rough-in/Trim Equipment | 25 | 25 | 07MAY08 | 11JUN08 | 21 |
| 8650 | Mech Room: Insulate Duct/Pipe | 40 | 40 | 07MAY08 | 02JUL08 | 36 |
| 8680 | Mech Room: Ready for Start-up & Commissioning | 0 | 0 | | 11JUN08 | 21 |
| **Transformer** | | | | | | |
| 9040 | Pull Cable & Terminations @ Transformer | 20 | 20 | 26MAR08 | 22APR08 | 56 |
| 9030 | Set Transformer | 10 | 10 | 09APR08 | 22APR08 | 56 |
| 9060 | Vertical Wire Completed to Elec Room | 0 | 0 | | 22APR08 | 56 |
| **Floor Closeout** | | | | | | |
| 8250 | Level-1: Clean Floor | 5 | 5 | 10JUL08 | 16JUL08 | 8 |
| 8255 | Level-1: Ready for Fire Alarm Test | 0 | 0 | 17JUL08 | | 8 |
| 8260 | Level-1: A/E Punchlist Floor | 5 | 5 | 17JUL08 | 23JUL08 | 12 |




| | |
|---|---|
| Start Date | 30OCT06 |
| Finish Date | 22AUG08 |
| Data Date | 19OCT07 |
| Run Date | 19OCT07 13:38 |

Current Schedule
Progress Bar
Critical Activity

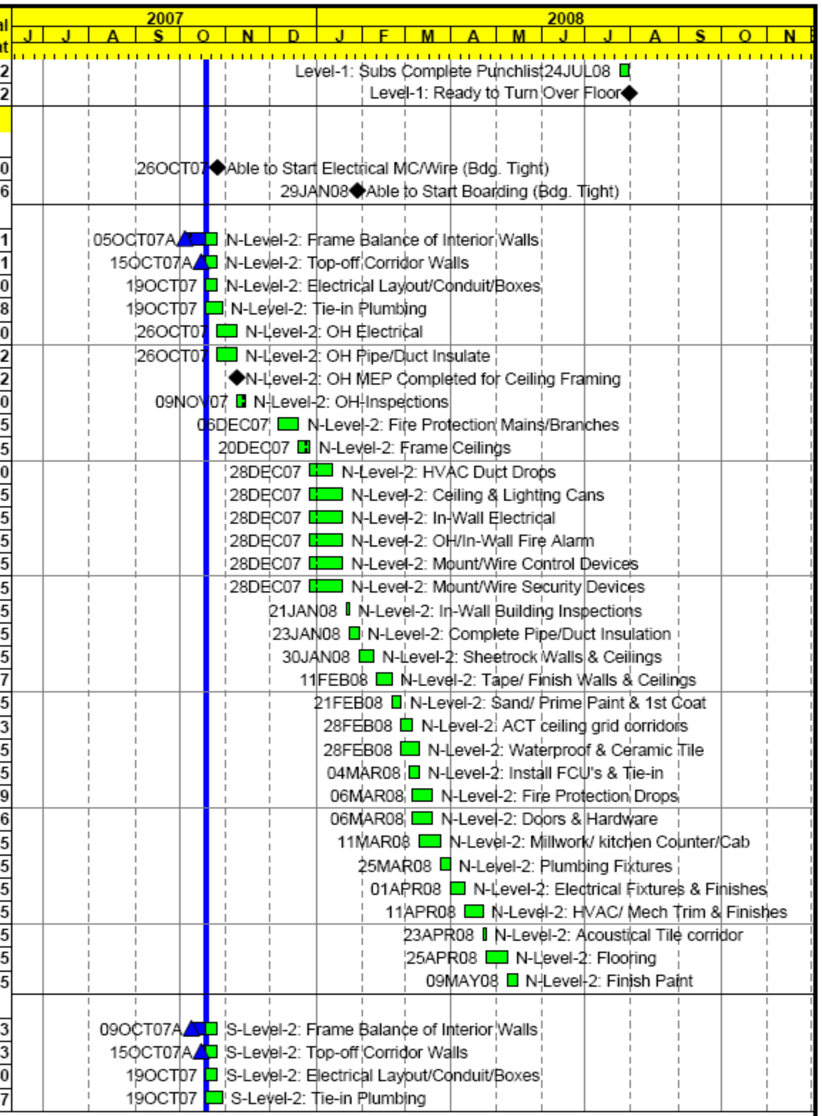
WP31

Sheet 5 of 14

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| 8270 | Level-1: Subs Complete Punchlist | 5 | 5 | 24JUL08 | 30JUL08 | 12 |
| 8280 | Level-1: Ready to Turn Over Floor | 0 | 0 | | 30JUL08 | 12 |
| **Level 2** | | | | | | |
| **General Floor Area** | | | | | | |
| 745 | Able to Start Electrical MC/Wire (Bdg. Tight) | 0 | 0 | 26OCT07 | | 40 |
| 980 | Able to Start Boarding (Bdg. Tight) | 0 | 0 | 29JAN08 | | 16 |
| **North Pod** | | | | | | |
| 652 | N-Level-2: Frame Balance of Interior Walls | 7 | 5 | 05OCT07A | 25OCT07 | 31 |
| 650 | N-Level-2: Top-off Corridor Walls | 7 | 5 | 15OCT07A | 25OCT07 | 31 |
| 700 | N-Level-2: Electrical Layout/Conduit/Boxes | 5 | 5 | 19OCT07 | 25OCT07 | 40 |
| 750 | N-Level-2: Tie-in Plumbing | 7 | 7 | 19OCT07 | 29OCT07 | 48 |
| 708 | N-Level-2: OH Electrical | 10 | 10 | 26OCT07 | 08NOV07 | 40 |
| 710 | N-Level-2: OH Pipe/Duct Insulate | 10 | 10 | 26OCT07 | 08NOV07 | 42 |
| 720 | N-Level-2: OH MEP Completed for Ceiling Framing | 0 | 0 | | 08NOV07 | 42 |
| 705 | N-Level-2: OH-Inspections | 2 | 2 | 09NOV07 | 13NOV07 | 40 |
| 670 | N-Level-2: Fire Protection Mains/Branches | 10 | 10 | 06DEC07 | 19DEC07 | 15 |
| 740 | N-Level-2: Frame Ceilings | 5 | 5 | 20DEC07 | 27DEC07 | 15 |
| 800 | N-Level-2: HVAC Duct Drops | 10 | 10 | 28DEC07 | 11JAN08 | 20 |
| 760 | N-Level-2: Ceiling & Lighting Cans | 15 | 15 | 28DEC07 | 18JAN08 | 15 |
| 765 | N-Level-2: In-Wall Electrical | 15 | 15 | 28DEC07 | 18JAN08 | 15 |
| 770 | N-Level-2: OH/In-Wall Fire Alarm | 15 | 15 | 28DEC07 | 18JAN08 | 15 |
| 780 | N-Level-2: Mount/Wire Control Devices | 15 | 15 | 28DEC07 | 18JAN08 | 15 |
| 790 | N-Level-2: Mount/Wire Security Devices | 15 | 15 | 28DEC07 | 18JAN08 | 15 |
| 810 | N-Level-2: In-Wall Building Inspections | 2 | 2 | 21JAN08 | 22JAN08 | 15 |
| 820 | N-Level-2: Complete Pipe/Duct Insulation | 5 | 5 | 23JAN08 | 29JAN08 | 15 |
| 830 | N-Level-2: Sheetrock Walls & Ceilings | 8 | 8 | 30JAN08 | 08FEB08 | 15 |
| 840 | N-Level-2: Tape/ Finish Walls & Ceilings | 8 | 8 | 11FEB08 | 20FEB08 | 37 |
| 850 | N-Level-2: Sand/ Prime Paint & 1st Coat | 5 | 5 | 21FEB08 | 27FEB08 | 45 |
| 870 | N-Level-2: ACT ceiling grid corridors | 5 | 5 | 28FEB08 | 05MAR08 | 63 |
| 880 | N-Level-2: Waterproof & Ceramic Tile | 8 | 8 | 28FEB08 | 10MAR08 | 45 |
| 942 | N-Level-2: Install FCU's & Tie-in | 5 | 5 | 04MAR08 | 10MAR08 | 45 |
| 890 | N-Level-2: Fire Protection Drops | 10 | 10 | 06MAR08 | 19MAR08 | 69 |
| 900 | N-Level-2: Doors & Hardware | 10 | 10 | 06MAR08 | 19MAR08 | 86 |
| 910 | N-Level-2: Millwork/ kitchen Counter/Cab | 10 | 10 | 11MAR08 | 24MAR08 | 45 |
| 920 | N-Level-2: Plumbing Fixtures | 5 | 5 | 25MAR08 | 31MAR08 | 45 |
| 930 | N-Level-2: Electrical Fixtures & Finishes | 8 | 8 | 01APR08 | 10APR08 | 45 |
| 940 | N-Level-2: HVAC/ Mech Trim & Finishes | 8 | 8 | 11APR08 | 22APR08 | 45 |
| 950 | N-Level-2: Acoustical Tile corridor | 2 | 2 | 23APR08 | 24APR08 | 45 |
| 960 | N-Level-2: Flooring | 10 | 10 | 25APR08 | 08MAY08 | 45 |
| 970 | N-Level-2: Finish Paint | 5 | 5 | 09MAY08 | 15MAY08 | 45 |
| **South Pod** | | | | | | |
| S-652 | S-Level-2: Frame Balance of Interior Walls | 7 | 5 | 09OCT07A | 25OCT07 | 43 |
| S-650 | S-Level-2: Top-off Corridor Walls | 7 | 5 | 15OCT07A | 25OCT07 | 43 |
| S-700 | S-Level-2: Electrical Layout/Conduit/Boxes | 5 | 5 | 19OCT07 | 25OCT07 | 50 |
| S-750 | S-Level-2: Tie-in Plumbing | 7 | 7 | 19OCT07 | 29OCT07 | 57 |




Start Date 30OCT06
Finish Date 22AUG08
Data Date 19OCT07
Run Date 19OCT07 13:38



Current Schedule
Progress Bar
Critical Activity

WP31

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

Sheet 6 of 14

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| S-708 | S-Level-2: OH Electrical | 10 | 10 | 26OCT07 | 08NOV07 | 50 |
| S-705 | S-Level-2: OH-Inspections | 2 | 2 | 09NOV07 | 13NOV07 | 50 |
| S-710 | S-Level-2: OH Pipe/Duct Insulate | 10 | 10 | 14NOV07 | 28NOV07 | 50 |
| S-720 | S-Level-2: OH MEP Completed for Ceiling Framing | 0 | 0 | | 28NOV07 | 60 |
| S-670 | S-Level-2: Fire Protection Mains/Branches | 10 | 10 | 06DEC07 | 19DEC07 | 45 |
| S-740 | S-Level-2: Frame Ceilings | 5 | 5 | 28DEC07 | 04JAN08 | 40 |
| S-800 | S-Level-2: HVAC Duct Drops | 10 | 10 | 07JAN08 | 18JAN08 | 45 |
| S-760 | S-Level-2: Ceiling & Lighting Cans | 15 | 15 | 07JAN08 | 25JAN08 | 40 |
| S-765 | S-Level-2: In-Wall Electrical | 15 | 15 | 07JAN08 | 25JAN08 | 40 |
| S-770 | S-Level-2: OH/In-Wall Fire Alarm | 15 | 15 | 07JAN08 | 25JAN08 | 40 |
| S-780 | S-Level-2: Mount/Wire Control Devices | 15 | 15 | 07JAN08 | 25JAN08 | 40 |
| S-790 | S-Level-2: Mount/Wire Security Devices | 15 | 15 | 07JAN08 | 25JAN08 | 40 |
| S-810 | S-Level-2: In-Wall Building Inspections | 2 | 2 | 28JAN08 | 29JAN08 | 40 |
| S-820 | S-Level-2: Complete Pipe/Duct Insulation | 5 | 5 | 30JAN08 | 05FEB08 | 40 |
| S-830 | S-Level-2: Sheetrock Walls & Ceilings | 8 | 8 | 26FEB08 | 06MAR08 | 26 |
| S-840 | S-Level-2: Tape/ Finish Walls & Ceilings | 8 | 8 | 07MAR08 | 18MAR08 | 26 |
| S-850 | S-Level-2: Sand/ Prime Paint & 1st Coat | 5 | 5 | 19MAR08 | 25MAR08 | 26 |
| S-870 | S-Level-2: ACT ceiling grid corridors | 5 | 5 | 26MAR08 | 01APR08 | 44 |
| S-942 | S-Level-2: Install FCU's & Tie-in | 5 | 5 | 26MAR08 | 01APR08 | 29 |
| S-880 | S-Level-2: Waterproof & Ceramic Tile | 8 | 8 | 26MAR08 | 04APR08 | 26 |
| S-890 | S-Level-2: Fire Protection Drops | 10 | 10 | 02APR08 | 15APR08 | 50 |
| S-900 | S-Level-2: Doors & Hardware | 10 | 10 | 02APR08 | 15APR08 | 52 |
| S-910 | S-Level-2: Millwork/ kitchen Counter/Cab | 10 | 10 | 07APR08 | 18APR08 | 26 |
| S-920 | S-Level-2: Plumbing Fixtures | 5 | 5 | 21APR08 | 25APR08 | 26 |
| S-930 | S-Level-2: Electrical Fixtures & Finishes | 8 | 8 | 28APR08 | 07MAY08 | 26 |
| S-940 | S-Level-2: HVAC/ Mech Trim & Finishes | 8 | 8 | 08MAY08 | 19MAY08 | 26 |
| S-950 | S-Level-2: Acoustical Tile corridor | 2 | 2 | 20MAY08 | 21MAY08 | 26 |
| S-960 | S-Level-2: Flooring | 10 | 10 | 22MAY08 | 05JUN08 | 26 |
| S-970 | S-Level-2: Finish Paint | 5 | 5 | 06JUN08 | 12JUN08 | 26 |
| **Floor Closeout** | | | | | | |
| 990 | Level-2: Clean Floor | 5 | 5 | 13JUN08 | 19JUN08 | 26 |
| 992 | Level-2: Ready for Fire Alarm Test | 0 | 0 | 20JUN08 | | 26 |
| 994 | Level-2: A/E Punchlist Floor | 5 | 5 | 20JUN08 | 26JUN08 | 30 |
| 996 | Level-2: Subs Complete Punchlist | 5 | 5 | 27JUN08 | 03JUL08 | 30 |
| 998 | Level-2: Ready to Turn Over Floor | 0 | 0 | | 03JUL08 | 30 |
| **Level 3** | | | | | | |
| **General Floor Area** | | | | | | |
| 745-3 | Able to Start Electrical MC/Wire (Bdg. Tight) | 0 | 0 | 26OCT07 | | 50 |
| 980-3 | Able to Start Boarding (Bdg. Tight North Pod) | 0 | 0 | 29JAN08 | | 24 |
| **North Pod** | | | | | | |
| 700-3 | N-Level-3: Electrical Layout/Conduit/Boxes | 5 | 5 | 19OCT07 | 25OCT07 | 50 |
| 650-3 | N-Level-3: Top-off Corridor Walls | 7 | 7 | 19OCT07 | 29OCT07 | 33 |
| 652-3 | N-Level-3: Frame Balance of Interior Walls | 7 | 7 | 19OCT07 | 29OCT07 | 29 |
| 680-3 | N-Level-3: Balance of OH HVAC Ductwork | 7 | 7 | 19OCT07 | 29OCT07 | 48 |
| 690-3 | N-Level-3: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 23OCT07 | 20NOV07 | 31 |

Start Date 30OCT06
Finish Date 22AUG08
Data Date 19OCT07
Run Date 19OCT07 13:38

Current Schedule
Progress Bar
Critical Activity

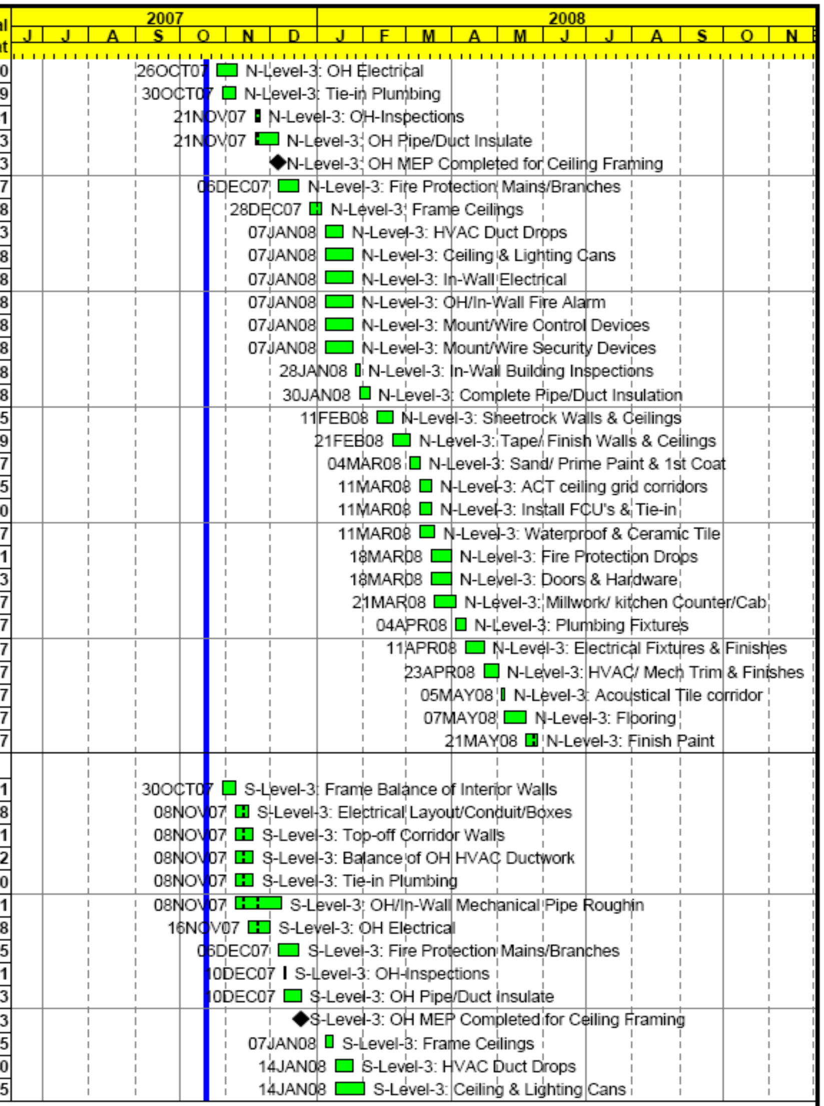
WP31

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

Sheet 7 of 14

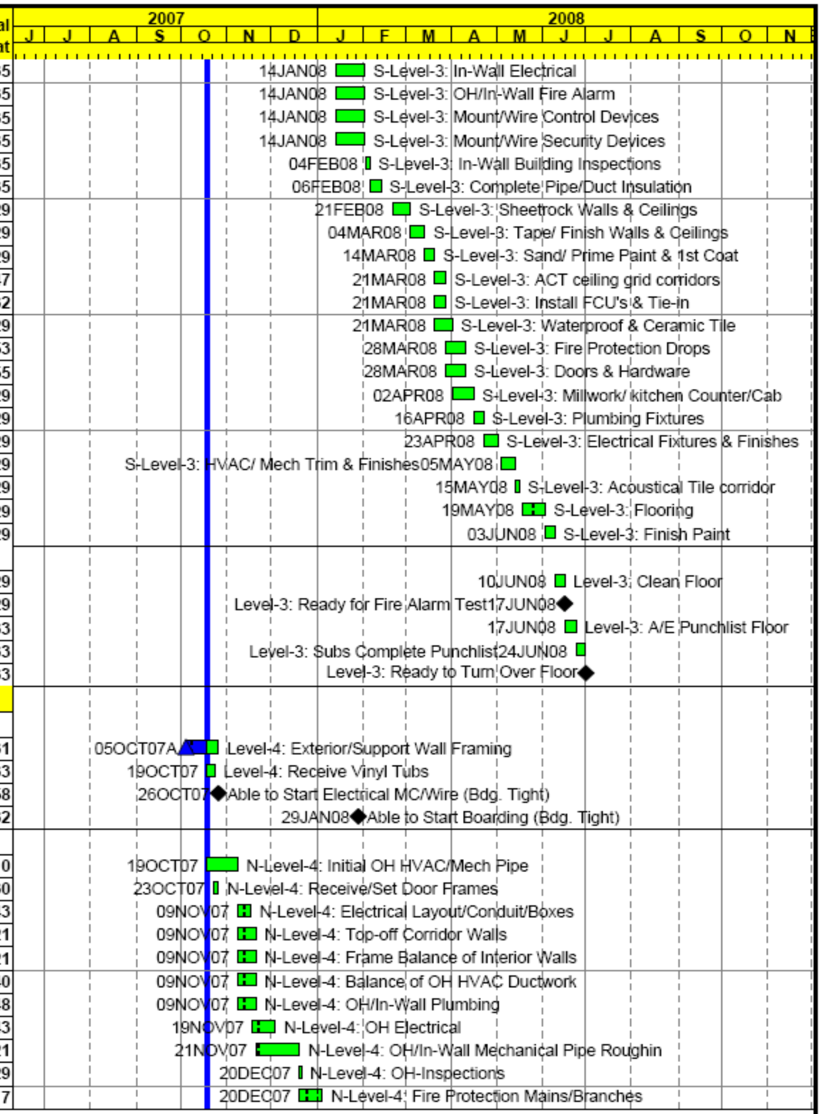
**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| 708-3 | N-Level-3: OH Electrical | 10 | 10 | 26OCT07 | 08NOV07 | 50 |
| 750-3 | N-Level-3: Tie-in Plumbing | 7 | 7 | 30OCT07 | 07NOV07 | 49 |
| 705-3 | N-Level-3: OH-Inspections | 2 | 2 | 21NOV07 | 23NOV07 | 41 |
| 710-3 | N-Level-3: OH Pipe/Duct Insulate | 10 | 10 | 21NOV07 | 05DEC07 | 33 |
| 720-3 | N-Level-3: OH MEP Completed for Ceiling Framing | 0 | 0 | | 05DEC07 | 33 |
| 670-3 | N-Level-3: Fire Protection Mains/Branches | 10 | 10 | 06DEC07 | 19DEC07 | 17 |
| 740-3 | N-Level-3: Frame Ceilings | 5 | 5 | 28DEC07 | 04JAN08 | 18 |
| 800-3 | N-Level-3: HVAC Duct Drops | 10 | 10 | 07JAN08 | 18JAN08 | 23 |
| 760-3 | N-Level-3: Ceiling & Lighting Cans | 15 | 15 | 07JAN08 | 25JAN08 | 18 |
| 765-3 | N-Level-3: In-Wall Electrical | 15 | 15 | 07JAN08 | 25JAN08 | 18 |
| 770-3 | N-Level-3: OH/In-Wall Fire Alarm | 15 | 15 | 07JAN08 | 25JAN08 | 18 |
| 780-3 | N-Level-3: Mount/Wire Control Devices | 15 | 15 | 07JAN08 | 25JAN08 | 18 |
| 790-3 | N-Level-3: Mount/Wire Security Devices | 15 | 15 | 07JAN08 | 25JAN08 | 18 |
| 810-3 | N-Level-3: In-Wall Building Inspections | 2 | 2 | 28JAN08 | 29JAN08 | 18 |
| 820-3 | N-Level-3: Complete Pipe/Duct Insulation | 5 | 5 | 30JAN08 | 05FEB08 | 18 |
| 830-3 | N-Level-3: Sheetrock Walls & Ceilings | 8 | 8 | 11FEB08 | 20FEB08 | 15 |
| 840-3 | N-Level-3: Tape/ Finish Walls & Ceilings | 8 | 8 | 21FEB08 | 03MAR08 | 29 |
| 850-3 | N-Level-3: Sand/ Prime Paint & 1st Coat | 5 | 5 | 04MAR08 | 10MAR08 | 37 |
| 870-3 | N-Level-3: ACT ceiling grid corridors | 5 | 5 | 11MAR08 | 17MAR08 | 55 |
| 942-3 | N-Level-3: Install FCU's & Tie-in | 5 | 5 | 11MAR08 | 17MAR08 | 40 |
| 880-3 | N-Level-3: Waterproof & Ceramic Tile | 8 | 8 | 11MAR08 | 20MAR08 | 37 |
| 890-3 | N-Level-3: Fire Protection Drops | 10 | 10 | 18MAR08 | 31MAR08 | 61 |
| 900-3 | N-Level-3: Doors & Hardware | 10 | 10 | 18MAR08 | 31MAR08 | 63 |
| 910-3 | N-Level-3: Millwork/ kitchen Counter/Cab | 10 | 10 | 21MAR08 | 03APR08 | 37 |
| 920-3 | N-Level-3: Plumbing Fixtures | 5 | 5 | 04APR08 | 10APR08 | 37 |
| 930-3 | N-Level-3: Electrical Fixtures & Finishes | 8 | 8 | 11APR08 | 22APR08 | 37 |
| 940-3 | N-Level-3: HVAC/ Mech Trim & Finishes | 8 | 8 | 23APR08 | 02MAY08 | 37 |
| 950-3 | N-Level-3: Acoustical Tile corridor | 2 | 2 | 05MAY08 | 06MAY08 | 37 |
| 960-3 | N-Level-3: Flooring | 10 | 10 | 07MAY08 | 20MAY08 | 37 |
| 970-3 | N-Level-3: Finish Paint | 5 | 5 | 21MAY08 | 28MAY08 | 37 |
| **South Pod** | | | | | | |
| S-652-3 | S-Level-3: Frame Balance of Interior Walls | 7 | 7 | 30OCT07 | 07NOV07 | 31 |
| S-700-3 | S-Level-3: Electrical Layout/Conduit/Boxes | 5 | 5 | 08NOV07 | 15NOV07 | 58 |
| S-650-3 | S-Level-3: Top-off Corridor Walls | 7 | 7 | 08NOV07 | 19NOV07 | 31 |
| S-680-3 | S-Level-3: Balance of OH HVAC Ductwork | 7 | 7 | 08NOV07 | 19NOV07 | 42 |
| S-750-3 | S-Level-3: Tie-in Plumbing | 7 | 7 | 08NOV07 | 19NOV07 | 50 |
| S-690-3 | S-Level-3: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 08NOV07 | 07DEC07 | 31 |
| S-708-3 | S-Level-3: OH Electrical | 10 | 10 | 16NOV07 | 30NOV07 | 58 |
| S-670-3 | S-Level-3: Fire Protection Mains/Branches | 10 | 10 | 06DEC07 | 19DEC07 | 25 |
| S-705-3 | S-Level-3: OH-Inspections | 2 | 2 | 10DEC07 | 11DEC07 | 51 |
| S-710-3 | S-Level-3: OH Pipe/Duct Insulate | 10 | 10 | 10DEC07 | 21DEC07 | 43 |
| S-720-3 | S-Level-3: OH MEP Completed for Ceiling Framing | 0 | 0 | | 21DEC07 | 43 |
| S-740-3 | S-Level-3: Frame Ceilings | 5 | 5 | 07JAN08 | 11JAN08 | 35 |
| S-800-3 | S-Level-3: HVAC Duct Drops | 10 | 10 | 14JAN08 | 25JAN08 | 40 |
| S-760-3 | S-Level-3: Ceiling & Lighting Cans | 15 | 15 | 14JAN08 | 01FEB08 | 35 |



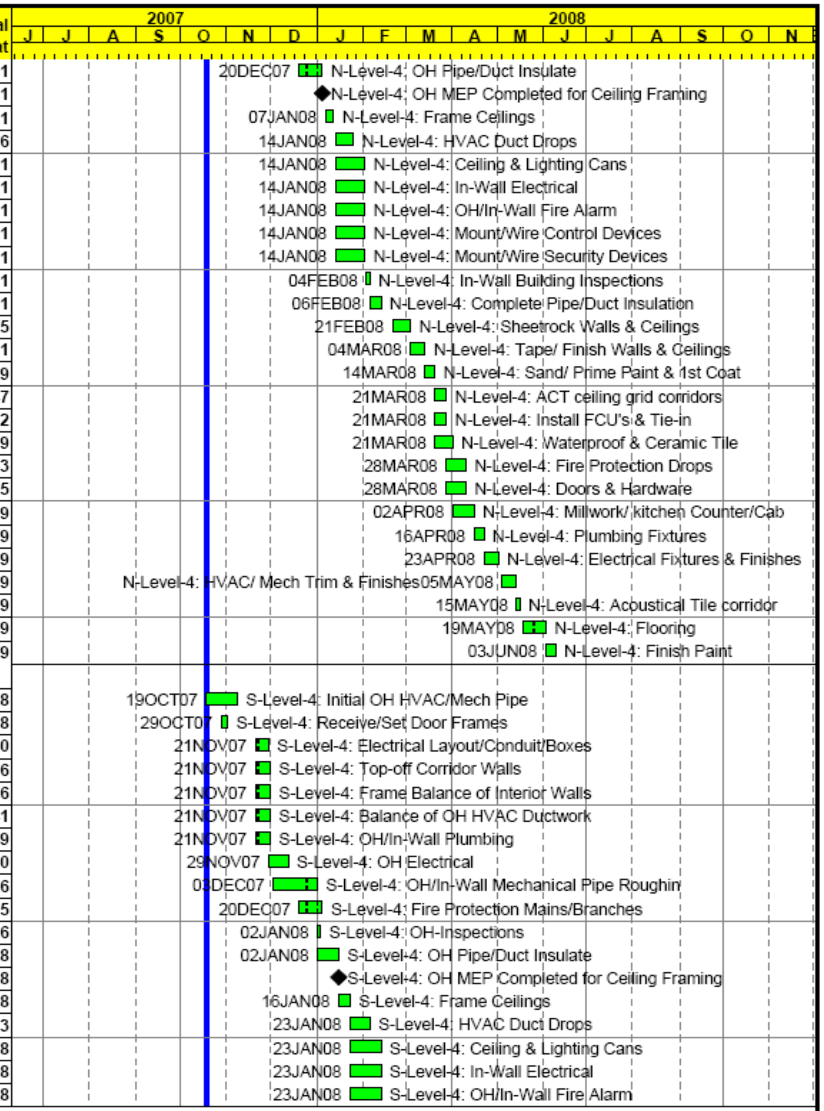

| | | | |
|---|---|---|---|
| Start Date 30OCT06<br>Finish Date 22AUG08<br>Data Date 19OCT07<br>Run Date 19OCT07 13:38 | Current Schedule<br>Progress Bar<br>Critical Activity | WP31<br>GILBANE BUILDING COMPANY<br>Constuction Activities<br>WPI RESIDENCE HALL | Sheet 8 of 14<br>**Baseline Schedule Rev#0 Progress Update (WP31)**<br>**Constuction Schedule**<br>**Updated 19OCT07** |

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| S-765-3 | S-Level-3: In-Wall Electrical | 15 | 15 | 14JAN08 | 01FEB08 | 35 |
| S-770-3 | S-Level-3: OH/In-Wall Fire Alarm | 15 | 15 | 14JAN08 | 01FEB08 | 35 |
| S-780-3 | S-Level-3: Mount/Wire Control Devices | 15 | 15 | 14JAN08 | 01FEB08 | 35 |
| S-790-3 | S-Level-3: Mount/Wire Security Devices | 15 | 15 | 14JAN08 | 01FEB08 | 35 |
| S-810-3 | S-Level-3: In-Wall Building Inspections | 2 | 2 | 04FEB08 | 05FEB08 | 35 |
| S-820-3 | S-Level-3: Complete Pipe/Duct Insulation | 5 | 5 | 06FEB08 | 12FEB08 | 35 |
| S-830-3 | S-Level-3: Sheetrock Walls & Ceilings | 8 | 8 | 21FEB08 | 03MAR08 | 29 |
| S-840-3 | S-Level-3: Tape/ Finish Walls & Ceilings | 8 | 8 | 04MAR08 | 13MAR08 | 29 |
| S-850-3 | S-Level-3: Sand/ Prime Paint & 1st Coat | 5 | 5 | 14MAR08 | 20MAR08 | 29 |
| S-870-3 | S-Level-3: ACT ceiling grid corridors | 5 | 5 | 21MAR08 | 27MAR08 | 47 |
| S-942-3 | S-Level-3: Install FCU's & Tie-in | 5 | 5 | 21MAR08 | 27MAR08 | 32 |
| S-880-3 | S-Level-3: Waterproof & Ceramic Tile | 8 | 8 | 21MAR08 | 01APR08 | 29 |
| S-890-3 | S-Level-3: Fire Protection Drops | 10 | 10 | 28MAR08 | 10APR08 | 53 |
| S-900-3 | S-Level-3: Doors & Hardware | 10 | 10 | 28MAR08 | 10APR08 | 55 |
| S-910-3 | S-Level-3: Millwork/ kitchen Counter/Cab | 10 | 10 | 02APR08 | 15APR08 | 29 |
| S-920-3 | S-Level-3: Plumbing Fixtures | 5 | 5 | 16APR08 | 22APR08 | 29 |
| S-930-3 | S-Level-3: Electrical Fixtures & Finishes | 8 | 8 | 23APR08 | 02MAY08 | 29 |
| S-940-3 | S-Level-3: HVAC/ Mech Trim & Finishes | 8 | 8 | 05MAY08 | 14MAY08 | 29 |
| S-950-3 | S-Level-3: Acoustical Tile corridor | 2 | 2 | 15MAY08 | 16MAY08 | 29 |
| S-960-3 | S-Level-3: Flooring | 10 | 10 | 19MAY08 | 02JUN08 | 29 |
| S-970-3 | S-Level-3: Finish Paint | 5 | 5 | 03JUN08 | 09JUN08 | 29 |
| **Floor Closeout** | | | | | | |
| 8250-3 | Level-3: Clean Floor | 5 | 5 | 10JUN08 | 16JUN08 | 29 |
| 8255-3 | Level-3: Ready for Fire Alarm Test | 0 | 0 | 17JUN08 | | 29 |
| 8260-3 | Level-3: A/E Punchlist Floor | 5 | 5 | 17JUN08 | 23JUN08 | 33 |
| 8270-3 | Level-3: Subs Complete Punchlist | 5 | 5 | 24JUN08 | 30JUN08 | 33 |
| 8280-3 | Level-3: Ready to Turn Over Floor | 0 | 0 | | 30JUN08 | 33 |
| **Level 4** | | | | | | |
| **General Floor Area** | | | | | | |
| 635-4 | Level-4: Exterior/Support Wall Framing | 10 | 5 | 05OCT07A | 25OCT07 | 31 |
| 675-4 | Level-4: Receive Vinyl Tubs | 3 | 3 | 19OCT07 | 23OCT07 | 33 |
| 745-4 | Able to Start Electrical MC/Wire (Bdg. Tight) | 0 | 0 | 26OCT07 | | 58 |
| 980-4 | Able to Start Boarding (Bdg. Tight) | 0 | 0 | 29JAN08 | | 32 |
| **North Pod** | | | | | | |
| 646-4 | N-Level-4: Initial OH HVAC/Mech Pipe | 15 | 15 | 19OCT07 | 08NOV07 | 10 |
| 730-4 | N-Level-4: Receive/Set Door Frames | 4 | 4 | 23OCT07 | 26OCT07 | 30 |
| 700-4 | N-Level-4: Electrical Layout/Conduit/Boxes | 5 | 5 | 09NOV07 | 16NOV07 | 43 |
| 650-4 | N-Level-4: Top-off Corridor Walls | 7 | 7 | 09NOV07 | 20NOV07 | 21 |
| 652-4 | N-Level-4: Frame Balance of Interior Walls | 7 | 7 | 09NOV07 | 20NOV07 | 21 |
| 680-4 | N-Level-4: Balance of OH HVAC Ductwork | 7 | 7 | 09NOV07 | 20NOV07 | 40 |
| 750-4 | N-Level-4: OH/In-Wall Plumbing | 7 | 7 | 09NOV07 | 20NOV07 | 48 |
| 708-4 | N-Level-4: OH Electrical | 10 | 10 | 19NOV07 | 03DEC07 | 43 |
| 690-4 | N-Level-4: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 21NOV07 | 19DEC07 | 21 |
| 705-4 | N-Level-4: OH-Inspections | 2 | 2 | 20DEC07 | 21DEC07 | 29 |
| 670-4 | N-Level-4: Fire Protection Mains/Branches | 10 | 10 | 20DEC07 | 04JAN08 | 17 |




| | | | |
|---|---|---|---|
| Start Date 30OCT06<br>Finish Date 22AUG08<br>Data Date 19OCT07<br>Run Date 19OCT07 13:38 | Current Schedule<br>Progress Bar<br>Critical Activity | WP31<br>GILBANE BUILDING COMPANY<br>Constuction Activities<br>WPI RESIDENCE HALL | Sheet 9 of 14<br>**Baseline Schedule Rev#0 Progress Update (WP31)**<br>**Constuction Schedule**<br>**Updated 19OCT07** |

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| 710-4 | N-Level-4: OH Pipe/Duct Insulate | 10 | 10 | 20DEC07 | 04JAN08 | 21 |
| 720-4 | N-Level-4: OH MEP Completed for Ceiling Framing | 0 | 0 | | 04JAN08 | 21 |
| 740-4 | N-Level-4: Frame Ceilings | 5 | 5 | 07JAN08 | 11JAN08 | 21 |
| 800-4 | N-Level-4: HVAC Duct Drops | 10 | 10 | 14JAN08 | 25JAN08 | 26 |
| 760-4 | N-Level-4: Ceiling & Lighting Cans | 15 | 15 | 14JAN08 | 01FEB08 | 21 |
| 765-4 | N-Level-4: In-Wall Electrical | 15 | 15 | 14JAN08 | 01FEB08 | 21 |
| 770-4 | N-Level-4: OH/In-Wall Fire Alarm | 15 | 15 | 14JAN08 | 01FEB08 | 21 |
| 780-4 | N-Level-4: Mount/Wire Control Devices | 15 | 15 | 14JAN08 | 01FEB08 | 21 |
| 790-4 | N-Level-4: Mount/Wire Security Devices | 15 | 15 | 14JAN08 | 01FEB08 | 21 |
| 810-4 | N-Level-4: In-Wall Building Inspections | 2 | 2 | 04FEB08 | 05FEB08 | 21 |
| 820-4 | N-Level-4: Complete Pipe/Duct Insulation | 5 | 5 | 06FEB08 | 12FEB08 | 21 |
| 830-4 | N-Level-4: Sheetrock Walls & Ceilings | 8 | 8 | 21FEB08 | 03MAR08 | 15 |
| 840-4 | N-Level-4: Tape/ Finish Walls & Ceilings | 8 | 8 | 04MAR08 | 13MAR08 | 21 |
| 850-4 | N-Level-4: Sand/ Prime Paint & 1st Coat | 5 | 5 | 14MAR08 | 20MAR08 | 29 |
| 870-4 | N-Level-4: ACT ceiling grid corridors | 5 | 5 | 21MAR08 | 27MAR08 | 47 |
| 942-4 | N-Level-4: Install FCU's & Tie-in | 5 | 5 | 21MAR08 | 27MAR08 | 32 |
| 880-4 | N-Level-4: Waterproof & Ceramic Tile | 8 | 8 | 21MAR08 | 01APR08 | 29 |
| 890-4 | N-Level-4: Fire Protection Drops | 10 | 10 | 28MAR08 | 10APR08 | 53 |
| 900-4 | N-Level-4: Doors & Hardware | 10 | 10 | 28MAR08 | 10APR08 | 55 |
| 910-4 | N-Level-4: Millwork/ kitchen Counter/Cab | 10 | 10 | 02APR08 | 15APR08 | 29 |
| 920-4 | N-Level-4: Plumbing Fixtures | 5 | 5 | 16APR08 | 22APR08 | 29 |
| 930-4 | N-Level-4: Electrical Fixtures & Finishes | 8 | 8 | 23APR08 | 02MAY08 | 29 |
| 940-4 | N-Level-4: HVAC/ Mech Trim & Finishes | 8 | 8 | 05MAY08 | 14MAY08 | 29 |
| 950-4 | N-Level-4: Acoustical Tile corridor | 2 | 2 | 15MAY08 | 16MAY08 | 29 |
| 960-4 | N-Level-4: Flooring | 10 | 10 | 19MAY08 | 02JUN08 | 29 |
| 970-4 | N-Level-4: Finish Paint | 5 | 5 | 03JUN08 | 09JUN08 | 29 |
| **South Pod** | | | | | | |
| S-646-4 | S-Level-4: Initial OH HVAC/Mech Pipe | 15 | 15 | 19OCT07 | 08NOV07 | 18 |
| S-730-4 | S-Level-4: Receive/Set Door Frames | 4 | 4 | 29OCT07 | 01NOV07 | 38 |
| S-700-4 | S-Level-4: Electrical Layout/Conduit/Boxes | 5 | 5 | 21NOV07 | 28NOV07 | 50 |
| S-650-4 | S-Level-4: Top-off Corridor Walls | 7 | 7 | 21NOV07 | 30NOV07 | 26 |
| S-652-4 | S-Level-4: Frame Balance of Interior Walls | 7 | 7 | 21NOV07 | 30NOV07 | 26 |
| S-680-4 | S-Level-4: Balance of OH HVAC Ductwork | 7 | 7 | 21NOV07 | 30NOV07 | 41 |
| S-750-4 | S-Level-4: OH/In-Wall Plumbing | 7 | 7 | 21NOV07 | 30NOV07 | 49 |
| S-708-4 | S-Level-4: OH Electrical | 10 | 10 | 29NOV07 | 12DEC07 | 50 |
| S-690-4 | S-Level-4: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 03DEC07 | 31DEC07 | 26 |
| S-670-4 | S-Level-4: Fire Protection Mains/Branches | 10 | 10 | 20DEC07 | 04JAN08 | 25 |
| S-705-4 | S-Level-4: OH-Inspections | 2 | 2 | 02JAN08 | 03JAN08 | 36 |
| S-710-4 | S-Level-4: OH Pipe/Duct Insulate | 10 | 10 | 02JAN08 | 15JAN08 | 28 |
| S-720-4 | S-Level-4: OH MEP Completed for Ceiling Framing | 0 | 0 | | 15JAN08 | 28 |
| S-740-4 | S-Level-4: Frame Ceilings | 5 | 5 | 16JAN08 | 22JAN08 | 28 |
| S-800-4 | S-Level-4: HVAC Duct Drops | 10 | 10 | 23JAN08 | 05FEB08 | 33 |
| S-760-4 | S-Level-4: Ceiling & Lighting Cans | 15 | 15 | 23JAN08 | 12FEB08 | 28 |
| S-765-4 | S-Level-4: In-Wall Electrical | 15 | 15 | 23JAN08 | 12FEB08 | 28 |
| S-770-4 | S-Level-4: OH/In-Wall Fire Alarm | 15 | 15 | 23JAN08 | 12FEB08 | 28 |




| | | | |
|---|---|---|---|
| Start Date | 30OCT06 | Current Schedule | WP31 |
| Finish Date | 22AUG08 | Progress Bar | |
| Data Date | 19OCT07 | Critical Activity | |
| Run Date | 19OCT07 13:38 | | |

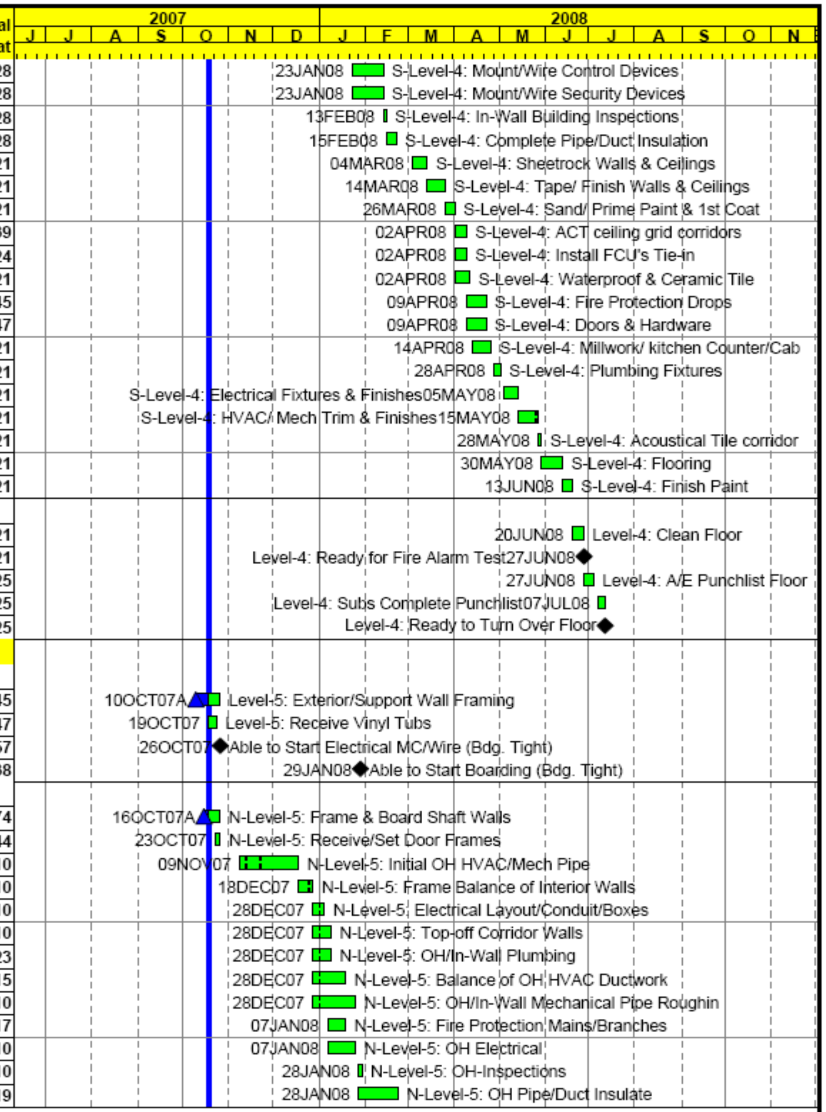


GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

Sheet 10 of 14

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| S-780-4 | S-Level-4: Mount/Wire Control Devices | 15 | 15 | 23JAN08 | 12FEB08 | 28 |
| S-790-4 | S-Level-4: Mount/Wire Security Devices | 15 | 15 | 23JAN08 | 12FEB08 | 28 |
| S-810-4 | S-Level-4: In-Wall Building Inspections | 2 | 2 | 13FEB08 | 14FEB08 | 28 |
| S-820-4 | S-Level-4: Complete Pipe/Duct Insulation | 5 | 5 | 15FEB08 | 21FEB08 | 28 |
| S-830-4 | S-Level-4: Sheetrock Walls & Ceilings | 8 | 8 | 04MAR08 | 13MAR08 | 21 |
| S-840-4 | S-Level-4: Tape/ Finish Walls & Ceilings | 8 | 8 | 14MAR08 | 25MAR08 | 21 |
| S-850-4 | S-Level-4: Sand/ Prime Paint & 1st Coat | 5 | 5 | 26MAR08 | 01APR08 | 21 |
| S-870-4 | S-Level-4: ACT ceiling grid corridors | 5 | 5 | 02APR08 | 08APR08 | 39 |
| S-942-4 | S-Level-4: Install FCU's Tie-in | 5 | 5 | 02APR08 | 08APR08 | 24 |
| S-880-4 | S-Level-4: Waterproof & Ceramic Tile | 8 | 8 | 02APR08 | 11APR08 | 21 |
| S-890-4 | S-Level-4: Fire Protection Drops | 10 | 10 | 09APR08 | 22APR08 | 45 |
| S-900-4 | S-Level-4: Doors & Hardware | 10 | 10 | 09APR08 | 22APR08 | 47 |
| S-910-4 | S-Level-4: Millwork/ kitchen Counter/Cab | 10 | 10 | 14APR08 | 25APR08 | 21 |
| S-920-4 | S-Level-4: Plumbing Fixtures | 5 | 5 | 28APR08 | 02MAY08 | 21 |
| S-930-4 | S-Level-4: Electrical Fixtures & Finishes | 8 | 8 | 05MAY08 | 14MAY08 | 21 |
| S-940-4 | S-Level-4: HVAC/ Mech Trim & Finishes | 8 | 8 | 15MAY08 | 27MAY08 | 21 |
| S-950-4 | S-Level-4: Acoustical Tile corridor | 2 | 2 | 28MAY08 | 29MAY08 | 21 |
| S-960-4 | S-Level-4: Flooring | 10 | 10 | 30MAY08 | 12JUN08 | 21 |
| S-970-4 | S-Level-4: Finish Paint | 5 | 5 | 13JUN08 | 19JUN08 | 21 |
| **Floor Closeout** | | | | | | |
| 8250-4 | Level-4: Clean Floor | 5 | 5 | 20JUN08 | 26JUN08 | 21 |
| 8255-4 | Level-4: Ready for Fire Alarm Test | 0 | 0 | 27JUN08 | | 21 |
| 8260-4 | Level-4: A/E Punchlist Floor | 5 | 5 | 27JUN08 | 03JUL08 | 25 |
| 8270-4 | Level-4: Subs Complete Punchlist | 5 | 5 | 07JUL08 | 11JUL08 | 25 |
| 8280-4 | Level-4: Ready to Turn Over Floor | 0 | 0 | | 11JUL08 | 25 |
| **Level 5** | | | | | | |
| **General Floor Area** | | | | | | |
| 635-5 | Level-5: Exterior/Support Wall Framing | 10 | 5 | 10OCT07A | 25OCT07 | 45 |
| 675-5 | Level-5: Receive Vinyl Tubs | 3 | 3 | 19OCT07 | 23OCT07 | 47 |
| 745-5 | Able to Start Electrical MC/Wire (Bdg. Tight) | 0 | 0 | 26OCT07 | | 57 |
| 980-5 | Able to Start Boarding (Bdg. Tight) | 0 | 0 | 29JAN08 | | 38 |
| **North Pod** | | | | | | |
| 654-5 | N-Level-5: Frame & Board Shaft Walls | 7 | 5 | 16OCT07A | 25OCT07 | 74 |
| 730-5 | N-Level-5: Receive/Set Door Frames | 4 | 4 | 23OCT07 | 26OCT07 | 44 |
| 646-5 | N-Level-5: Initial OH HVAC/Mech Pipe | 25 | 25 | 09NOV07 | 17DEC07 | 10 |
| 652-5 | N-Level-5: Frame Balance of Interior Walls | 7 | 7 | 18DEC07 | 27DEC07 | 10 |
| 700-5 | N-Level-5: Electrical Layout/Conduit/Boxes | 5 | 5 | 28DEC07 | 04JAN08 | 10 |
| 650-5 | N-Level-5: Top-off Corridor Walls | 7 | 7 | 28DEC07 | 08JAN08 | 10 |
| 750-5 | N-Level-5: OH/In-Wall Plumbing | 7 | 7 | 28DEC07 | 08JAN08 | 23 |
| 680-5 | N-Level-5: Balance of OH HVAC Ductwork | 15 | 15 | 28DEC07 | 18JAN08 | 15 |
| 690-5 | N-Level-5: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 28DEC07 | 25JAN08 | 10 |
| 670-5 | N-Level-5: Fire Protection Mains/Branches | 10 | 10 | 07JAN08 | 18JAN08 | 17 |
| 708-5 | N-Level-5: OH Electrical | 15 | 15 | 07JAN08 | 25JAN08 | 10 |
| 705-5 | N-Level-5: OH-Inspections | 2 | 2 | 28JAN08 | 29JAN08 | 10 |
| 710-5 | N-Level-5: OH Pipe/Duct Insulate | 20 | 20 | 28JAN08 | 22FEB08 | 19 |




Start Date 30OCT06
Finish Date 22AUG08
Data Date 19OCT07
Run Date 19OCT07 13:38

Current Schedule
Progress Bar
Critical Activity

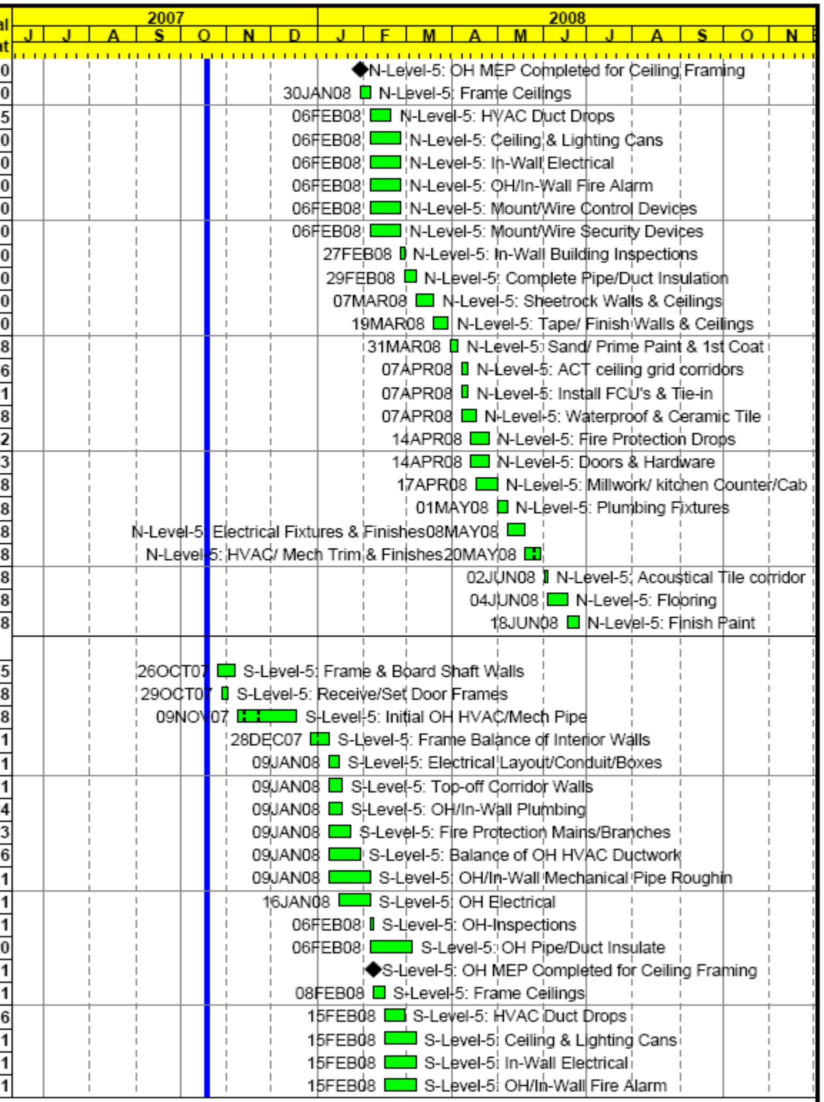
WP31

Sheet 11 of 14

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| 720-5 | N-Level-5: OH MEP Completed for Ceiling Framing | 0 | 0 | | 29JAN08 | 10 |
| 740-5 | N-Level-5: Frame Ceilings | 5 | 5 | 30JAN08 | 05FEB08 | 10 |
| 800-5 | N-Level-5: HVAC Duct Drops | 10 | 10 | 06FEB08 | 19FEB08 | 15 |
| 760-5 | N-Level-5: Ceiling & Lighting Cans | 15 | 15 | 06FEB08 | 26FEB08 | 10 |
| 765-5 | N-Level-5: In-Wall Electrical | 15 | 15 | 06FEB08 | 26FEB08 | 10 |
| 770-5 | N-Level-5: OH/In-Wall Fire Alarm | 15 | 15 | 06FEB08 | 26FEB08 | 10 |
| 780-5 | N-Level-5: Mount/Wire Control Devices | 15 | 15 | 06FEB08 | 26FEB08 | 10 |
| 790-5 | N-Level-5: Mount/Wire Security Devices | 15 | 15 | 06FEB08 | 26FEB08 | 10 |
| 810-5 | N-Level-5: In-Wall Building Inspections | 2 | 2 | 27FEB08 | 28FEB08 | 10 |
| 820-5 | N-Level-5: Complete Pipe/Duct Insulation | 5 | 5 | 29FEB08 | 06MAR08 | 10 |
| 830-5 | N-Level-5: Sheetrock Walls & Ceilings | 8 | 8 | 07MAR08 | 18MAR08 | 10 |
| 840-5 | N-Level-5: Tape/ Finish Walls & Ceilings | 8 | 8 | 19MAR08 | 28MAR08 | 10 |
| 850-5 | N-Level-5: Sand/ Prime Paint & 1st Coat | 5 | 5 | 31MAR08 | 04APR08 | 18 |
| 870-5 | N-Level-5: ACT ceiling grid corridors | 5 | 5 | 07APR08 | 11APR08 | 36 |
| 942-5 | N-Level-5: Install FCU's & Tie-in | 5 | 5 | 07APR08 | 11APR08 | 21 |
| 880-5 | N-Level-5: Waterproof & Ceramic Tile | 8 | 8 | 07APR08 | 16APR08 | 18 |
| 890-5 | N-Level-5: Fire Protection Drops | 10 | 10 | 14APR08 | 25APR08 | 42 |
| 900-5 | N-Level-5: Doors & Hardware | 10 | 10 | 14APR08 | 25APR08 | 83 |
| 910-5 | N-Level-5: Millwork/ kitchen Counter/Cab | 10 | 10 | 17APR08 | 30APR08 | 18 |
| 920-5 | N-Level-5: Plumbing Fixtures | 5 | 5 | 01MAY08 | 07MAY08 | 18 |
| 930-5 | N-Level-5: Electrical Fixtures & Finishes | 8 | 8 | 08MAY08 | 19MAY08 | 18 |
| 940-5 | N-Level-5: HVAC/ Mech Trim & Finishes | 8 | 8 | 20MAY08 | 30MAY08 | 18 |
| 950-5 | N-Level-5: Acoustical Tile corridor | 2 | 2 | 02JUN08 | 03JUN08 | 18 |
| 960-5 | N-Level-5: Flooring | 10 | 10 | 04JUN08 | 17JUN08 | 18 |
| 970-5 | N-Level-5: Finish Paint | 5 | 5 | 18JUN08 | 24JUN08 | 18 |
| **South Pod** | | | | | | |
| S-654-5 | S-Level-5: Frame & Board Shaft Walls | 7 | 7 | 26OCT07 | 05NOV07 | 75 |
| S-730-5 | S-Level-5: Receive/Set Door Frames | 4 | 4 | 29OCT07 | 01NOV07 | 48 |
| S-646-5 | S-Level-5: Initial OH HVAC/Mech Pipe | 25 | 25 | 09NOV07 | 17DEC07 | 18 |
| S-652-5 | S-Level-5: Frame Balance of Interior Walls | 7 | 7 | 28DEC07 | 08JAN08 | 11 |
| S-700-5 | S-Level-5: Electrical Layout/Conduit/Boxes | 5 | 5 | 09JAN08 | 15JAN08 | 11 |
| S-650-5 | S-Level-5: Top-off Corridor Walls | 7 | 7 | 09JAN08 | 17JAN08 | 11 |
| S-750-5 | S-Level-5: OH/In-Wall Plumbing | 7 | 7 | 09JAN08 | 17JAN08 | 24 |
| S-670-5 | S-Level-5: Fire Protection Mains/Branches | 10 | 10 | 09JAN08 | 22JAN08 | 23 |
| S-680-5 | S-Level-5: Balance of OH HVAC Ductwork | 15 | 15 | 09JAN08 | 29JAN08 | 16 |
| S-690-5 | S-Level-5: OH/In-Wall Mechanical Pipe Roughin | 20 | 20 | 09JAN08 | 05FEB08 | 11 |
| S-708-5 | S-Level-5: OH Electrical | 15 | 15 | 16JAN08 | 05FEB08 | 11 |
| S-705-5 | S-Level-5: OH-Inspections | 2 | 2 | 06FEB08 | 07FEB08 | 11 |
| S-710-5 | S-Level-5: OH Pipe/Duct Insulate | 20 | 20 | 06FEB08 | 04MAR08 | 20 |
| S-720-5 | S-Level-5: OH MEP Completed for Ceiling Framing | 0 | 0 | | 07FEB08 | 11 |
| S-740-5 | S-Level-5: Frame Ceilings | 5 | 5 | 08FEB08 | 14FEB08 | 11 |
| S-800-5 | S-Level-5: HVAC Duct Drops | 10 | 10 | 15FEB08 | 28FEB08 | 16 |
| S-760-5 | S-Level-5: Ceiling & Lighting Cans | 15 | 15 | 15FEB08 | 06MAR08 | 11 |
| S-765-5 | S-Level-5: In-Wall Electrical | 15 | 15 | 15FEB08 | 06MAR08 | 11 |
| S-770-5 | S-Level-5: OH/In-Wall Fire Alarm | 15 | 15 | 15FEB08 | 06MAR08 | 11 |




| | |
|---|---|
| Start Date | 30OCT06 |
| Finish Date | 22AUG08 |
| Data Date | 19OCT07 |
| Run Date | 19OCT07 13:38 |

Current Schedule
Progress Bar
Critical Activity

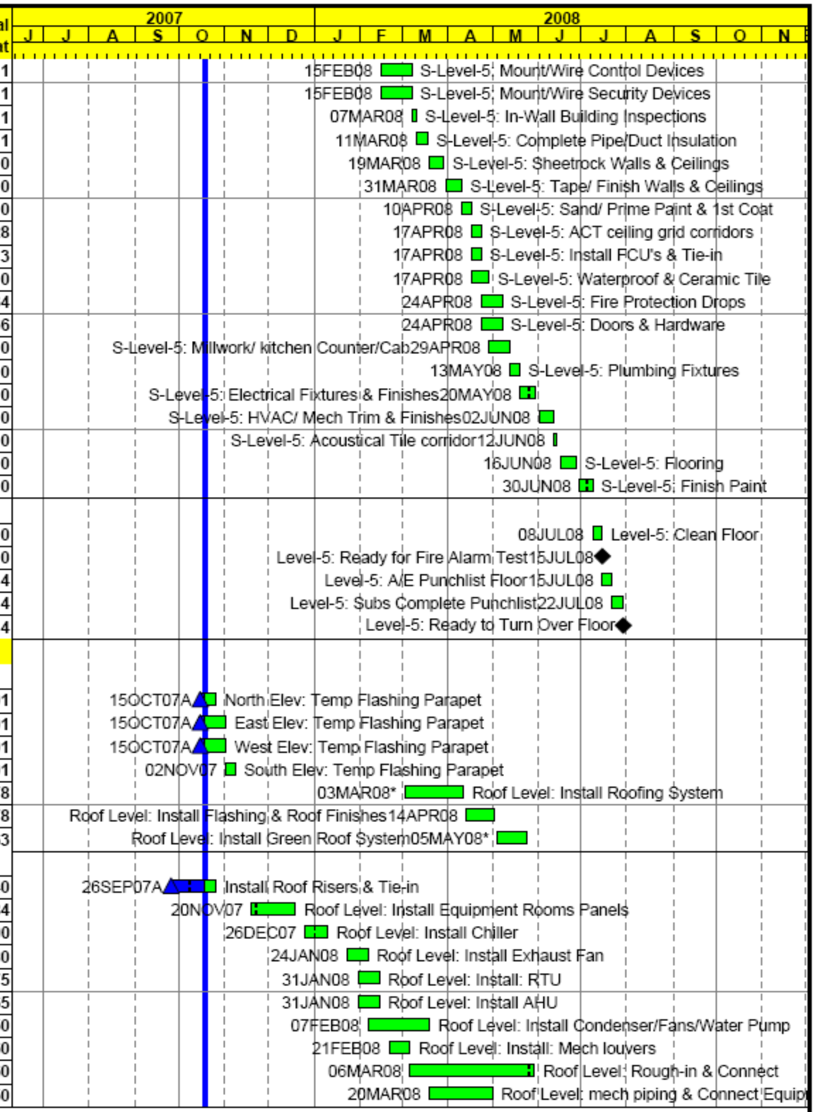
WP31

Sheet 12 of 14

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| S-780-5 | S-Level-5: Mount/Wire Control Devices | 15 | 15 | 15FEB08 | 06MAR08 | 11 |
| S-790-5 | S-Level-5: Mount/Wire Security Devices | 15 | 15 | 15FEB08 | 06MAR08 | 11 |
| S-810-5 | S-Level-5: In-Wall Building Inspections | 2 | 2 | 07MAR08 | 10MAR08 | 11 |
| S-820-5 | S-Level-5: Complete Pipe/Duct Insulation | 5 | 5 | 11MAR08 | 17MAR08 | 11 |
| S-830-5 | S-Level-5: Sheetrock Walls & Ceilings | 8 | 8 | 19MAR08 | 28MAR08 | 10 |
| S-840-5 | S-Level-5: Tape/ Finish Walls & Ceilings | 8 | 8 | 31MAR08 | 09APR08 | 10 |
| S-850-5 | S-Level-5: Sand/ Prime Paint & 1st Coat | 5 | 5 | 10APR08 | 16APR08 | 10 |
| S-870-5 | S-Level-5: ACT ceiling grid corridors | 5 | 5 | 17APR08 | 23APR08 | 28 |
| S-942-5 | S-Level-5: Install FCU's & Tie-in | 5 | 5 | 17APR08 | 23APR08 | 13 |
| S-880-5 | S-Level-5: Waterproof & Ceramic Tile | 8 | 8 | 17APR08 | 28APR08 | 10 |
| S-890-5 | S-Level-5: Fire Protection Drops | 10 | 10 | 24APR08 | 07MAY08 | 34 |
| S-900-5 | S-Level-5: Doors & Hardware | 10 | 10 | 24APR08 | 07MAY08 | 36 |
| S-910-5 | S-Level-5: Millwork/ kitchen Counter/Cab | 10 | 10 | 29APR08 | 12MAY08 | 10 |
| S-920-5 | S-Level-5: Plumbing Fixtures | 5 | 5 | 13MAY08 | 19MAY08 | 10 |
| S-930-5 | S-Level-5: Electrical Fixtures & Finishes | 8 | 8 | 20MAY08 | 30MAY08 | 10 |
| S-940-5 | S-Level-5: HVAC/ Mech Trim & Finishes | 8 | 8 | 02JUN08 | 11JUN08 | 10 |
| S-950-5 | S-Level-5: Acoustical Tile corridor | 2 | 2 | 12JUN08 | 13JUN08 | 10 |
| S-960-5 | S-Level-5: Flooring | 10 | 10 | 16JUN08 | 27JUN08 | 10 |
| S-970-5 | S-Level-5: Finish Paint | 5 | 5 | 30JUN08 | 07JUL08 | 10 |
| **Floor Closeout** | | | | | | |
| 8250-5 | Level-5: Clean Floor | 5 | 5 | 08JUL08 | 14JUL08 | 10 |
| 8255-5 | Level-5: Ready for Fire Alarm Test | 0 | 0 | 15JUL08 | | 10 |
| 8260-5 | Level-5: A/E Punchlist Floor | 5 | 5 | 15JUL08 | 21JUL08 | 14 |
| 8270-5 | Level-5: Subs Complete Punchlist | 5 | 5 | 22JUL08 | 28JUL08 | 14 |
| 8280-5 | Level-5: Ready to Turn Over Floor | 0 | 0 | | 28JUL08 | 14 |
| **Roof Level** | | | | | | |
| **Stucture** | | | | | | |
| 8734 | North Elev: Temp Flashing Parapet | 5 | 5 | 15OCT07A | 25OCT07 | 91 |
| 8735 | East Elev: Temp Flashing Parapet | 10 | 10 | 15OCT07A | 01NOV07 | 91 |
| 8736 | West Elev: Temp Flashing Parapet | 10 | 10 | 15OCT07A | 01NOV07 | 91 |
| 8737 | South Elev: Temp Flashing Parapet | 5 | 5 | 02NOV07 | 08NOV07 | 91 |
| 8700 | Roof Level: Install Roofing System | 30 | 30 | 03MAR08* | 11APR08 | 78 |
| 8730 | Roof Level: Install Flashing & Roof Finishes | 15 | 15 | 14APR08 | 02MAY08 | 78 |
| 8732 | Roof Level: Install Green Roof System | 15 | 15 | 05MAY08* | 23MAY08 | 63 |
| **Mechanical** | | | | | | |
| 8720 | Install Roof Risers & Tie-in | 15 | 5 | 26SEP07A | 25OCT07 | 40 |
| 8710 | Roof Level: Install Equipment Rooms Panels | 20 | 20 | 20NOV07 | 18DEC07 | 84 |
| 8770 | Roof Level: Install Chiller | 10 | 10 | 26DEC07 | 09JAN08 | 100 |
| 8760 | Roof Level: Install Exhaust Fan | 10 | 10 | 24JAN08 | 06FEB08 | 80 |
| 8750 | Roof Level: Install: RTU | 10 | 10 | 31JAN08 | 13FEB08 | 75 |
| 8780 | Roof Level: Install AHU | 10 | 10 | 31JAN08 | 13FEB08 | 65 |
| 8790 | Roof Level: Install Condenser/Fans/Water Pump | 30 | 30 | 07FEB08 | 19MAR08 | 50 |
| 8850 | Roof Level: Install: Mech louvers | 10 | 10 | 21FEB08 | 05MAR08 | 60 |
| 8800 | Roof Level: Rough-in & Connect | 60 | 60 | 06MAR08 | 29MAY08 | 60 |
| 8810 | Roof Level: mech piping & Connect Equipment | 30 | 30 | 20MAR08 | 30APR08 | 50 |




| | |
|---|---|
| Start Date | 30OCT06 |
| Finish Date | 22AUG08 |
| Data Date | 19OCT07 |
| Run Date | 19OCT07 13:38 |

Current Schedule
Progress Bar
Critical Activity

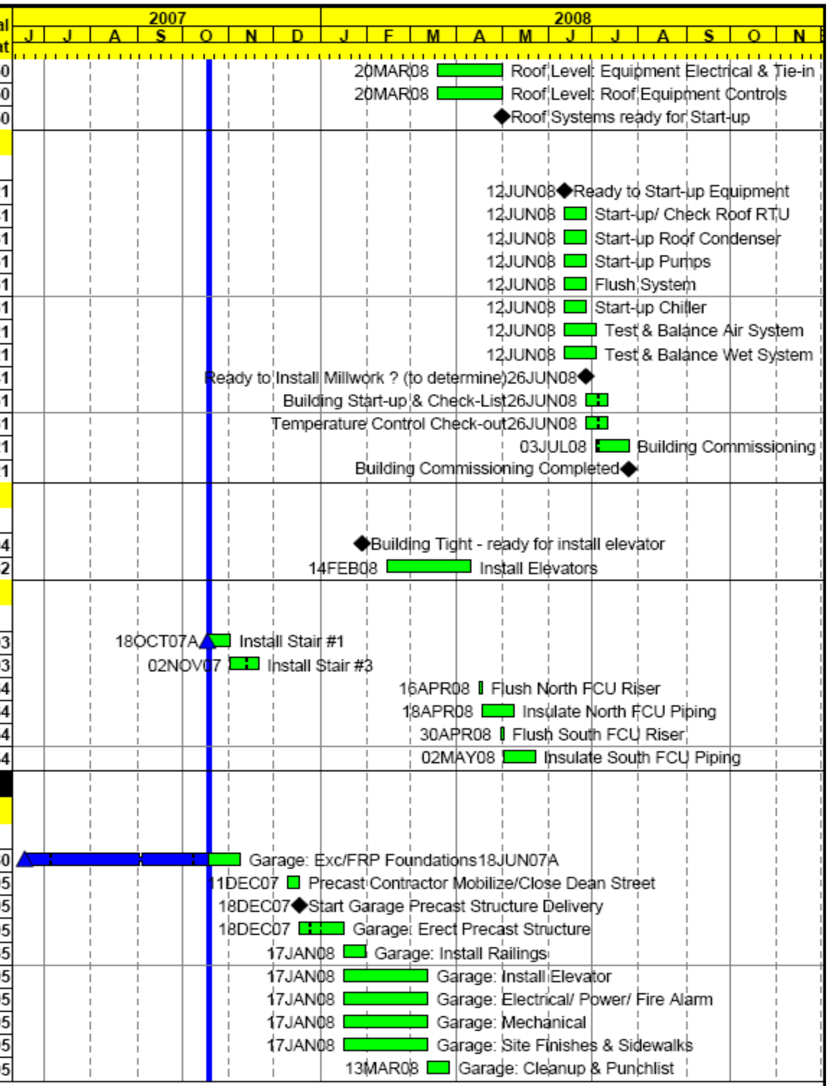
WP31

GILBANE BUILDING COMPANY
Constuction Activities
WPI RESIDENCE HALL

Sheet 13 of 14

**Baseline Schedule Rev#0 Progress Update (WP31)**
**Constuction Schedule**
**Updated 19OCT07**

| Activity ID | Activity Description | Orig Dur | Rem Dur | Early Start | Early Finish | Total Float |
|---|---|---|---|---|---|---|
| 8820 | Roof Level: Equipment Electrical & Tie-in | 30 | 30 | 20MAR08 | 30APR08 | 50 |
| 8830 | Roof Level: Roof Equipment Controls | 30 | 30 | 20MAR08 | 30APR08 | 50 |
| 8840 | Roof Systems ready for Start-up | 0 | 0 | | 30APR08 | 50 |
| **Systems Start-up & Commissioning** | | | | | | |
| 8910 | Ready to Start-up Equipment | 0 | 0 | 12JUN08 | | 21 |
| 8860 | Start-up/ Check Roof RTU | 10 | 10 | 12JUN08 | 25JUN08 | 41 |
| 8870 | Start-up Roof Condenser | 10 | 10 | 12JUN08 | 25JUN08 | 31 |
| 8880 | Start-up Pumps | 10 | 10 | 12JUN08 | 25JUN08 | 31 |
| 8890 | Flush System | 10 | 10 | 12JUN08 | 25JUN08 | 31 |
| 8900 | Start-up Chiller | 10 | 10 | 12JUN08 | 25JUN08 | 31 |
| 8940 | Test & Balance Air System | 15 | 15 | 12JUN08 | 02JUL08 | 21 |
| 8950 | Test & Balance Wet System | 15 | 15 | 12JUN08 | 02JUL08 | 21 |
| 8980 | Ready to Install Millwork ? (to determine) | 0 | 0 | 26JUN08 | | 41 |
| 8920 | Building Start-up & Check-List | 10 | 10 | 26JUN08 | 10JUL08 | 31 |
| 8930 | Temperature Control Check-out | 10 | 10 | 26JUN08 | 10JUL08 | 31 |
| 8960 | Building Commissioning | 15 | 15 | 03JUL08 | 24JUL08 | 21 |
| 8970 | Building Commissioning Completed | 0 | 0 | | 24JUL08 | 21 |
| **Elevator** | | | | | | |
| 9000 | Building Tight - ready for install elevator | 0 | 0 | | 28JAN08 | 94 |
| 9015 | Install Elevators | 40 | 40 | 14FEB08 | 09APR08 | 82 |
| **General Building** | | | | | | |
| 9048 | Install Stair #1 | 12 | 10 | 18OCT07A | 01NOV07 | 193 |
| 9050 | Install Stair #3 | 12 | 12 | 02NOV07 | 20NOV07 | 193 |
| 942-1 | Flush North FCU Riser | 2 | 2 | 16APR08 | 17APR08 | 64 |
| 942-6 | Insulate North FCU Piping | 15 | 15 | 18APR08 | 08MAY08 | 64 |
| 942-7 | Flush South FCU Riser | 2 | 2 | 30APR08 | 01MAY08 | 54 |
| 942-8 | Insulate South FCU Piping | 15 | 15 | 02MAY08 | 22MAY08 | 54 |
| **Garage** | | | | | | |
| 6500 | Garage: Exc/FRP Foundations | 30 | 15 | 18JUN07A | 08NOV07 | 130 |
| 6535 | Precast Contractor Mobilize/Close Dean Street | 5 | 5 | 11DEC07 | 17DEC07 | 105 |
| 6505 | Start Garage Precast Structure Delivery | 0 | 0 | 18DEC07 | | 105 |
| 6515 | Garage: Erect Precast Structure | 20 | 20 | 18DEC07 | 16JAN08 | 105 |
| 6520 | Garage: Install Railings | 10 | 10 | 17JAN08 | 30JAN08 | 135 |
| 6530 | Garage: Install Elevator | 40 | 40 | 17JAN08 | 12MAR08 | 105 |
| 6540 | Garage: Electrical/ Power/ Fire Alarm | 40 | 40 | 17JAN08 | 12MAR08 | 105 |
| 6550 | Garage: Mechanical | 40 | 40 | 17JAN08 | 12MAR08 | 105 |
| 6552 | Garage: Site Finishes & Sidewalks | 40 | 40 | 17JAN08 | 12MAR08 | 105 |
| 6560 | Garage: Cleanup & Punchlist | 10 | 10 | 13MAR08 | 26MAR08 | 105 |




| | | | |
|---|---|---|---|
| Start Date 30OCT06 | Current Schedule | WP31 | Sheet 14 of 14 |
| Finish Date 22AUG08 | Progress Bar | GILBANE BUILDING COMPANY | **Baseline Schedule Rev#0 Progress Update (WP31)** |
| Data Date 19OCT07 | Critical Activity | Constuction Activities | **Constuction Schedule** |
| Run Date 19OCT07 13:38 | | WPI RESIDENCE HALL | **Updated 19OCT07** |

# Appendix C: Concrete Takeoff Sheets

## ESTIMATE WORK SHEET

**Project:** NEW RESHALL
**Location** WPI
**Architect** Canon
**Items** Footings

Concrete Spread Footings

**Estimate No.**
**Sheet No.**
**Date**
**By** **Checked**

| Cost Code | Description | Dimensions: Length Ft. | Length In. | Width Ft. | Width In. | Height Ft. | Height In. | | Volume CF | Count | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F6 | 6 | 0 | 6 | 0 | 0 | 18 | | 54.00 | 4 | 8.00 | CY |
| | F6-42 | 6 | 0 | 41 | 8 | 0 | 18 | | 375.00 | 1 | 13.89 | CY |
| | F7 | 7 | 0 | 7 | 0 | 0 | 20 | | 81.67 | 3 | 9.07 | CY |
| | F8 | 8 | 0 | 8 | 0 | 0 | 22 | | 117.33 | 16 | 69.53 | CY |
| | F9 | 9 | 0 | 9 | 0 | | 24 | | 162.00 | 9 | 54.00 | CY |
| | F9-18 | 9 | 0 | 18 | 2.5 | 0 | 24 | | 327.75 | 8 | 97.11 | CY |
| | F10 | 10 | 0 | 10 | 0 | 0 | 26 | | 216.67 | 20 | 160.49 | CY |
| | F11 | 11 | 0 | 11 | 0 | 0 | 29 | | 292.42 | 1 | 10.83 | CY |
| | F13U | 13 | 0 | 13 | 0 | 0 | 36 | | 507.00 | 13 | 244.11 | CY |
| | | | | | | | | | | | | |
| | Subtotal | | | | | | | | | | 667.04 | CY |
| | Add 5% Waste | | | | | | | | | | 33.35 | CY |
| | Total | | | | | | | | | | 700.39 | CY |
| | | | | | | | | | | | | |

# ESTIMATE WORK SHEET

| | | | |
|---|---|---|---|
| **Project:** NEW RESHALL | Concrete Piers | **Estimate No.** | |
| **Location** WPI | | **Sheet No.** | |
| **Architect** Canon | | **Date** | |
| **Items** Piers | | **By** | **Checked** |

| Cost Code | Description | Dimensions Length Ft. | Length In. | Width Ft. | Width In. | Height Ft. | Height In. | | Volume CF | Count # | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **P24** | **0** | **24** | **0** | **24** | **2** | **0** | | **8** | **35** | **10.37** | **CY** |
| | | **0** | **24** | **0** | **24** | **4** | **6** | | **18** | **1** | **0.67** | **CY** |
| | | **0** | **24** | **0** | **24** | **5** | **0** | | **20** | **22** | **16.30** | **CY** |
| | | **0** | **24** | **0** | **24** | **6** | **0** | | **24** | **1** | **0.89** | **CY** |
| | | **0** | **24** | **0** | **24** | **6** | **6** | | **26** | **4** | **3.85** | **CY** |
| | | **0** | **24** | **0** | **24** | **7** | **0** | | **28** | **1** | **1.04** | **CY** |
| | | **0** | **24** | **0** | **24** | **10** | **5** | | **41.66667** | **4** | **6.17** | **CY** |
| | | | | | | | | | | | | |
| | **Subtotal P24** | | | | | | | | | | **39.28** | **CY** |
| | | | | | | | | | | | | |
| | **P30** | **0** | **30** | **0** | **30** | **2** | **0** | | **12.5** | **6** | **2.78** | **CY** |
| | | **0** | **30** | **0** | **30** | **5** | **0** | | **31.25** | **8** | **9.26** | **CY** |
| | | | | | | | | | | | | |
| | **Subtotal P30** | | | | | | | | | | **12.04** | **CY** |
| | | | | | | | | | | | | |
| | **Subtotal** | | | | | | | | | | **51.32** | **CY** |
| | **Add 5% Waste** | | | | | | | | | | **2.57** | **CY** |
| | **Total** | | | | | | | | | | **53.89** | **CY** |

## ESTIMATE WORK SHEET

**Project:** NEW RESHALL
**Location** WPI
**Architect** Canon
**Items** Grade Beams

Grade Beams

**Estimate No.** 
**Sheet No.** 
**Date** 
**By** **Checked** 

| Cost Code | Description | Length Ft. | Length In. | Width Ft. | Width In. | Height Ft. | Height In. | | Volume CF | Count | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GB01 | 5 | 0 | 2 | 6 | 3 | 6 | | 43.75 | 12 | 19.44 | CY |
| | | | | | | | | | | | | |
| | Subtotal | | | | | | | | | | 19.44 | CY |
| | Add 5% Waste | | | | | | | | | | 0.97 | CY |
| | Total | | | | | | | | | | 20.42 | CY |

## ESTIMATE WORK SHEET

**Project:** NEW RESHALL
**Location** WPI
**Architect** Canon
**Items** Concrete Continuous Footings

**Estimate No.** 
**Sheet No.** 
**Date** 
**By** **Checked** 

| Cost Code | Description | Length Ft. | Length In. | Height Ft. | Height In. | Width Ft. | In. | Volume CF | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | Walls With Upper Lip | 819 | 0 | 6 | 3 | 1 | 3 | 6398.44 | 236.98 | CY |
| | | | | | | | | | | |
| | Walls Withough Upper Lip | 136 | 0 | 4 | 9 | 1 | 3 | 807.50 | 29.91 | CY |
| | | | | | | | | | | |
| | Subtotal | | | | | | | 7205.94 | 266.89 | CY |
| | Add 5% for Waste | | | | | | | | 13.34 | CY |
| | Total | | | | | | | | 280.23 | CY |

# ESTIMATE WORK SHEET

## Concrete Slab

| | |
|---|---|
| **Project:** | NEW RESHALL |
| **Location** | WPI |
| **Architect** | Canon |
| **Items** | Concrete Slab |

**Estimate No.**
**Sheet No.**
**Date**
**By** **Checked**

| Cost Code | Description | Dimensions Length Ft. | Length In. | Width Ft. | Width In. | Height Ft. | Height In. | | | | | Volume CF | Count | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1st Floor** | | | | | | | | | | | | | | |
| | **Section 1** | 15 | 11.5 | 35 | 8 | 0 | 5 | | | | | 237.1586 | 3 | 26.35 | CY |
| | **Section 2** | 40.04 | 0 | 13 | 0 | 0 | 5 | | | | | 216.8833 | 2 | 16.07 | CY |
| | **Section 3** | 99.458 | 0 | 53 | 0 | 0 | 5 | | | | | 2196.364 | 2 | 162.69 | CY |
| | **Section 4** | 15 | 11.5 | 44 | 4 | 0 | 5 | | | | | 294.7859 | 1 | 10.92 | CY |
| | **Section 5** | 52 | 4.5 | 94 | 4 | 0 | 5 | | | | | 2058.628 | 1 | 76.25 | CY |
| | | | | | | | | | | | | | | | |
| | **Subtotal** | | | | | | | | | | | | | 292.27 | CY |
| | | | | | | | | | | | | | | | |
| | **Elevator Shafts** | 10.541 | 0 | 8 | 4 | 0 | 5 | | | | | 36.60069 | 2 | 2.71 | CY |
| | | | | | | | | | | | | | | | |
| | **First Floor Total** | | | | | | | | | | | | | 289.56 | CY |
| | | | | | | | | | | | | | | | |
| | **2nd Floor** | | | | | | | | | | | | | 289.56 | CY |
| | **Glass Extension 1** | 19 | 7.5 | 3 | 0 | 0 | 5 | | | | | 24.53125 | 8 | 7.27 | CY |
| | **Glass Extension 2** | 11 | 6 | 3 | 0 | 0 | 5 | | | | | 14.375 | 6 | 3.19 | CY |
| | | | | | | | | | | | | | | | |
| | **Subtotal** | | | | | | | | | | | | | 300.02 | CY |
| | | | | | | | | | | | | | | | |
| | **Stairwells** | 9.208 | 0 | 17.2 | 0 | 0 | 5 | | | | | 65.99067 | 4 | 9.78 | CY |
| | | | | | | | | | | | | | | | |
| | **2nd Floor Total** | | | | | | | | | | | | | 290.25 | CY |
| | | | | | | | | | | | | | | | |
| | **3rd Floor** | | | | | | | | | | | | | 290.25 | CY |
| | | | | | | | | | | | | | | | |
| | **4th Floor** | | | | | | | | | | | | | 290.25 | CY |
| | | | | | | | | | | | | | | | |
| | **5th Floor** | | | | | | | | | | | | | 290.25 | CY |
| | | | | | | | | | | | | | | | |
| | **Roof** | | | | | | | | | | | | | 290.25 | CY |
| | | | | | | | | | | | | | | | |
| | **Subtotal** | | | | | | | | | | | | | 1740.80 | CY |
| | **Add 5% Waste** | | | | | | | | | | | | | 87.04 | CY |
| | **Slab Total** | | | | | | | | | | | | | 1827.84 | CY |

# Appendix D: Concrete Estimate

**Concrete Slab**

| Activity | Quantity (CY) | Concrete Cost | Placement Cost | Formwork | Reinforcing (Fibrous) | Finishing | Curing | Total Cost/Floor |
|---|---|---|---|---|---|---|---|---|
| 1st Floor Slab 4000PSI | 289.56 | $26,349.96 | $5,458.21 | $4,687.00 (5 Uses @ 15" High) | $6,659.88 | $9,375.00 | $2,711.25 | $55,241.30 |
| 2nd Floor Slab 4000PSI | 290.25 | $26,412.75 | $5,892.08 | $4,578.00 | $6,675.75 | $9,375.00 | $2,711.25 | $55,644.83 |
| 3rd Floor Slab 4000PSI | 290.25 | $26,412.75 | $6,327.45 | $4,578.00 | $6,675.75 | $9,375.00 | $2,711.25 | $56,080.20 |
| 5th Floor Slab 4000PSI | 290.25 | $26,412.75 | $6,762.83 | $4,578.00 | $6,675.75 | $9,375.00 | $2,711.25 | $56,515.58 |
| Roof Slab 4000PSI | 290.25 | $26,412.75 | $7,198.20 | $4,120.20 | $6,675.75 | $9,375.00 | $2,711.25 | $56,493.15 |
| | | | | | | | Total Cost of Slab | $279,975.05 |

**Grade Beams**

| Activity | Quantity (CY) | Concrete Cost | Placement Cost | Formwork | Reinforcing Tons | Reinforcing Cost | Total Cost |
|---|---|---|---|---|---|---|---|
| GB01 4000PSI | 20.42 | $1,858.22 | $194.60 | $1,100.40 (4 Uses @ 36" High) | 1.682 | $2,228.65 | $5,381.87 |

**Piers**

| Activity | Quantity (CY) | Description | Total Cost/Type |
|---|---|---|---|
| P24<br>4000PSI | 39.28 | 24" x 24" Average Reinforcing<br>(Includes Forms, Concrete, Placement and Reinforcing) | $31,856.08 |
| P30<br>4000PSI | 12.04 | 30"x30" Average Reinforcing<br>(Includes Forms, Concrete, Placement and Reinforcing) | $7,958.44 |
| | | Total Cost of Footings | $39,814.52 |

**Continuous Footings**

| Activity | Quantity (CY) | Concrete Cost | Placement Cost | Formwork | Reinforcing (Fiberious) | Total Cost/Type |
|---|---|---|---|---|---|---|
| Walls With Upper Lip<br>4000PSI | 237 | $21,567.00 | $2,855.85 | $24,262.88 | $4,664.00 | $53,349.73 |
| Walls Without Lip<br>4000 PSI | 30 | $2,730.00 | $357.30 | $3,062.04 | $806.93 | $6,956.27 |
| | | | | | Total Cost | $60,305.99 |

**Spread Footings**

| Activity | Quantity (CY) | Description | Total Cost |
|---|---|---|---|
| Spread Footings<br>(Over 5 CY Each) | 700.39 | Spread Footings Over 5 CY<br>(Includes Forms, Concrete, Placement and Reinforcing) | $202,594.81 |

**Concrete Total**

| Activity | Volume (CY) | Cost |
|---|---|---|
| Concrete Slab | 1827.84 | $279,975.05 |
| Grade Beams | 20.42 | $5,381.87 |
| Piers | 53.89 | $39,814.52 |
| Continuous Footings | 213.25 | $60,305.99 |
| Spread Footings | 700.39 | $202,594.81 |
| Subtotal | 2815.79 | $588,072.24 |
| Cost Index: Springfield MA x1.08 | | $635,118.02 |
| Total | | $635,118.02 |

# Appendix E: Steel Takeoff Sheets

## ESTIMATE WORK SHEET

**Project:** WPI NEW RES HALL **STRUCTURAL STEEL** **Estimate No.**
**Location** Worcester, MA **Sheet No.**
**Architect** Canon Design **Date**
**Items** Second Floor Framing **By** **Checked**

| Cost Code | Description | Designation | Pounds / Foot | Length Ft. | Length In. | Length Ft. | Cost | | | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | W14x22 | W14x22 | 22 | 1481 | | 1481 | | | | 32,582 | Pounds |
| | W14x26 | W14x26 | 26 | 110 | | 110 | | | | 2,860 | Pounds |
| | W14x30 | W14x30 | 30 | 384 | | 384 | | | | 11,520 | Pounds |
| | W14x34 | W14x34 | 34 | 275 | | 275 | | | | 9,350 | Pounds |
| | W14x48 | W14x48 | 48 | 50 | | 50 | | | | 2,400 | Pounds |
| | W16x26 | W16x26 | 26 | 550 | | 550 | | | | 14,300 | Pounds |
| | W18x40 | W16x40 | 40 | 78 | | 78 | | | | 3,120 | Pounds |
| | W16x45 | W16x45 | 45 | 8 | | 8 | | | | 360 | Pounds |
| | W18x35 | W18x35 | 35 | 200 | | 200 | | | | 7,000 | Pounds |
| | W21x44 | W21x44 | 44 | 90 | | 90 | | | | 3,960 | Pounds |
| | W24x55 | W24x55 | 55 | 172 | | 172 | | | | 9,460 | Pounds |
| | W24x76 | W24x76 | 76 | 58 | | 58 | | | | 4,408 | Pounds |
| | W8x15 | W8x15 | 15 | 130 | | 130 | | | | 1,950 | Pounds |
| | W10x26 | W10x12 | 26 | 55 | | 55 | | | | 1,430 | Pounds |
| | C8x11.5 | C8x11.5 | 11.5 | 350 | | 350 | | | | 4,025 | Pounds |
| | W36x135 | W36x135 | 135 | 19 | | 19 | | | | 2,565 | Pounds |
| | W18x119 | W18x119 | 119 | 200 | | 200 | | | | 23,800 | Pounds |
| | W27x84 | W27x84 | 84 | 12 | | 12 | | | | 1,008 | Pounds |
| | W36x150 | W36x150 | 150 | 19 | | 19 | | | | 2,850 | Pounds |
| | MC7x22.5 | MC7x22.5 | 22.5 | 50 | | 50 | | | | 1,125 | Pounds |
| | W10x68 | W10x68 | 68 | 45 | | 45 | | | | 3,060 | Pounds |
| | | | | | | 0 | | | | 0 | |
| | | | | | | | | | Total | 111,290 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | 10% For Connections | | 122,419 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | | | 61.21 | Tons |

# ESTIMATE WORK SHEET

**Project:** WPI NEW RES HALL

**STRUCTURAL STEEL**

**Estimate No.**

**Location** Worcester, MA

**Sheet No.**

**Architect** Canon Design

**Date**

**Items** Third Floor Framing

**By** **Checked**

| Cost Code | Description | Designation | Pounds / Foot | Length Ft. | Length In. | Length Ft. | | | | | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W14x22 | W14x22 | 22 | 1428 | | 1428 | | | | | 31,416 | Pounds |
| | W14x26 | W14x26 | 26 | 434 | | 434 | | | | | 11,284 | Pounds |
| | W14x30 | W14x30 | 30 | 384 | | 384 | | | | | 11,520 | Pounds |
| | W14x34 | W14x34 | 34 | 275 | | 275 | | | | | 9,350 | Pounds |
| | W14x48 | W14x48 | 48 | 92 | | 92 | | | | | 4,416 | Pounds |
| | W16x26 | W16x26 | 26 | 562 | | 562 | | | | | 14,612 | Pounds |
| | W16x40 | W16x40 | 40 | 14 | | 14 | | | | | 560 | Pounds |
| | W16x45 | W16x45 | 45 | 8 | | 8 | | | | | 360 | Pounds |
| | W18x35 | W18x35 | 35 | 72 | | 72 | | | | | 2,520 | Pounds |
| | W21x44 | W21x44 | 44 | 90 | | 90 | | | | | 3,960 | Pounds |
| | W24x55 | W24x55 | 55 | 172 | | 172 | | | | | 9,460 | Pounds |
| | W24x76 | W24x76 | 76 | 58 | | 58 | | | | | 4,408 | Pounds |
| | W8x15 | W8x15 | 15 | 78 | | 78 | | | | | 1,170 | Pounds |
| | W10x12 | W10x12 | 12 | 16 | | 16 | | | | | 192 | Pounds |
| | C8x11.5 | C8x11.5 | 11.5 | 350 | | 350 | | | | | 4,025 | Pounds |
| | Wt7x15 | Wt7x15 | 15 | 24 | | 24 | | | | | 360 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | Total | 109,613 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | 10% For Connections | | 120,574 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | | 60.29 | Tons |

# ESTIMATE WORK SHEET

**STRUCTURAL STEEL**

| | | | |
|---|---|---|---|
| **Project:** | WPI NEW RES HALL | **Estimate No.** | |
| **Location** | Worcester, MA | **Sheet No.** | |
| **Architect** | Canon Design | **Date** | |
| **Items** | Fourth Floor Framing | **By** | **Checked** |

| Cost Code | Description | Designation | Pounds / Foot | Length Ft. | Length In. | Length Ft. | | | | | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W14x22 | W14x22 | 22 | 1428 | | 1428 | | | | | 31,416 | Pounds |
| | W14x26 | W14x26 | 26 | 434 | | 434 | | | | | 11,284 | Pounds |
| | W14x30 | W14x30 | 30 | 384 | | 384 | | | | | 11,520 | Pounds |
| | W14x34 | W14x34 | 34 | 275 | | 275 | | | | | 9,350 | Pounds |
| | W14x48 | W14x48 | 48 | 92 | | 92 | | | | | 4,416 | Pounds |
| | W16x26 | W16x26 | 26 | 562 | | 562 | | | | | 14,612 | Pounds |
| | W16x40 | W16x40 | 40 | 14 | | 14 | | | | | 560 | Pounds |
| | W16x45 | W16x45 | 45 | 8 | | 8 | | | | | 360 | Pounds |
| | W18x35 | W18x35 | 35 | 72 | | 72 | | | | | 2,520 | Pounds |
| | W21x44 | W21x44 | 44 | 90 | | 90 | | | | | 3,960 | Pounds |
| | W24x55 | W24x55 | 55 | 172 | | 172 | | | | | 9,460 | Pounds |
| | W24x76 | W24x76 | 76 | 58 | | 58 | | | | | 4,408 | Pounds |
| | W8x15 | W8x15 | 15 | 78 | | 78 | | | | | 1,170 | Pounds |
| | W10x12 | W10x12 | 12 | 16 | | 16 | | | | | 192 | Pounds |
| | C8x11.5 | C8x11.5 | 11.5 | 350 | | 350 | | | | | 4,025 | Pounds |
| | Wt7x15 | Wt7x15 | 15 | 24 | | 24 | | | | | 360 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | Total | 109,613 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | 10% For Connections | | 120,574 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | | 60.29 | Tons |

# ESTIMATE WORK SHEET

**STRUCTURAL STEEL**

**Project:** WPI NEW RES HALL
**Location** Worcester, MA
**Architect** Canon Design
**Items** Fifth Floor Framing

**Estimate No.**
**Sheet No.**
**Date**
**By** **Checked**

| Cost Code | Description | Designation | Pounds / Foot | Length Ft. | Length In. | Length Ft. | | | | | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W14x22 | W14x22 | 22 | 1428 | | 1428 | | | | | 31,416 | Pounds |
| | W14x26 | W14x26 | 26 | 434 | | 434 | | | | | 11,284 | Pounds |
| | W14x30 | W14x30 | 30 | 384 | | 384 | | | | | 11,520 | Pounds |
| | W14x34 | W14x34 | 34 | 275 | | 275 | | | | | 9,350 | Pounds |
| | W14x48 | W14x48 | 48 | 92 | | 92 | | | | | 4,416 | Pounds |
| | W16x26 | W16x26 | 26 | 562 | | 562 | | | | | 14,612 | Pounds |
| | W16x40 | W16x40 | 40 | 14 | | 14 | | | | | 560 | Pounds |
| | W16x45 | W16x45 | 45 | 8 | | 8 | | | | | 360 | Pounds |
| | W18x35 | W18x35 | 35 | 72 | | 72 | | | | | 2,520 | Pounds |
| | W21x44 | W21x44 | 44 | 90 | | 90 | | | | | 3,960 | Pounds |
| | W24x55 | W24x55 | 55 | 172 | | 172 | | | | | 9,460 | Pounds |
| | W24x76 | W24x76 | 76 | 58 | | 58 | | | | | 4,408 | Pounds |
| | W8x15 | W8x15 | 15 | 78 | | 78 | | | | | 1,170 | Pounds |
| | W10x12 | W10x12 | 12 | 16 | | 16 | | | | | 192 | Pounds |
| | C8x11.5 | C8x11.5 | 11.5 | 350 | | 350 | | | | | 4,025 | Pounds |
| | Wt7x15 | Wt7x15 | 15 | 24 | | 24 | | | | | 360 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | Total | 109,613 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | 10% For Connections | | 120,574 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | | 60.29 | Tons |

# ESTIMATE WORK SHEET

**STRUCTURAL STEEL**

**Project:** WPI NEW RES HALL
**Location** Worcester, MA
**Architect** Canon Design
**Items** Roof Framing

**Estimate No.**
**Sheet No.**
**Date**
**By** **Checked**

| Cost Code | Description | Designation | Pounds / Foot | Length Ft. | Length In. | Length Ft. | | | | | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W12x26 | W12x26 | 26 | 290 | | 290 | | | | | 7,540 | Pounds |
| | W14x22 | W14x22 | 22 | 320 | | 320 | | | | | 7,040 | Pounds |
| | W18x46 | W18x46 | 46 | 12 | | 12 | | | | | 552 | Pounds |
| | W18x55 | W18x55 | 55 | 100 | | 100 | | | | | 5,500 | Pounds |
| | W18x40 | W18x40 | 40 | 124 | | 124 | | | | | 4,960 | Pounds |
| | W16x26 | W16x26 | 26 | 1175 | | 1175 | | | | | 30,550 | Pounds |
| | W16x31 | W16x31 | 31 | 138 | | 138 | | | | | 4,278 | Pounds |
| | W18x50 | W18x50 | 50 | 90 | | 90 | | | | | 4,500 | Pounds |
| | W18x35 | W18x35 | 35 | 1088 | | 1088 | | | | | 38,080 | Pounds |
| | W21x44 | W21x44 | 44 | 188 | | 188 | | | | | 8,272 | Pounds |
| | W24x55 | W24x55 | 55 | 292 | | 292 | | | | | 16,060 | Pounds |
| | W24x76 | W24x76 | 76 | 56 | | 56 | | | | | 4,256 | Pounds |
| | W8x15 | W8x15 | 15 | 10 | | 10 | | | | | 150 | Pounds |
| | W10x15 | W10x15 | 15 | 25 | | 25 | | | | | 375 | Pounds |
| | Wt7x15 | Wt7x15 | 15 | 10 | | 10 | | | | | 150 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | Total | 132,263 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | 10% For Connections | | 145,489 | Pounds |
| | | | | | | | | | | | | |
| | | | | | | | | | | | 72.74 | Tons |

# ESTIMATE WORK SHEET

**STRUCTURAL STEEL**

**Project:** WPI NEW RES HALL
**Location** Worcester, MA
**Architect** Canon Design
**Items** Bracing

**Estimate No.** 
**Sheet No.** 
**Date** 
**By** **Checked** 

| Cost Code | Description | Designation | Pounds / Foot | Length Ft. | Length In. | | | | | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | HSS7x7x1/2" | HSS7x7x1/2" | 41.9 | 328 | | | | | | 13,743 | Pounds |
| | 200k | | | | | | | | | | |
| | HSS7x7x1/2" | HSS7x7x1/2" | 41.9 | 620 | | | | | | 25,978 | Pounds |
| | 300k | | | | | | | | | | |
| | HSS7x7x1/2" | HSS7x7x1/2" | 41.9 | 104 | | | | | | 4,358 | Pounds |
| | 400k | | | | | | | | | | |
| | HSS8x8x5/8" | HSS8x8x5/8" | 59.1 | 128 | | | | | | 7,565 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | Total | 51,644 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | 10% For Connections | | 56,808 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | | | 28.40 | Tons |

# ESTIMATE WORK SHEET

**Project:** WPI NEW RES HALL — **STRUCTURAL STEEL** — **Estimate No.**
**Location** Worcester, MA — **Sheet No.**
**Architect** Canon Design — ~~**Date**~~
**Items** Vertical Steel — **By** — **Checked**

| Cost Code | Description | Designation | Pounds / Foot | Length Ft. | Length In. | Length Ft. | | | | Quantity | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | W10x33 | W10x33 | 33 | 1344 | | 1344 | | | | 44,352 | Pounds |
| | W10x49 | W10x49 | 49 | 1484 | | 1484 | | | | 72,716 | Pounds |
| | W12x87 | W12x87 | 87 | 392 | | 392 | | | | 34,104 | Pounds |
| | W12x152 | W12x152 | 152 | 280 | | 280 | | | | 42,560 | Pounds |
| | W10x77 | W10x77 | 77 | 56 | | 56 | | | | 4,312 | Pounds |
| | W12x190 | W12x190 | 190 | 112 | | 112 | | | | 21,280 | Pounds |
| | W10x54 | W10x54 | 54 | 28 | | 28 | | | | 1,512 | Pounds |
| | HSS7x7x1/2" | HSS7x7x1/2" | 41.9 | 239 | | 239 | | | | 10,014 | Pounds |
| | HSS6x6x1/2" | HSS6x6x1/2" | 35.1 | 717 | | 717 | | | | 25,167 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | | Total | 256,017 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | 10% For Connections | | 281,618 | Pounds |
| | | | | | | | | | | | |
| | | | | | | | | | | 140.81 | Tons |

# Appendix F: Steel Estimate

Steel Tonage per Floor

| Activity | Steel Quantity (Tons) | Cost |
|---|---|---|
| 2nd Floor Framing | 61.21 | $170,163.80 |
| 3rd Floor Framing | 60.29 | $167,606.20 |
| 4th Floor Framing | 60.29 | $167,606.20 |
| 5th Floor Framing | 60.29 | $167,606.20 |
| Roof Framing | 72.74 | $202,217.20 |
| Bracing | 28.4 | $78,952.00 |
| Vertical Steel | 140.81 | $391,451.80 |
| Total Tonage Cost | 484.03 | $1,175,439.60 |
| x City Cost Index Springfield MA: 1.08 | | $1,269,474.77 |

# Appendix G: Earned Value Analysis Spreadsheet

| | | Actual Percent Completed | | Scheduled Complete | | | | | | | | | Actual Labor Hours | | Scheduled Labor Hours | | Actual Cost | | Scheduled Cost | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity | Unit | December 12th | January 15th | December 12th | January 30th | Labor Hours | Material | Labor | Cost/Unit | # of Unit | Total Labor Hours | Total Cost | December 12th | January 30th | December 12th | January 30th | December | January | December | January |
| East Elevation/North Pod: Brick Veneer | M | 50.00% | 100.00% | 100.00% | 100.00% | 26.667 | 470.000 | 880.000 | 1350.000 | 34.425 | 918.011 | $46,473.75 | 459.01 | 688.51 | 918.01 | 918.01 | $23,236.88 | $46,473.75 | $46,473.75 | $46,473.75 |
| East Elevation/North Pod: Curtain Wall | S.F. | 0.00% | 100.00% | 0.00% | 100.00% | 0.164 | 30.000 | 6.100 | 36.100 | 2604.000 | 427.056 | $94,004.40 | 0.00 | 427.06 | 0.00 | 427.06 | $0.00 | $94,004.40 | $0.00 | $94,004.40 |
| East Elevation/North Pod: Curtain Wall Trim & Seal | S.F. | 0.00% | 75.00% | 0.00% | 100.00% | 0.168 | 11.550 | 5.750 | 17.300 | 2604.000 | 437.472 | $45,049.20 | 0.00 | 437.47 | 0.00 | 437.47 | $0.00 | $33,786.90 | $0.00 | $45,049.20 |
| East Elevation/North Pod: Erect Staging | C.S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.189 | 25.500 | 35.500 | 61.000 | 51.000 | 9.639 | $3,111.00 | 9.64 | 9.64 | 9.64 | 9.64 | $3,111.00 | $3,111.00 | $3,111.00 | $3,111.00 |
| East Elevation/North Pod: Punch Windows | Ea | 0.00% | 100.00% | 0.00% | 100.00% | 1.600 | 194.000 | 64.000 | 258.000 | 16.000 | 25.600 | $4,128.00 | 0.00 | 20.48 | 0.00 | 25.60 | $0.00 | $4,128.00 | $0.00 | $4,128.00 |
| East Elevation/North Pod: Spray Foam/Window Membrane 50% | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.012 | 0.230 | 0.340 | 0.570 | 5100.000 | 61.200 | $2,907.00 | 61.20 | 61.20 | 61.20 | 61.20 | $2,907.00 | $2,907.00 | $2,907.00 | $2,907.00 |
| East Elevation/North Pod: Veneer Ties | C | 100.00% | 100.00% | 100.00% | 100.00% | 0.762 | 92.000 | 28.000 | 120.000 | 136.170 | 103.762 | $16,340.40 | 103.76 | 103.76 | 103.76 | 103.76 | $16,340.40 | $16,340.40 | $16,340.40 | $16,340.40 |
| East Elevation/North Pod: Washdown & Staging Removal | S.F. | 0.00% | 100.00% | 60.00% | 100.00% | 0.023 | 0.060 | 0.640 | 0.700 | 5100.000 | 117.300 | $3,570.00 | 0.00 | 117.30 | 70.38 | 117.30 | $0.00 | $3,570.00 | $2,142.00 | $3,570.00 |
| East Elevation/South Pod: Brick Veneer | M | 50.00% | 100.00% | 16.67% | 100.00% | 26.667 | 470.000 | 880.000 | 1350.000 | 34.425 | 918.011 | $46,473.75 | 459.01 | 918.01 | 153.00 | 918.01 | $23,236.88 | $46,473.75 | $7,745.63 | $46,473.75 |
| East Elevation/South Pod: Curtain Wall | S.F. | 0.00% | 95.00% | 0.00% | 55.00% | 0.164 | 30.000 | 6.100 | 36.100 | 2604.000 | 427.056 | $94,004.40 | 0.00 | 405.70 | 0.00 | 234.88 | $0.00 | $89,304.18 | $0.00 | $51,702.42 |
| East Elevation/South Pod: Curtain Wall Trim & Seal | S.F. | 0.00% | 50.00% | 0.00% | 0.00% | 0.168 | 11.550 | 5.750 | 17.300 | 2604.000 | 437.472 | $45,049.20 | 0.00 | 218.74 | 0.00 | 0.00 | $0.00 | $22,524.60 | $0.00 | $0.00 |
| East Elevation/South Pod: Erect Staging | C.S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.189 | 25.500 | 35.500 | 61.000 | 51.000 | 9.639 | $3,111.00 | 9.64 | 9.64 | 9.64 | 9.64 | $3,111.00 | $3,111.00 | $3,111.00 | $3,111.00 |
| East Elevation/South Pod: Punch Windows | Ea | 0.00% | 100.00% | 0.00% | 100.00% | 1.600 | 194.000 | 64.000 | 258.000 | 16.000 | 25.600 | $4,128.00 | 0.00 | 25.60 | 0.00 | 25.60 | $0.00 | $4,128.00 | $0.00 | $4,128.00 |
| East Elevation/South Pod: Spray Foam/Window Membrane 50% | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.012 | 0.230 | 0.340 | 0.570 | 5100.000 | 61.200 | $2,907.00 | 61.20 | 61.20 | 61.20 | 61.20 | $2,907.00 | $2,907.00 | $2,907.00 | $2,907.00 |
| East Elevation/South Pod: Veneer Ties | C | 90.00% | 100.00% | 100.00% | 100.00% | 0.762 | 92.000 | 28.000 | 120.000 | 13.617 | 10.376 | $1,634.04 | 9.34 | 10.38 | 10.38 | 10.38 | $1,470.64 | $1,634.04 | $1,634.04 | $1,634.04 |
| East Elevation/South Pod: Washdown & Staging Removal | S.F. | 0.00% | 100.00% | 0.00% | 100.00% | 0.023 | 0.060 | 0.640 | 0.700 | 5100.000 | 117.300 | $3,570.00 | 0.00 | 117.30 | 0.00 | 117.30 | $0.00 | $3,570.00 | $0.00 | $3,570.00 |
| East Elevation: Exterior Sheathing | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.013 | 0.960 | 0.470 | 1.430 | 10200.000 | 132.600 | $14,586.00 | 132.60 | 132.60 | 132.60 | 132.60 | $14,586.00 | $14,586.00 | $14,586.00 | $14,586.00 |
| East Elevation: Install Base Pre-cast | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.125 | 12.400 | 4.890 | 17.290 | 5437.000 | 679.625 | $94,005.73 | 679.63 | 679.63 | 679.63 | 679.63 | $94,005.73 | $94,005.73 | $94,005.73 | $94,005.73 |
| North Elevation/North Pod: Brick Veneer | M | 66.00% | 75.00% | 100.00% | 100.00% | 26.667 | 470.000 | 880.000 | 1350.000 | 15.390 | 410.405 | $20,776.50 | 270.87 | 307.80 | 410.41 | 410.41 | $13,712.49 | $15,582.38 | $20,776.50 | $20,776.50 |
| North Elevation/North Pod: Curtain Wall | S.F. | 40.00% | 100.00% | 0.00% | 100.00% | 0.164 | 30.000 | 6.100 | 36.100 | 3570.000 | 585.480 | $128,877.00 | 234.19 | 585.48 | 0.00 | 585.48 | $51,550.80 | $128,877.00 | $0.00 | $128,877.00 |
| North Elevation/North Pod: Curtain Wall Trim & Seal | S.F. | 0.00% | 100.00% | 0.00% | 100.00% | 0.168 | 11.550 | 5.750 | 17.300 | 3570.000 | 599.760 | $61,761.00 | 0.00 | 599.76 | 0.00 | 599.76 | $0.00 | $61,761.00 | $0.00 | $61,761.00 |
| North Elevation/North Pod: Erect Staging | C.S.F. | 66.00% | 100.00% | 100.00% | 100.00% | 0.189 | 25.500 | 35.500 | 61.000 | 22.800 | 4.309 | $1,390.80 | 2.84 | 4.31 | 4.31 | 4.31 | $917.93 | $1,390.80 | $1,390.80 | $1,390.80 |
| North Elevation/North Pod: Punch Windows | Ea | 0.00% | 80.00% | 80.00% | 100.00% | 1.600 | 194.000 | 64.000 | 258.000 | 20.000 | 32.000 | $5,160.00 | 0.00 | 25.60 | 25.60 | 32.00 | $0.00 | $4,128.00 | $4,128.00 | $5,160.00 |
| North Elevation/North Pod: Spray foam/Window Membrane | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.012 | 0.230 | 0.340 | 0.570 | 2280.000 | 27.360 | $1,299.60 | 27.36 | 27.36 | 27.36 | 27.36 | $1,299.60 | $1,299.60 | $1,299.60 | $1,299.60 |
| North Elevation/North Pod: Veneer Ties | C | 100.00% | 100.00% | 100.00% | 100.00% | 0.762 | 92.000 | 28.000 | 120.000 | 60.876 | 46.388 | $7,305.12 | 46.39 | 46.39 | 46.39 | 46.39 | $7,305.12 | $7,305.12 | $7,305.12 | $7,305.12 |
| North Elevation/North Pod: Washdown & Staging Removal | S.F. | 66.00% | 100.00% | 100.00% | 100.00% | 0.023 | 0.060 | 0.640 | 0.700 | 2280.000 | 52.440 | $1,596.00 | 34.61 | 52.44 | 52.44 | 52.44 | $1,053.36 | $1,596.00 | $1,596.00 | $1,596.00 |
| North Elevation: Exterior Sheathing | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.013 | 0.960 | 0.470 | 1.430 | 2280.000 | 29.640 | $3,260.40 | 29.64 | 29.64 | 29.64 | 29.64 | $3,260.40 | $3,260.40 | $3,260.40 | $3,260.40 |
| North Elevation: Install Base Pre-cast | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.125 | 12.400 | 4.890 | 17.290 | 1960.000 | 245.000 | $33,888.40 | 245.00 | 245.00 | 245.00 | 245.00 | $33,888.40 | $33,888.40 | $33,888.40 | $33,888.40 |
| South Elevation/South Pod: Brick Veneer | M | 0.00% | 100.00% | 100.00% | 100.00% | 26.667 | 470.000 | 880.000 | 1350.000 | 15.390 | 410.405 | $20,776.50 | 0.00 | 410.41 | 410.41 | 410.41 | $0.00 | $20,776.50 | $20,776.50 | $20,776.50 |
| South Elevation/South Pod: Curtain Wall | S.F. | 0.00% | 50.00% | 0.00% | 100.00% | 0.164 | 30.000 | 6.100 | 36.100 | 3570.000 | 585.480 | $128,877.00 | 0.00 | 292.74 | 0.00 | 585.48 | $0.00 | $64,438.50 | $0.00 | $128,877.00 |
| South Elevation/South Pod: Curtain Wall Trim & Seal | S.F. | 0.00% | 0.00% | 0.00% | 80.00% | 0.168 | 11.550 | 5.750 | 17.300 | 6570.000 | 1103.760 | $113,661.00 | 0.00 | 0.00 | 0.00 | 883.01 | $0.00 | $0.00 | $0.00 | $90,928.80 |
| South Elevation/South Pod: Erect Staging | C.S.F. | 0.00% | 100.00% | 100.00% | 100.00% | 0.189 | 25.500 | 35.500 | 61.000 | 22.800 | 4.309 | $1,390.80 | 0.00 | 4.31 | 4.31 | 4.31 | $0.00 | $1,390.80 | $1,390.80 | $1,390.80 |
| South Elevation/South Pod: Punch Windows | Ea | 0.00% | 0.00% | 0.00% | 100.00% | 1.600 | 194.000 | 64.000 | 258.000 | 20.000 | 32.000 | $5,160.00 | 0.00 | 0.00 | 0.00 | 32.00 | $0.00 | $0.00 | $0.00 | $5,160.00 |
| South Elevation/South Pod: Spray foam/Window Membrane | S.F. | 50.00% | 100.00% | 100.00% | 100.00% | 0.012 | 0.230 | 0.340 | 0.570 | 2280.000 | 27.360 | $1,299.60 | 13.68 | 27.36 | 27.36 | 27.36 | $649.80 | $1,299.60 | $1,299.60 | $1,299.60 |
| South Elevation/South Pod: Veneer Ties | C | 100.00% | 100.00% | 100.00% | 100.00% | 0.762 | 92.000 | 28.000 | 120.000 | 60.876 | 46.388 | $7,305.12 | 46.39 | 46.39 | 46.39 | 46.39 | $7,305.12 | $7,305.12 | $7,305.12 | $7,305.12 |
| South Elevation/South Pod: Washdown & Staging Removal | S.F. | 0.00% | 100.00% | 0.00% | 100.00% | 0.023 | 0.060 | 0.640 | 0.700 | 2280.000 | 52.440 | $1,596.00 | 0.00 | 52.44 | 0.00 | 52.44 | $0.00 | $1,596.00 | $0.00 | $1,596.00 |
| West Elevation: Exterior Sheathing | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.013 | 0.960 | 0.470 | 1.430 | 10200.000 | 132.600 | $14,586.00 | 132.60 | 132.60 | 132.60 | 132.60 | $14,586.00 | $14,586.00 | $14,586.00 | $14,586.00 |
| South Elevation: Install Base Pre-cast | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.125 | 12.400 | 4.890 | 17.290 | 1960.000 | 245.000 | $33,888.40 | 245.00 | 245.00 | 245.00 | 245.00 | $33,888.40 | $33,888.40 | $33,888.40 | $33,888.40 |
| South Elevation: Exterior Sheathing | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.013 | 0.960 | 0.470 | 1.430 | 2280.000 | 29.640 | $3,260.40 | 29.64 | 29.64 | 29.64 | 29.64 | $3,260.40 | $3,260.40 | $3,260.40 | $3,260.40 |
| West Elevation/North Pod: Brick Veneer | M | 0.00% | 33.00% | 66.67% | 100.00% | 26.667 | 470.000 | 880.000 | 1350.000 | 34.425 | 918.011 | $46,473.75 | 0.00 | 302.94 | 612.01 | 918.01 | $0.00 | $15,336.34 | $30,982.50 | $46,473.75 |
| West Elevation/North Pod: Curtain Wall | S.F. | 0.00% | 75.00% | 0.00% | 100.00% | 0.164 | 30.000 | 6.100 | 36.100 | 2604.000 | 427.056 | $94,004.40 | 0.00 | 320.29 | 0.00 | 427.06 | $0.00 | $70,503.30 | $0.00 | $94,004.40 |
| West Elevation/North Pod: Curtain Wall Trim & Seal | S.F. | 0.00% | 0.00% | 0.00% | 25.00% | 0.168 | 11.550 | 5.750 | 17.300 | 2604.000 | 437.472 | $45,049.20 | 0.00 | 0.00 | 0.00 | 109.37 | $0.00 | $0.00 | $0.00 | $11,262.30 |
| West Elevation/North Pod: Erect Staging 50% | C.S.F. | 40.00% | 90.00% | 100.00% | 100.00% | 0.189 | 25.500 | 35.500 | 61.000 | 77.040 | 14.561 | $4,699.44 | 5.82 | 13.10 | 14.56 | 14.56 | $1,879.78 | $4,229.50 | $4,699.44 | $4,699.44 |
| West Elevation/North Pod: Punch Windows | Ea | 100.00% | 100.00% | 0.00% | 100.00% | 1.600 | 194.000 | 64.000 | 258.000 | 16.000 | 25.600 | $4,128.00 | 25.60 | 25.60 | 0.00 | 25.60 | $4,128.00 | $4,128.00 | $0.00 | $4,128.00 |
| West Elevation/North Pod: Spray Foam/Window Membrane 50% | S.F. | 0.00% | 100.00% | 100.00% | 100.00% | 0.012 | 0.230 | 0.340 | 0.570 | 51.000 | 0.612 | $29.07 | 0.00 | 0.61 | 0.61 | 0.61 | $0.00 | $29.07 | $29.07 | $29.07 |
| West Elevation/North Pod: Veneer Ties | C | 5.00% | 100.00% | 100.00% | 100.00% | 0.762 | 92.000 | 28.000 | 120.000 | 136.170 | 103.762 | $16,340.40 | 5.19 | 103.76 | 103.76 | 103.76 | $817.02 | $16,340.40 | $16,340.40 | $16,340.40 |
| West Elevation/North Pod: Washdown & Staging Removal | S.F. | 0.00% | 0.00% | 0.00% | 100.00% | 0.020 | 0.060 | 0.640 | 0.700 | 5100.000 | 102.000 | $3,570.00 | 0.00 | 0.00 | 0.00 | 102.00 | $0.00 | $0.00 | $0.00 | $3,570.00 |
| West Elevation/South Pod: Brick Veneer | M | 0.00% | 85.00% | 0.00% | 100.00% | 26.667 | 470.000 | 880.000 | 1350.000 | 34.425 | 918.011 | $46,473.75 | 0.00 | 780.31 | 0.00 | 918.01 | $0.00 | $39,502.69 | $0.00 | $46,473.75 |
| West Elevation/South Pod: Curtain Wall | S.F. | 0.00% | 40.00% | 0.00% | 10.00% | 0.164 | 30.000 | 6.100 | 36.100 | 2604.000 | 427.056 | $94,004.40 | 0.00 | 170.82 | 0.00 | 42.71 | $0.00 | $37,601.76 | $0.00 | $9,400.44 |
| West Elevation/South Pod: Curtain Wall Trim & Seal | S.F. | 0.00% | 0.00% | 0.00% | 0.00% | 0.168 | 11.550 | 5.750 | 17.300 | 2604.000 | 437.472 | $45,049.20 | 0.00 | 0.00 | 0.00 | 0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| West Elevation/South Pod: Erect Staging 50% | C.S.F. | 0.00% | 100.00% | 100.00% | 100.00% | 0.189 | 25.500 | 35.500 | 61.000 | 51.000 | 9.639 | $3,111.00 | 0.00 | 9.64 | 9.64 | 9.64 | $0.00 | $3,111.00 | $3,111.00 | $3,111.00 |
| West Elevation/South Pod: Punch Windows | Ea | 0.00% | 100.00% | 0.00% | 40.00% | 1.600 | 194.000 | 64.000 | 258.000 | 16.000 | 25.600 | $4,128.00 | 0.00 | 25.60 | 0.00 | 10.24 | $0.00 | $4,128.00 | $0.00 | $1,651.20 |
| West Elevation/South Pod: Spray Foam/Window Membrane 50% | S.F. | 0.00% | 100.00% | 100.00% | 100.00% | 0.012 | 0.230 | 0.340 | 0.570 | 5100.000 | 61.200 | $2,907.00 | 0.00 | 61.20 | 61.20 | 61.20 | $0.00 | $2,907.00 | $2,907.00 | $2,907.00 |
| West Elevation/South Pod: Veneer Ties | C | 90.00% | 100.00% | 100.00% | 100.00% | 0.762 | 92.000 | 28.000 | 120.000 | 136.170 | 103.762 | $16,340.40 | 93.39 | 103.76 | 103.76 | 103.76 | $14,706.36 | $16,340.40 | $16,340.40 | $16,340.40 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Elevation/South Pod: Washdown & Staging Removal | S.F. | 0.00% | 0.00% | 0.00% | 100.00% | 0.023 | 0.060 | 0.640 | 0.700 | 5100.000 | 117.300 | $3,570.00 | 0.00 | 0.00 | 0.00 | 117.30 | $0.00 | $0.00 | $0.00 | $3,570.00 |
| West Elevation: Install Base Pre-cast | S.F. | 100.00% | 100.00% | 100.00% | 100.00% | 0.125 | 12.400 | 4.890 | 17.290 | 5437.000 | 679.625 | $94,005.73 | 679.63 | 679.63 | 679.63 | 679.63 | $94,005.73 | $94,005.73 | $94,005.73 | $94,005.73 |
| **Total** | | 42.05% | 84.51% | 58.61% | 92.91% | | | | | | 14429.822 | $1,646,052.25 | 4152.85 | 10206.14 | 5531.45 | 12414.14 | $473,127.22 | $1,202,358.95 | $519,530.73 | $1,370,052.01 |

# Appendix H: Activity Information from RS Means Cost Data 2006

| | | | | Bare Costs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity | Unit | Crew | Labor Hours | Material | Labor | Equipment | Total | Add-Ons | | | | | |
| East Elevation/North Pod: Brick Veneer | M | D-8 | 26.667 | 470.000 | 880.000 | 0.000 | 1350.000 | | | | | | |
| East Elevation/North Pod: Curtain Wall | S.F. | H-1 | 0.164 | 30.000 | 6.100 | 0.000 | 36.100 | | | | | | |
| East Elevation/North Pod: Curtain Wall Trim & Seal | S.F. | 2 Glaz | 0.168 | 11.550 | 5.750 | 0.000 | 17.300 | | | | | | |
| East Elevation/North Pod: Erect Staging 50% | C.S.F. | 3 Carp | 0.189 | 25.500 | 35.500 | 0.000 | 61.000 | | | | | | |
| East Elevation/North Pod: Punch Windows | Ea | 2 Sswk | 1.600 | 194.000 | 64.000 | 0.000 | 258.000 | | | | | | |
| East Elevation/North Pod: Spray Foam/Window Membrane 50% | S.F. | G-2 | 0.012 | 0.230 | 0.340 | 0.060 | 0.630 | | | | | | |
| East Elevation/North Pod: Veneer Ties | C | 1 Bric | 0.762 | 92.000 | 28.000 | 0.000 | 120.000 | | | | | | |
| East Elevation/North Pod: Washdown & Staging Removal | S.F. | D-1 | 0.020 | 0.060 | 0.640 | 0.000 | 0.700 | | | | | | |
| East Elevation/South Pod: Brick Veneer | M | D-8 | 26.667 | 470.000 | 880.000 | 0.000 | 1350.000 | | | | | | |
| East Elevation/South Pod: Curtain Wall | S.F. | H-1 | 0.164 | 30.000 | 6.100 | 0.000 | 36.100 | | | | | | |
| East Elevation/South Pod: Curtain Wall Trim & Seal | S.F. | 2 Glaz | 0.168 | 11.550 | 5.750 | 0.000 | 17.300 | | | | | | |
| East Elevation/South Pod: Erect Staging 50% | C.S.F. | 3 Carp | 0.189 | 25.500 | 35.500 | 0.000 | 61.000 | | | | | | |
| East Elevation/South Pod: Punch Windows | Ea | 2 Sswk | 1.600 | 194.000 | 64.000 | 0.000 | 258.000 | | | | | | |
| East Elevation/South Pod: Spray Foam/Window Membrane 50% | S.F. | G-2 | 0.012 | 0.230 | 0.340 | 0.060 | 0.630 | | | | | | |
| East Elevation/South Pod: Veneer Ties | C | 1 Bric | 0.762 | 92.000 | 28.000 | 0.000 | 120.000 | | | | | | |
| East Elevation/South Pod: Washdown & Staging Removal | S.F. | D-1 | 0.023 | 0.060 | 0.640 | 0.000 | 0.700 | REMOVAL | 4 Carp | 400.000 | S.F./Hr | 0.0025 | Labor Hours/S.F. |
| East Elevation: Exterior Sheathing | S.F. | 2 Carp | 0.013 | 0.960 | 0.470 | 0.000 | 1.430 | | | | | | |
| East Elevation: Install Base Pre-cast | S.F. | C-11 | 0.125 | 12.400 | 4.890 | 2.670 | 19.960 | | | | | | |
| North Elevation/North Pod: Brick Veneer | M | D-8 | 26.667 | 470.000 | 880.000 | 0.000 | 1350.000 | | | | | | |
| North Elevation/North Pod: Curtain Wall | S.F. | H-1 | 0.164 | 30.000 | 6.100 | 0.000 | 36.100 | | | | | | |
| North Elevation/North Pod: Curtain Wall Trim & Seal | S.F. | 2 Glaz | 0.168 | 11.550 | 5.750 | 0.000 | 17.300 | | | | | | |
| North Elevation/North Pod: Erect Staging | C.S.F. | 3 Carp | 0.189 | 25.500 | 35.500 | 0.000 | 61.000 | | | | | | |
| North Elevation/North Pod: Punch Windows | Ea | 2 | 1.600 | 194.00 | 64.000 | 0.000 | 258.00 | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sswk | | 0 | | | 0 | | | | | | |
| North Elevation/North Pod: Spray foam/Window Membrane | S.F. | G-2 | 0.012 | 0.230 | 0.340 | 0.060 | 0.630 | | | | | | |
| North Elevation/North Pod: Veneer Ties | C | 1 Bric | 0.762 | 92.000 | 28.000 | 0.000 | 120.000 | | | | | | |
| North Elevation/North Pod: Washdown & Staging Removal | S.F. | D-1 | 0.020 | 0.060 | 0.640 | 0.000 | 0.700 | REMOVAL | 4 Carp | 400.000 | S.F./Hr | 0.0025 | Labor Hours/S.F. |
| North Elevation: Exterior Sheathing | S.F. | 2 Carp | 0.013 | 0.960 | 0.470 | 0.000 | 1.430 | | | | | | |
| North Elevation: Install Base Pre-cast | S.F. | C-11 | 0.125 | 12.400 | 4.890 | 2.670 | 19.960 | | | | | | |
| South Elevation/South Pod: Brick Veneer | M | D-8 | 26.667 | 470.000 | 880.000 | 0.000 | 1350.000 | | | | | | |
| South Elevation/South Pod: Curtain Wall | S.F. | H-1 | 0.164 | 30.000 | 6.100 | 0.000 | 36.100 | | | | | | |
| South Elevation/South Pod: Curtain Wall Trim & Seal | S.F. | 2 Glaz | 0.168 | 11.550 | 5.750 | 0.000 | 17.300 | | | | | | |
| South Elevation/South Pod: Erect Staging | C.S.F. | 3 Carp | 0.189 | 25.500 | 35.500 | 0.000 | 61.000 | | | | | | |
| South Elevation/South Pod: Punch Windows | Ea | 2 Sswk | 1.600 | 194.000 | 64.000 | 0.000 | 258.000 | | | | | | |
| South Elevation/South Pod: Spray foam/Window Membrane | S.F. | G-2 | 0.012 | 0.230 | 0.340 | 0.060 | 0.630 | | | | | | |
| South Elevation/South Pod: Veneer Ties | C | 1 Bric | 0.762 | 92.000 | 28.000 | 0.000 | 120.000 | | | | | | |
| South Elevation/South Pod: Washdown & Staging Removal | S.F. | D-1 | 0.020 | 0.060 | 0.640 | 0.000 | 0.700 | REMOVAL | 4 Carp | 400.000 | S.F./Hr | 0.0025 | Labor Hours/S.F. |
| South Elevation: Exterior Sheathing | S.F. | 2 Carp | 0.013 | 0.960 | 0.470 | 0.000 | 1.430 | | | | | | |
| South Elevation: Install Base Pre-cast | S.F. | C-11 | 0.125 | 12.400 | 4.890 | 2.670 | 19.960 | | | | | | |
| South Pod: Exterior Sheathing | S.F. | 2 Carp | 0.013 | 0.960 | 0.470 | 0.000 | 1.430 | | | | | | |
| West Elevation/North Pod: Brick Veneer | M | D-8 | 26.667 | 470.000 | 880.000 | 0.000 | 1350.000 | | | | | | |
| West Elevation/North Pod: Curtain Wall | S.F. | H-1 | 0.164 | 30.000 | 6.100 | 0.000 | 36.100 | | | | | | |
| West Elevation/North Pod: Curtain Wall Trim & Seal | S.F. | 2 Glaz | 0.168 | 11.550 | 5.750 | 0.000 | 17.300 | | | | | | |
| West Elevation/North Pod: Erect Staging 50% | C.S.F. | 3 Carp | 0.189 | 25.500 | 35.500 | 0.000 | 61.000 | | | | | | |
| West Elevation/North Pod: Punch Windows | Ea | 2 Sswk | 1.600 | 194.000 | 64.000 | 0.000 | 258.000 | | | | | | |
| West Elevation/North Pod: Spray Foam/Window Membrane 50% | S.F. | G-2 | 0.012 | 0.230 | 0.340 | 0.060 | 0.630 | | | | | | |
| West Elevation/North Pod: Veneer Ties | C | 1 Bric | 0.762 | 92.000 | 28.000 | 0.000 | 120.000 | | | | | | |
| West Elevation/North Pod: Washdown & Staging Removal | S.F. | D-1 | 0.020 | 0.060 | 0.640 | 0.000 | 0.700 | REMOVAL | 4 Carp | 400.000 | S.F./Hr | 0.0025 | Labor Hours/S.F. |
| West Elevation/South Pod: Brick Veneer | M | D-8 | 26.667 | 470.000 | 880.000 | 0.000 | 1350.000 | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Elevation/South Pod: Curtain Wall | S.F. | H-1 | 0.164 | 30.000 | 6.100 | 0.000 | 36.100 | | | | | | |
| West Elevation/South Pod: Curtain Wall Trim & Seal | S.F. | 2 Glaz | 0.168 | 11.550 | 5.750 | 0.000 | 17.300 | | | | | | |
| West Elevation/South Pod: Erect Staging 50% | C.S.F. | 3 Carp | 0.189 | 25.500 | 35.500 | 0.000 | 61.000 | | | | | | |
| West Elevation/South Pod: Punch Windows | Ea | 2 Sswk | 1.600 | 194.000 | 64.000 | 0.000 | 258.000 | | | | | | |
| West Elevation/South Pod: Spray Foam/Window Membrane 50% | S.F. | G-2 | 0.012 | 0.230 | 0.340 | 0.060 | 0.630 | | | | | | |
| West Elevation/South Pod: Veneer Ties | C | 1 Bric | 0.762 | 92.000 | 28.000 | 0.000 | 120.000 | | | | | | |
| West Elevation/South Pod: Washdown & Staging Removal | S.F. | D-1 | 0.020 | 0.060 | 0.640 | 0.000 | 0.700 | REMOVAL | 4 Carp | 400.000 | S.F./Hr | 0.0025 | Labor Hours/S.F. |
| West Elevation: Install Base Pre-cast | S.F. | C-11 | 0.125 | 12.400 | 4.890 | 2.670 | 19.960 | | | | | | |
| West Elevation: Install Base Pre-cast | S.F. | C-11 | 0.125 | 12.400 | 4.890 | 2.670 | 19.960 | | | | | | |

# Appendix I: Total by Floor in Square Feet

| Floor | Walls Height | Linear Ft. | Sq. Ft. of Wall | Linear Ft. Precast | Sq. Ft. Precast | % Precast | Linear Ft. Brick | Sq. Ft. Brick | % Brick of Total | Linear Ft. Curtain Wall | Sq. Ft. CW | % CW of Total | Total % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 13 | 1042 | 13546 | 1042 | 13546 | 100.00 % | 0 | 0 | 0.00% | 0 | 0 | 0.00% | 100.00 % |
| **2** | 10 | 1042 | 10420 | 0 | 0 | 0.00% | 624 | 6240 | 59.88% | 418 | 4180 | 40.12% | 100.00 % |
| **3** | 10 | 1042 | 10420 | 0 | 0 | 0.00% | 624 | 6240 | 59.88% | 418 | 4180 | 40.12% | 100.00 % |
| **4** | 10 | 1042 | 10420 | 0 | 0 | 0.00% | 624 | 6240 | 59.88% | 418 | 4180 | 40.12% | 100.00 % |
| **5** | 10 | 1042 | 10420 | 0 | 0 | 0.00% | 624 | 6240 | 59.88% | 418 | 4180 | 40.12% | 100.00 % |
| **Roof** | 2 | 1042 | 2084 | 624 | 1248 | 59.88% | 0 | 0 | 0.00% | 418 | 836 | 40.12% | 100.00 % |
| **Total** | -- | | 57310 | | **14794** | **25.81%** | | **24960** | **43.55%** | | 17556 | **30.63%** | 100.00 % |

# Appendix J: Total Area by Activity in Square Feet

| Area | Wall Type | Total Height | Linear Ft. | Area (Ft^2) | Precast Elevation | Wall Height | Linear Ft. | Area (ft^2) | True Area(Incl. Top pieces) |
|---|---|---|---|---|---|---|---|---|---|
| **North Elevation/North Pod** | **Brick** | 40 | 57 | 2280 | **North** | 13 | 142 | 1846 | 1960 |
| **South Elevation/South Pod** | **Brick** | 40 | 57 | 2280 | **East** | 13 | 379 | 4927 | 5437 |
| **East Elevation/North Pod** | **Brick** | 40 | 127.5 | 5100 | **South** | 13 | 142 | 1846 | 1960 |
| **East Elevation/South Pod** | **Brick** | 40 | 127.5 | 5100 | **West** | 13 | 379 | 4927 | 5437 |
| **West Elevation/North Pod** | **Brick** | 40 | 127.5 | 5100 | **North** | 2 | 57 | 114 | |
| **West Elevation/South Pod** | **Brick** | 40 | 127.5 | 5100 | **East** | 2 | 255 | 510 | |
| **North Elevation/North Pod** | **Curtain Wall** | 42 | 85 | 3570 | **South** | 2 | 57 | 114 | |
| **South Elevation/South Pod** | **Curtain Wall** | 42 | 85 | 3570 | **West** | 2 | 255 | 510 | |
| **East Elevation/North Pod** | **Curtain Wall** | 42 | 62 | 2604 | | | | | |
| **East Elevation/South Pod** | **Curtain Wall** | 42 | 62 | 2604 | | | | | |
| **West Elevation/North Pod** | **Curtain Wall** | 42 | 62 | 2604 | | | | | |
| **West Elevation/South Pod** | **Curtain Wall** | 42 | 62 | 2604 | | | | | |
| **Totals** | | -- | 1042 | 42516 | | | 1666 | 14794 | |

***Only Floors 2-5

## Appendix K: Table for CPI vs. SPI

| SPI | CPI |
|---|---|
| 0.73 | 1 |
| 0.96 | 1 |

## Appendix L: Earned Value Indices Spreadsheet

| BAC | BCWP | CPI | ETC | EAC |
|---|---|---|---|---|
| $1,608,858.61 | $1,241,832.55 | 1 | 367026.1 | $1,608,858.61 |

# Appendix M: Microsoft Project Screenshot December 12th, 2007

Microsoft Project - MQPWALLSDec12th.mpp

Project Guide: Custom tracking

| | Task Name | Work | Actual | Baseline Cost | PlannedWork | ACWP | BCWS | BCWP | SV | CPI | SPI | % Complete | EAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Exterior Walls** | **14,201.52 hrs** | **4,152.88 hrs** | **$1,608,858.61** | **14090.22 hrs** | **$391,383.06** | **$535,183.52** | **$391,470.83** | **($143,712.69)** | **1** | **0.73** | **33%** | **$1,608,497.87** |
| 2 | **All Building Elevations** | **2,173.77 hrs** | **2,173.77 hrs** | **$291,481.06** | **2173.77 hrs** | **$291,481.06** | **$291,481.06** | **$291,481.06** | **$0.00** | **1** | **1** | **90%** | **$291,481.06** |
| 3 | **Architectural Pre-cast** | **1,849.27 hrs** | **1,849.27 hrs** | **$255,788.26** | **1849.27 hrs** | **$255,788.26** | **$255,788.26** | **$255,788.26** | **$0.00** | **1** | **1** | **85%** | **$255,788.26** |
| 7 | East Elevation: Install Base Pre-cast | 679.63 hrs | 679.63 hrs | $94,005.73 | 679.63 hrs | $94,005.73 | $94,005.73 | $94,005.73 | $0.00 | 1 | 1 | 100% | $94,005.73 |
| 4 | Level-1: Install Tube for Pre-cast Support | 0 hrs | 0 hrs | $0.00 | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 5 | Level-1:Spray Fire Proof (@precast) | 0 hrs | 0 hrs | $0.00 | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 6 | North Elevation: Install Base Pre-cast | 245 hrs | 245 hrs | $33,888.40 | 245 hrs | $33,888.40 | $33,888.40 | $33,888.40 | $0.00 | 1 | 1 | 100% | $33,888.40 |
| 8 | South Elevation: Install Base Pre-cast | 245 hrs | 245 hrs | $33,888.40 | 245 hrs | $33,888.40 | $33,888.40 | $33,888.40 | $0.00 | 1 | 1 | 100% | $33,888.40 |
| 9 | West Elevation: Install Base Pre-cast | 679.63 hrs | 679.63 hrs | $94,005.73 | 679.63 hrs | $94,005.73 | $94,005.73 | $94,005.73 | $0.00 | 1 | 1 | 100% | $94,005.73 |
| 10 | **Exterior Sheathing** | **324.5 hrs** | **324.5 hrs** | **$35,692.80** | **324.5 hrs** | **$35,692.80** | **$35,692.80** | **$35,692.80** | **$0.00** | **1** | **1** | **99%** | **$35,692.80** |
| 12 | East Elevation: Exterior Sheathing | 132.6 hrs | 132.6 hrs | $14,586.00 | 132.6 hrs | $14,586.00 | $14,586.00 | $14,586.00 | $0.00 | 1 | 1 | 100% | $14,586.00 |
| 16 | North "Tight" for Elec. Roughin & Insulation | 0 hrs | 0 hrs | $0.00 | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 11 | North Elevation: Exterior Sheathing | 29.65 hrs | 29.65 hrs | $3,260.40 | 29.65 hrs | $3,260.40 | $3,260.40 | $3,260.40 | $0.00 | 1 | 1 | 100% | $3,260.40 |
| 17 | South "Tight" for Elec. Roughin & Insulation | 0 hrs | 0 hrs | $0.00 | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 14 | South Elevation: Exterior Sheathing | 29.65 hrs | 29.65 hrs | $3,260.40 | 29.65 hrs | $3,260.40 | $3,260.40 | $3,260.40 | $0.00 | 1 | 1 | 100% | $3,260.40 |
| 15 | Start Exterior Sheathing (4th 100% & 5th 50% fr) | 0 hrs | 0 hrs | $0.00 | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 13 | West Elevation: Exterior Sheathing | 132.6 hrs | 132.6 hrs | $14,586.00 | 132.6 hrs | $14,586.00 | $14,586.00 | $14,586.00 | $0.00 | 1 | 1 | 100% | $14,586.00 |
| 18 | **North Pod** | **6,069.53 hrs** | **1,286.47 hrs** | **$658,044.03** | **5958.25 hrs** | **$69,752.08** | **$184,834.84** | **$69,838.72** | **($114,996.12)** | **1** | **0.38** | **27%** | **$657,227.67** |
| 28 | **East Facade** | **2,100.03 hrs** | **633.6 hrs** | **$215,583.75** | **2100.03 hrs** | **$45,595.28** | **$55,922.78** | **$45,595.28** | **($10,327.50)** | **1** | **0.82** | **28%** | **$215,583.75** |
| 32 | East Elevation/North Pod: Brick Veneer | 918.02 hrs | 459 hrs | $46,473.75 | 918.02 hrs | $23,236.88 | $33,564.38 | $23,236.88 | ($10,327.50) | 1 | 0.69 | 50% | $46,473.75 |
| 35 | East Elevation/North Pod: Curtain Wall | 427.07 hrs | 0 hrs | $94,004.40 | 427.07 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $94,004.40 |
| 36 | East Elevation/North Pod: Curtain Wall Trim & Seal | 437.47 hrs | 0 hrs | $45,049.20 | 437.47 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $45,049.20 |
| 31 | East Elevation/North Pod: Erect Staging 50% | 9.63 hrs | 9.63 hrs | $3,111.00 | 9.63 hrs | $3,111.00 | $3,111.00 | $3,111.00 | $0.00 | 1 | 1 | 100% | $3,111.00 |
| 34 | East Elevation/North Pod: Punch Windows | 25.6 hrs | 0 hrs | $4,128.00 | 25.6 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $4,128.00 |
| 30 | East Elevation/North Pod: Spray Foam/Window Membrane 50% | 61.2 hrs | 61.2 hrs | $2,907.00 | 61.2 hrs | $2,907.00 | $2,907.00 | $2,907.00 | $0.00 | 1 | 1 | 100% | $2,907.00 |
| 29 | East Elevation/North Pod: Veneer Ties | 103.77 hrs | 103.77 hrs | $16,340.40 | 103.77 hrs | $16,340.40 | $16,340.40 | $16,340.40 | $0.00 | 1 | 1 | 100% | $16,340.40 |
| 33 | East Elevation/North Pod: Washdown & Staging Removal | 117.3 hrs | 0 hrs | $3,570.00 | 117.3 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $3,570.00 |
| 19 | **North Facade** | **1,869.45 hrs** | **616.25 hrs** | **$228,166.02** | **1758.13 hrs** | **$21,501.51** | **$36,981.60** | **$21,572.54** | **($15,409.05)** | **1** | **0.58** | **38%** | **$227,414.68** |
| 23 | North Elevation/North Pod: Brick Veneer | 459.02 hrs | 270.87 hrs | $20,776.50 | 410.4 hrs | $11,011.55 | $20,776.50 | $11,086.70 | ($9,689.80) | 1.01 | 0.53 | 53% | $20,635.66 |
| 25 | North Elevation/North Pod: Curtain Wall | 585.48 hrs | 234.2 hrs | $128,877.00 | 585.48 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 40% | $128,877.00 |
| 27 | North Elevation/North Pod: Curtain Wall Trim & Seal | 599.77 hrs | 0 hrs | $61,761.00 | 599.77 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $61,761.00 |
| 22 | North Elevation/North Pod: Erect Staging | 9.63 hrs | 2.83 hrs | $1,390.80 | 4.32 hrs | $917.93 | $1,390.80 | $914.35 | ($476.45) | 1 | 0.66 | 66% | $1,396.24 |
| 26 | North Elevation/North Pod: Punch Windows | 32 hrs | 0 hrs | $5,160.00 | 32 hrs | $0.00 | $4,613.58 | $0.00 | ($4,613.58) | 0 | 0 | 0% | $5,160.00 |
| 21 | North Elevation/North Pod: Spray foam/Window Membrane | 27.37 hrs | 27.37 hrs | $1,299.60 | 27.37 hrs | $1,286.60 | $1,299.60 | $1,286.06 | ($13.54) | 1 | 0.99 | 99% | $1,300.15 |
| 20 | North Elevation/North Pod: Veneer Ties | 103.77 hrs | 46.38 hrs | $7,305.12 | 46.38 hrs | $7,232.07 | $7,305.12 | $7,232.07 | ($73.05) | 1 | 0.99 | 99% | $7,305.12 |
| 24 | North Elevation/North Pod: Washdown & Staging Removal | 52.43 hrs | 34.62 hrs | $1,596.00 | 52.43 hrs | $1,053.36 | $1,596.00 | $1,053.36 | ($542.64) | 1 | 0.66 | 66% | $1,596.00 |
| 37 | **West Facade** | **2,100.03 hrs** | **36.62 hrs** | **$214,294.26** | **2100.03 hrs** | **$2,655.30** | **$91,930.47** | **$2,670.90** | **($89,259.56)** | **1.01** | **0.03** | **17%** | **$213,042.31** |
| 46 | North Pod Building "Tight" for Boarding | 0 hrs | 0 hrs | $46,473.75 | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $46,473.75 |
| 41 | West Elevation/North Pod: Brick Veneer | 918.02 hrs | 0 hrs | $94,004.40 | 918.02 hrs | $0.00 | $67,892.07 | $0.00 | ($67,892.07) | 0 | 0 | 0% | $94,004.40 |
| 44 | West Elevation/North Pod: Curtain Wall | 427.07 hrs | 0 hrs | $45,049.20 | 427.07 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $45,049.20 |

Exterior Walls

Project Guide: Custom tracking

| | Task Name | Work | Actual | Baseline Cost | PlannedWork | ACWP | BCWS | BCWP | SV | CPI | SPI | % Complete | EAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | West Elevation/North Pod: Curtain Wall Trim & Seal | 437.47 hrs | 0 hrs | $4,699.44 | 437.47 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $4,699.44 |
| 40 | West Elevation/North Pod: Erect Staging 50% | 9.63 hrs | 5.82 hrs | $4,128.00 | 9.63 hrs | $2,476.80 | $4,128.00 | $2,492.28 | ($1,635.72) | 1.01 | 0.6 | 60% | $4,102.36 |
| 43 | West Elevation/North Pod: Punch Windows | 25.6 hrs | 25.6 hrs | $29.07 | 25.6 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 100% | $29.07 |
| 39 | West Elevation/North Pod: Spray Foam/Window Membrane 50% | 61.2 hrs | 0 hrs | $16,340.40 | 61.2 hrs | $0.00 | $16,340.40 | $0.00 | ($16,340.40) | 0 | 0 | 0% | $16,340.40 |
| 38 | West Elevation/North Pod: Veneer Ties | 103.77 hrs | 5.18 hrs | $3,570.00 | 103.77 hrs | $178.50 | $3,570.00 | $178.62 | ($3,391.38) | 1 | 0.05 | 5% | $3,567.52 |
| 42 | West Elevation/North Pod: Washdown & Staging Removal | 117.3 hrs | 0 hrs | $0.00 | 117.3 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 47 | **− South Pod** | **5,958.23 hrs** | **692.65 hrs** | **$659,333.52** | **5958.28 hrs** | **$30,149.92** | **$58,867.62** | **$30,151.05** | **($28,716.57)** | **1** | **0.51** | **12%** | **$659,308.71** |
| 48 | **− East Facade** | **2,100.03 hrs** | **539.18 hrs** | **$215,583.75** | **2100.03 hrs** | **$7,488.64** | **$22,358.40** | **$7,488.64** | **($14,869.76)** | **1** | **0.33** | **20%** | **$215,583.75** |
| 52 | East Elevation/South Pod: Brick Veneer | 918.02 hrs | 459 hrs | $46,473.75 | 918.02 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 50% | $46,473.75 |
| 55 | East Elevation/South Pod: Curtain Wall | 427.07 hrs | 0 hrs | $94,004.40 | 427.07 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $94,004.40 |
| 56 | East Elevation/South Pod: Curtain Wall Trim & Seal | 437.47 hrs | 0 hrs | $45,049.20 | 437.47 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $45,049.20 |
| 51 | East Elevation/South Pod: Erect Staging 50% | 9.63 hrs | 9.63 hrs | $3,111.00 | 9.63 hrs | $3,111.00 | $3,111.00 | $3,111.00 | $0.00 | 1 | 1 | 100% | $3,111.00 |
| 54 | East Elevation/South Pod: Punch Windows | 25.6 hrs | 0 hrs | $4,128.00 | 25.6 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $4,128.00 |
| 50 | East Elevation/South Pod: Spray Foam/Window Membrane 50% | 61.2 hrs | 61.2 hrs | $2,907.00 | 61.2 hrs | $2,907.00 | $2,907.00 | $2,907.00 | $0.00 | 1 | 1 | 100% | $2,907.00 |
| 49 | East Elevation/South Pod: Veneer Ties | 103.77 hrs | 9.33 hrs | $16,340.40 | 103.77 hrs | $1,470.64 | $16,340.40 | $1,470.64 | ($14,869.76) | 1 | 0.09 | 9% | $16,340.40 |
| 53 | East Elevation/South Pod: Washdown & Staging Removal | 117.3 hrs | 0 hrs | $3,570.00 | 117.3 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $3,570.00 |
| 66 | **− South Facade** | **1,758.15 hrs** | **60.07 hrs** | **$228,166.02** | **1758.15 hrs** | **$7,954.92** | **$14,150.82** | **$7,954.92** | **($6,195.90)** | **1** | **0.56** | **8%** | **$228,166.02** |
| 70 | South Elevation/South Pod: Brick Veneer | 410.42 hrs | 0 hrs | $20,776.50 | 410.42 hrs | $0.00 | $4,155.30 | $0.00 | ($4,155.30) | 0 | 0 | 0% | $20,776.50 |
| 73 | South Elevation/South Pod: Curtain Wall | 585.48 hrs | 0 hrs | $128,877.00 | 585.48 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $128,877.00 |
| 74 | South Elevation/South Pod: Curtain Wall Trim & Seal | 599.77 hrs | 0 hrs | $61,761.00 | 599.77 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $61,761.00 |
| 69 | South Elevation/South Pod: Erect Staging | 4.32 hrs | 0 hrs | $1,390.80 | 4.32 hrs | $0.00 | $1,390.80 | $0.00 | ($1,390.80) | 0 | 0 | 0% | $1,390.80 |
| 72 | South Elevation/South Pod: Punch Windows | 32 hrs | 0 hrs | $5,160.00 | 32 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $5,160.00 |
| 68 | South Elevation/South Pod: Spray foam/Window Membrane | 27.37 hrs | 13.68 hrs | $1,299.60 | 27.37 hrs | $649.80 | $1,299.60 | $649.80 | ($649.80) | 1 | 0.5 | 50% | $1,299.60 |
| 67 | South Elevation/South Pod: Veneer Ties | 46.38 hrs | 46.38 hrs | $7,305.12 | 46.38 hrs | $7,305.12 | $7,305.12 | $7,305.12 | $0.00 | 1 | 1 | 100% | $7,305.12 |
| 71 | South Elevation/South Pod: Washdown & Staging Removal | 52.43 hrs | 0 hrs | $1,596.00 | 52.43 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $1,596.00 |
| 57 | **− West Facade** | **2,100.03 hrs** | **93.38 hrs** | **$215,583.75** | **2100.03 hrs** | **$14,706.36** | **$22,358.40** | **$14,707.49** | **($7,650.91)** | **1** | **0.66** | **8%** | **$215,567.12** |
| 61 | West Elevation/South Pod: Brick Veneer | 918.02 hrs | 0 hrs | $46,473.75 | 918.02 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $46,473.75 |
| 64 | West Elevation/South Pod: Curtain Wall | 427.07 hrs | 0 hrs | $94,004.40 | 427.07 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $94,004.40 |
| 65 | West Elevation/South Pod: Curtain Wall Trim & Seal | 437.47 hrs | 0 hrs | $45,049.20 | 437.47 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $45,049.20 |
| 60 | West Elevation/South Pod: Erect Staging 50% | 9.63 hrs | 0 hrs | $3,111.00 | 9.63 hrs | $0.00 | $3,111.00 | $0.00 | ($3,111.00) | 0 | 0 | 0% | $3,111.00 |
| 63 | West Elevation/South Pod: Punch Windows | 25.6 hrs | 0 hrs | $4,128.00 | 25.6 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $4,128.00 |
| 59 | West Elevation/South Pod: Spray Foam/Window Membrane 50% | 61.2 hrs | 0 hrs | $2,907.00 | 61.2 hrs | $0.00 | $2,907.00 | $0.00 | ($2,907.00) | 0 | 0 | 0% | $2,907.00 |
| 58 | West Elevation/South Pod: Veneer Ties | 103.77 hrs | 93.38 hrs | $16,340.40 | 103.77 hrs | $14,706.36 | $16,340.40 | $14,707.49 | ($1,632.91) | 1 | 0.9 | 90% | $16,339.14 |
| 62 | West Elevation/South Pod: Washdown & Staging Removal | 117.3 hrs | 0 hrs | $3,570.00 | 117.3 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $3,570.00 |

# Appendix N: Microsoft Project Screenshot January 30th, 2008

Microsoft Project - MQPWALLSJAN30th.mpp

| | Task Name | Work | Actual | PlannedWork | ACWP | BCWS | BCWP | SV | CPI | SPI | % Complete | EAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Exterior Walls** | **4,281.52 hrs** | **12,139.28 hrs** | **14090.22 hrs** | **$1,242,247.29** | **$1,288,319.84** | **$1,241,832.55** | **($46,487.29)** | **1** | **0.96** | **89%** | **$1,609,395.93** |
| 2 | **All Building Elevations** | **2,253.77 hrs** | **2,253.77 hrs** | **2173.77 hrs** | **$291,481.06** | **$291,481.06** | **$291,481.06** | **$0.00** | **1** | **1** | **99%** | **$291,481.06** |
| 3 | **Architectural Pre-cast** | **1,929.27 hrs** | **1,929.27 hrs** | **1849.27 hrs** | **$255,788.26** | **$255,788.26** | **$255,788.26** | **$0.00** | **1** | **1** | **100%** | **$255,788.26** |
| 7 | East Elevation: Install Base Pre-cast | 679.63 hrs | 679.63 hrs | 679.63 hrs | $94,005.73 | $94,005.73 | $94,005.73 | $0.00 | 1 | 1 | 100% | $94,005.73 |
| 4 | Level-1: Install Tube for Pre-cast Support | 40 hrs | 40 hrs | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 100% | $0.00 |
| 5 | Level-1:Spray Fire Proof (@precast) | 40 hrs | 40 hrs | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 100% | $0.00 |
| 6 | North Elevation: Install Base Pre-cast | 245 hrs | 245 hrs | 245 hrs | $33,888.40 | $33,888.40 | $33,888.40 | $0.00 | 1 | 1 | 100% | $33,888.40 |
| 8 | South Elevation: Install Base Pre-cast | 245 hrs | 245 hrs | 245 hrs | $33,888.40 | $33,888.40 | $33,888.40 | $0.00 | 1 | 1 | 100% | $33,888.40 |
| 9 | West Elevation: Install Base Pre-cast | 679.63 hrs | 679.63 hrs | 679.63 hrs | $94,005.73 | $94,005.73 | $94,005.73 | $0.00 | 1 | 1 | 100% | $94,005.73 |
| 10 | **Exterior Sheathing** | **324.5 hrs** | **324.5 hrs** | **324.5 hrs** | **$35,692.80** | **$35,692.80** | **$35,692.80** | **$0.00** | **1** | **1** | **99%** | **$35,692.80** |
| 12 | East Elevation: Exterior Sheathing | 132.6 hrs | 132.6 hrs | 132.6 hrs | $14,586.00 | $14,586.00 | $14,586.00 | $0.00 | 1 | 1 | 100% | $14,586.00 |
| 16 | North "Tight" for Elec. Roughin & Insulation | 0 hrs | 0 hrs | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 11 | North Elevation: Exterior Sheathing | 29.65 hrs | 29.65 hrs | 29.65 hrs | $3,260.40 | $3,260.40 | $3,260.40 | $0.00 | 1 | 1 | 100% | $3,260.40 |
| 17 | South "Tight" for Elec. Roughin & Insulation | 0 hrs | 0 hrs | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 14 | South Elevation: Exterior Sheathing | 29.65 hrs | 29.65 hrs | 29.65 hrs | $3,260.40 | $3,260.40 | $3,260.40 | $0.00 | 1 | 1 | 100% | $3,260.40 |
| 15 | Start Exterior Sheathing (4th 100% & 5th 50% fr) | 0 hrs | 0 hrs | 0 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $0.00 |
| 13 | West Elevation: Exterior Sheathing | 132.6 hrs | 132.6 hrs | 132.6 hrs | $14,586.00 | $14,586.00 | $14,586.00 | $0.00 | 1 | 1 | 100% | $14,586.00 |
| 18 | **North Pod** | **6,069.53 hrs** | **5,790.17 hrs** | **5958.25 hrs** | **$574,086.03** | **$620,495.86** | **$574,008.57** | **($46,487.29)** | **1** | **0.93** | **98%** | **$658,132.83** |
| 28 | **East Facade** | **2,100.03 hrs** | **2,010.97 hrs** | **2100.03 hrs** | **$198,817.35** | **$198,690.30** | **$198,690.30** | **$0.00** | **1** | **1** | **98%** | **$215,721.60** |
| 32 | East Elevation/North Pod: Brick Veneer | 918.02 hrs | 918.02 hrs | 918.02 hrs | $46,473.75 | $46,473.75 | $46,473.75 | $0.00 | 1 | 1 | 100% | $46,473.75 |
| 35 | East Elevation/North Pod: Curtain Wall | 427.07 hrs | 427.07 hrs | 427.07 hrs | $94,004.40 | $94,004.40 | $94,004.40 | $0.00 | 1 | 1 | 100% | $94,004.40 |
| 36 | East Elevation/North Pod: Curtain Wall Trim & Seal | 437.47 hrs | 348.4 hrs | 437.47 hrs | $28,282.80 | $28,155.75 | $28,155.75 | $0.00 | 1 | 1 | 80% | $45,252.48 |
| 31 | East Elevation/North Pod: Erect Staging 50% | 9.63 hrs | 9.63 hrs | 9.63 hrs | $3,111.00 | $3,111.00 | $3,111.00 | $0.00 | 1 | 1 | 100% | $3,111.00 |
| 34 | East Elevation/North Pod: Punch Windows | 25.6 hrs | 25.6 hrs | 25.6 hrs | $4,128.00 | $4,128.00 | $4,128.00 | $0.00 | 1 | 1 | 100% | $4,128.00 |
| 30 | East Elevation/North Pod: Spray Foam/Window Membrane 50 | 61.2 hrs | 61.2 hrs | 61.2 hrs | $2,907.00 | $2,907.00 | $2,907.00 | $0.00 | 1 | 1 | 100% | $2,907.00 |
| 29 | East Elevation/North Pod: Veneer Ties | 103.77 hrs | 103.77 hrs | 103.77 hrs | $16,340.40 | $16,340.40 | $16,340.40 | $0.00 | 1 | 1 | 100% | $16,340.40 |
| 33 | East Elevation/North Pod: Washdown & Staging Removal | 117.3 hrs | 117.3 hrs | 117.3 hrs | $3,570.00 | $3,570.00 | $3,570.00 | $0.00 | 1 | 1 | 100% | $3,570.00 |
| 19 | **North Facade** | **1,869.45 hrs** | **1,768.23 hrs** | **1758.13 hrs** | **$209,197.20** | **$209,273.59** | **$209,260.05** | **($13.54)** | **1** | **1** | **97%** | **$228,097.49** |
| 23 | North Elevation/North Pod: Brick Veneer | 459.02 hrs | 459.02 hrs | 410.4 hrs | $20,776.50 | $20,776.50 | $20,776.50 | $0.00 | 1 | 1 | 100% | $20,776.50 |
| 25 | North Elevation/North Pod: Curtain Wall | 585.48 hrs | 585.48 hrs | 585.48 hrs | $128,877.00 | $128,877.00 | $128,877.00 | $0.00 | 1 | 1 | 100% | $128,877.00 |
| 27 | North Elevation/North Pod: Curtain Wall Trim & Seal | 599.77 hrs | 498.53 hrs | 599.77 hrs | $42,805.18 | $42,868.57 | $42,868.57 | $0.00 | 1 | 1 | 83% | $61,669.67 |
| 22 | North Elevation/North Pod: Erect Staging | 9.63 hrs | 9.63 hrs | 4.32 hrs | $1,390.80 | $1,390.80 | $1,390.80 | $0.00 | 1 | 1 | 100% | $1,390.80 |
| 26 | North Elevation/North Pod: Punch Windows | 32 hrs | 32 hrs | 32 hrs | $5,160.00 | $5,160.00 | $5,160.00 | $0.00 | 1 | 1 | 100% | $5,160.00 |
| 21 | North Elevation/North Pod: Spray foam/Window Membrane | 27.37 hrs | 27.37 hrs | 27.37 hrs | $1,286.60 | $1,299.60 | $1,286.06 | ($13.54) | 1 | 0.99 | 99% | $1,300.15 |
| 20 | North Elevation/North Pod: Veneer Ties | 103.77 hrs | 103.77 hrs | 46.38 hrs | $7,305.12 | $7,305.12 | $7,305.12 | $0.00 | 1 | 1 | 100% | $7,305.12 |
| 24 | North Elevation/North Pod: Washdown & Staging Removal | 52.43 hrs | 52.43 hrs | 52.43 hrs | $1,596.00 | $1,596.00 | $1,596.00 | $0.00 | 1 | 1 | 100% | $1,596.00 |
| 37 | **West Facade** | **2,100.03 hrs** | **2,010.97 hrs** | **2100.03 hrs** | **$166,071.47** | **$212,531.97** | **$166,058.22** | **($46,473.75)** | **1** | **0.78** | **98%** | **$214,311.36** |
| 46 | North Pod Building "Tight" for Boarding | 0 hrs | 0 hrs | 0 hrs | $0.00 | $46,473.75 | $0.00 | ($46,473.75) | 0 | 0 | 0% | $46,473.75 |
| 41 | West Elevation/North Pod: Brick Veneer | 918.02 hrs | 918.02 hrs | 918.02 hrs | $94,004.40 | $94,004.40 | $94,004.40 | $0.00 | 1 | 1 | 100% | $94,004.40 |
| 44 | West Elevation/North Pod: Curtain Wall | 427.07 hrs | 427.07 hrs | 427.07 hrs | $45,049.20 | $45,049.20 | $45,049.20 | $0.00 | 1 | 1 | 100% | $45,049.20 |

Project Guide: Custom tracking

| | Task Name | Work | Actual | PlannedWork | ACWP | BCWS | BCWP | SV | CPI | SPI | % Complete | EAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | West Elevation/North Pod: Curtain Wall Trim & Seal | 437.47 hrs | 348.4 hrs | 437.47 hrs | $2,950.40 | $2,937.15 | $2,937.15 | $0.00 | 1 | 1 | 80% | $4,720.65 |
| 40 | West Elevation/North Pod: Erect Staging 50% | 9.63 hrs | 9.63 hrs | 9.63 hrs | $4,128.00 | $4,128.00 | $4,128.00 | $0.00 | 1 | 1 | 100% | $4,128.00 |
| 43 | West Elevation/North Pod: Punch Windows | 25.6 hrs | 25.6 hrs | 25.6 hrs | $29.07 | $29.07 | $29.07 | $0.00 | 1 | 1 | 100% | $29.07 |
| 39 | West Elevation/North Pod: Spray Foam/Window Membrane 5( | 61.2 hrs | 61.2 hrs | 61.2 hrs | $16,340.40 | $16,340.40 | $16,340.40 | $0.00 | 1 | 1 | 100% | $16,340.40 |
| 38 | West Elevation/North Pod: Veneer Ties | 103.77 hrs | 103.77 hrs | 103.77 hrs | $3,570.00 | $3,570.00 | $3,570.00 | $0.00 | 1 | 1 | 100% | $3,570.00 |
| 42 | West Elevation/North Pod: Washdown & Staging Removal | 117.3 hrs | 117.3 hrs | 117.3 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 100% | $0.00 |
| **47** | **− South Pod** | **5,958.23 hrs** | **4,095.35 hrs** | **5958.28 hrs** | **$376,680.20** | **$376,342.92** | **$376,342.92** | **$0.00** | **1** | **1** | **75%** | **$659,924.42** |
| **48** | **− East Facade** | **2,100.03 hrs** | **1,367.38 hrs** | **2100.03 hrs** | **$98,908.82** | **$98,792.85** | **$98,792.85** | **$0.00** | **1** | **1** | **68%** | **$215,836.82** |
| 52 | East Elevation/South Pod: Brick Veneer | 918.02 hrs | 918.02 hrs | 918.02 hrs | $46,473.75 | $46,473.75 | $46,473.75 | $0.00 | 1 | 1 | 100% | $46,473.75 |
| 55 | East Elevation/South Pod: Curtain Wall | 427.07 hrs | 136.05 hrs | 427.07 hrs | $23,607.15 | $23,501.10 | $23,501.10 | $0.00 | 1 | 1 | 32% | $94,428.59 |
| 56 | East Elevation/South Pod: Curtain Wall Trim & Seal | 437.47 hrs | 0 hrs | 437.47 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $45,049.20 |
| 51 | East Elevation/South Pod: Erect Staging 50% | 9.63 hrs | 9.63 hrs | 9.63 hrs | $3,111.00 | $3,111.00 | $3,111.00 | $0.00 | 1 | 1 | 100% | $3,111.00 |
| 54 | East Elevation/South Pod: Punch Windows | 25.6 hrs | 21.43 hrs | 25.6 hrs | $2,899.52 | $2,889.60 | $2,889.60 | $0.00 | 1 | 1 | 84% | $4,142.18 |
| 50 | East Elevation/South Pod: Spray Foam/Window Membrane 5( | 61.2 hrs | 61.2 hrs | 61.2 hrs | $2,907.00 | $2,907.00 | $2,907.00 | $0.00 | 1 | 1 | 100% | $2,907.00 |
| 49 | East Elevation/South Pod: Veneer Ties | 103.77 hrs | 103.77 hrs | 103.77 hrs | $16,340.40 | $16,340.40 | $16,340.40 | $0.00 | 1 | 1 | 100% | $16,340.40 |
| 53 | East Elevation/South Pod: Washdown & Staging Removal | 117.3 hrs | 117.3 hrs | 117.3 hrs | $3,570.00 | $3,570.00 | $3,570.00 | $0.00 | 1 | 1 | 100% | $3,570.00 |
| **66** | **− South Facade** | **1,758.15 hrs** | **1,360.58 hrs** | **1758.15 hrs** | **$178,862.56** | **$178,757.22** | **$178,757.22** | **$0.00** | **1** | **1** | **90%** | **$228,300.48** |
| 70 | South Elevation/South Pod: Brick Veneer | 410.42 hrs | 410.42 hrs | 410.42 hrs | $20,776.50 | $20,776.50 | $20,776.50 | $0.00 | 1 | 1 | 100% | $20,776.50 |
| 73 | South Elevation/South Pod: Curtain Wall | 585.48 hrs | 585.48 hrs | 585.48 hrs | $128,877.00 | $128,877.00 | $128,877.00 | $0.00 | 1 | 1 | 100% | $128,877.00 |
| 74 | South Elevation/South Pod: Curtain Wall Trim & Seal | 599.77 hrs | 202.2 hrs | 599.77 hrs | $12,457.54 | $12,352.20 | $12,352.20 | $0.00 | 0.99 | 1 | 34% | $62,287.70 |
| 69 | South Elevation/South Pod: Erect Staging | 4.32 hrs | 4.32 hrs | 4.32 hrs | $1,390.80 | $1,390.80 | $1,390.80 | $0.00 | 1 | 1 | 100% | $1,390.80 |
| 72 | South Elevation/South Pod: Punch Windows | 32 hrs | 32 hrs | 32 hrs | $5,160.00 | $5,160.00 | $5,160.00 | $0.00 | 1 | 1 | 100% | $5,160.00 |
| 68 | South Elevation/South Pod: Spray foam/Window Membrane | 27.37 hrs | 27.37 hrs | 27.37 hrs | $1,299.60 | $1,299.60 | $1,299.60 | $0.00 | 1 | 1 | 100% | $1,299.60 |
| 67 | South Elevation/South Pod: Veneer Ties | 46.38 hrs | 46.38 hrs | 46.38 hrs | $7,305.12 | $7,305.12 | $7,305.12 | $0.00 | 1 | 1 | 100% | $7,305.12 |
| 71 | South Elevation/South Pod: Washdown & Staging Removal | 52.43 hrs | 52.43 hrs | 52.43 hrs | $1,596.00 | $1,596.00 | $1,596.00 | $0.00 | 1 | 1 | 100% | $1,596.00 |
| **57** | **− West Facade** | **2,100.03 hrs** | **1,367.38 hrs** | **2100.03 hrs** | **$98,908.82** | **$98,792.85** | **$98,792.85** | **$0.00** | **1** | **1** | **68%** | **$215,836.82** |
| 61 | West Elevation/South Pod: Brick Veneer | 918.02 hrs | 918.02 hrs | 918.02 hrs | $46,473.75 | $46,473.75 | $46,473.75 | $0.00 | 1 | 1 | 100% | $46,473.75 |
| 64 | West Elevation/South Pod: Curtain Wall | 427.07 hrs | 136.05 hrs | 427.07 hrs | $23,607.15 | $23,501.10 | $23,501.10 | $0.00 | 1 | 1 | 32% | $94,428.59 |
| 65 | West Elevation/South Pod: Curtain Wall Trim & Seal | 437.47 hrs | 0 hrs | 437.47 hrs | $0.00 | $0.00 | $0.00 | $0.00 | 0 | 0 | 0% | $45,049.20 |
| 60 | West Elevation/South Pod: Erect Staging 50% | 9.63 hrs | 9.63 hrs | 9.63 hrs | $3,111.00 | $3,111.00 | $3,111.00 | $0.00 | 1 | 1 | 100% | $3,111.00 |
| 63 | West Elevation/South Pod: Punch Windows | 25.6 hrs | 21.43 hrs | 25.6 hrs | $2,899.52 | $2,889.60 | $2,889.60 | $0.00 | 1 | 1 | 84% | $4,142.18 |
| 59 | West Elevation/South Pod: Spray Foam/Window Membrane 5( | 61.2 hrs | 61.2 hrs | 61.2 hrs | $2,907.00 | $2,907.00 | $2,907.00 | $0.00 | 1 | 1 | 100% | $2,907.00 |
| 58 | West Elevation/South Pod: Veneer Ties | 103.77 hrs | 103.77 hrs | 103.77 hrs | $16,340.40 | $16,340.40 | $16,340.40 | $0.00 | 1 | 1 | 100% | $16,340.40 |
| 62 | West Elevation/South Pod: Washdown & Staging Removal | 117.3 hrs | 117.3 hrs | 117.3 hrs | $3,570.00 | $3,570.00 | $3,570.00 | $0.00 | 1 | 1 | 100% | $3,570.00 |

# Appendix O: Cost Analysis Spreadsheet

Cost Comparison

| Design | Section | Concrete Cost $ | Placement Cost $ | Formwork$ | Reinforcing (steel) $ | Total Cost per section $ | Total Cost$ |
|---|---|---|---|---|---|---|---|
| Original | Spread Footing | 1264 | 165.43 | 765.1 | 2240 | 4434.53 | |
| | Piers | 424.06 | 133.28 | 997.54 | 1275 | 2829.88 | |
| | Foundation Wall | 1440.53 | 188.54 | 3522.73 | 2115 | 7266.8 | |
| | | | | | | | 14531.21 |
| Cannon Tieback Solution | Dead Man | 1253.07 | 164 | 606.26 | 3920 | | |
| | | | | | | | 5943.33 |
| Cannon + Orginal Design | | 4381.66 | 651.25 | 5891.63 | 9550 | | |
| | | | | | | | 20474.54 |
| Redesign | Spread Footing and Key | 3867.5 | 506.29 | 1177 | 3360 | 8910.79 | |
| | Walls and Counterforts | 4791.15 | 627.06 | 11922.73 | 22500 | 39840.94 | |
| | | | | | | | 48751.73 |

# Appendix P: Concrete Takeoff for Different Designs

| | | |
|---|---|---|
| Takeoff Comparison | | |
| | | |
| Design | Section | Quantity (yds.$^3$) |
| | | |
| Original | Spread Footing | 13.89 |
| | Piers | 4.66 |
| | Foundation Wall | 15.83 |
| | Total | 34.38 |
| | | |
| Cannon Tieback Solution | Dead Man | 13.77 |
| | Total | 13.77 |
| | | |
| Cannon + Original Design | Total | 48.15 |
| | | |
| Redesign | Spread Footing and Key | 42.51 |
| | Walls and Counterforts | 52.65 |
| | Total | 95.16 |

| | | |
|---|---|---|
| Cannon Tieback Solution | | |
| | | |
| Dead Man | Length (ft.) | 18 |
| | Width (ft.) | 10.33 |
| | Height (ft.) | 2 |
| | Total (ft$^3$) | 371.88 |
| | Total (yds$^3$) | 13.77 |
| Total Weight (lbs) | | 55782 |
| Total Weight (tons) | | 27.89 |

| | | |
|---|---|---|
| Designed Footing, Wall and Counterforts | | |
| Footing | Length (ft.) | 41 |
| | Width (ft.) | 12 |
| | Height (ft.) | 2 |
| | Total ($ft^3$) | 984 |
| | Total ($yds^3$) | 36.44 |
| | | |
| Counterforts, 5 | Base (ft.) | 8 |
| | Height (ft.) | 12.15 |
| | Width (ft.) | 1 |
| | Counterforts | 5 |
| | Total ($ft^3$) | 486 |
| | Total ($yds^3$) | 18 |
| | | |
| Foundation Wall | Length (ft.) | 38.5 |
| | Width (ft.) | 2 |
| | Height (ft.) | 12.15 |
| | Total ($ft^3$) | 935.5 |
| | Total ($yds^3$) | 34.65 |
| | | |
| Key | Length (ft.) | 41 |
| | Width (ft.) | 2 |
| | Height (ft.) | 2 |
| | Total ($ft^3$) | 164 |
| | Total ($yds^3$) | 6.07 |
| | | |
| Total Cubic Feet | | 2569.5 |
| Total Cubic Yards | | 95.17 |
| Total Weight (lbs) | | 385425 |
| Total Weight (tons) | | 192.71 |

| | | |
|---|---|---|
| Original Footing and Foundation wall | | |
| | | |
| Spread Footing | Length (ft.) | 41.67 |
| | Width (ft.) | 6 |
| | Height (ft.) | 1.5 |
| | Total ($ft^3$) | 375.03 |
| | Total ($yds^3$) | 13.89 |
| | | |
| Piers, 3 | Length (ft.) | 2 |
| | Width (ft.) | 2 |
| | Height (ft.) | 10.48 |
| | Piers | 3 |
| | Total ($ft^3$) | 125.76 |
| | Total ($yds^3$) | 4.66 |
| | | |
| Foundation Wall | Length (ft.) | 31.66 |
| | Width (ft.) | 1.333 |
| | Height (ft.) | 10.15 |
| | Total ($ft^3$) | 427.39 |
| | Total ($yds^3$) | 15.83 |
| | | |
| Total Cubic Feet | | 928.18 |
| Total Cubic Yards | | 34.38 |
| Total Weight (lbs) | | 139227 |
| Total Weight (tons) | | 69.61 |

Tieback Additional Cost

| | | | | | | |
|---|---|---|---|---|---|---|
| Excavation | | | | Cost$ | Total Cost$ | |
| | Bank Cubic Yards | | | | | |
| | 249.26 | | | 388.85 | | |
| Equipment | | | | | | |
| | Type | Mobilization | Demob. | | | |
| | Excavator 150+ hp | 250.5 | 250.5 | 501 | | |
| Installation | | | | | | |
| | Section | | | | | |
| | Deadman | | | 2268.61 | | |
| | Tiebacks | | | 2885.8 | | |
| Additional Parts | | | | | | |
| | Structural Tube | | | 1300 | | |
| | Bolts | | | 66.8 | | |
| Back Filling | Cubic Yards | | | | | |
| | 235.3 | | | 174.12 | | |
| | | | | | 7585.18 | |

| | |
|---|---|
| | Final Cost$ |
| Tieback, Original, and Install $ | 28059.72 + engineering costs |
| Redesign Cost Installed | 48751.73 |

# Appendix Q: Design Computations, Notes, and Diagrams

1188.31 135.7 1

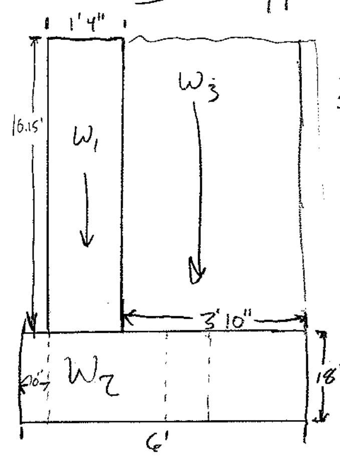
Analysis of Original Wall

2'22"
3'10"

1'11"
1'4"
10" 2'25"
4'1"

$\frac{3'10"}{2}$

1'11"




3'10"
1'4"
5'2"

$y = \frac{11.65^2 + 3(11.65)(34)}{3(11.65 + 2(17))} = \frac{789}{136.95} = 5.33$

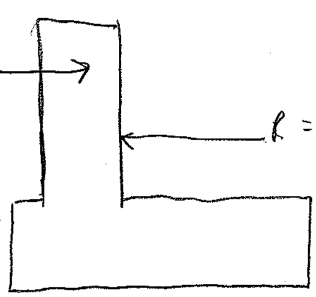
$P = \frac{1}{2}(.333)(130)(11.65')(45.65)$

$= 11,511.3$

$M_o = 11,511.3 \times 5.33$

$= 61,354$ ft-lbs.

| Component Weights | $W_{lb}$ | $X_{ft}$ | $M_r$ ft-lbs |
|---|---|---|---|
| $W_1$ 1.33×10.15×150 | 2029 | 1.5' | 3044 |
| $W_2$ 6'×1.5×150 | 1350 | 3' | 4050 |
| $W_3$ 3.83×10.15×130 | 5054 | 4.08' | 20,620 |
| Totals: | 8433 lbs | | 27,714 |



Resistant force from soil and concrete is 27,714 ft-lbs

P = 61,354 ft-lbs overturning moment

∴ wall will pivot about front lower corner and overturn.

Load Conditions - DL = 750 tons

$U = 1.4D = 1.4(750)$ tons
$= 1050$ tons

Determining surcharge from building

75 columns in building carrying 1050 tons

$\frac{1050 \text{ tons}}{75 \text{ columns}} = 14$ tons/column =

14 tons × 3 columns on southeast foundation wall

42 tons × 2000 = 84,000 pounds

$\frac{84000}{39' \text{length}} = 2154$ psf → surcharge from weight of building

Design Cantilevered wall → estimated base thickness of 2'

$f'_c = 4000$ psi
$f_y = 60{,}000$ psi

$h = 10.15' + 4'$ for frost cover → 14.15'

$s = 2154$ psf
$w = 130$ pcf
$\beta_1 = .85$
$\alpha = 30°$
$f = .5$

$h' = \frac{s}{w} = \frac{2154}{130} = 16.7' \rightarrow 17'$

free arm distance of 12.15'

$C_a = \frac{1-\sin\alpha}{1+\sin\alpha} = \frac{1-\sin 30}{1+\sin 30} = \frac{1-.5}{1+.5} = .333$

Pressure $P$

$P = \frac{1}{2} C_{ah}\, wh(h+2h')$
$= \frac{1}{2}(.333)(130)(12.15)(12.15+2(17))$
$= 12{,}136.8$ lbs.
$= 12{,}137$ lbs.

$y = \frac{h^2 + 3hh'}{3(h+2h')}$
$= \frac{(12.15)^2 + 3(12.15)(17)}{3(12.15+2(17))}$
$= \frac{767.28}{138.45}$
$= 5.54'$

$M_u = 1.7 \times 12{,}137(5.54)$
$= 114{,}306.26$ ft-lbs

$\rho_b = \frac{.85(4000)}{60{,}000}(.85)\left(\frac{87{,}000}{87{,}000+60{,}000}\right)$

$\rho_{all} = \left(\frac{\rho_b}{2}\right)(.75)$

$\rho_b = .0567\ (.85)(.59)$

$\rho_{all} = \left(\frac{.0284}{2}\right)(.75)$

$\rho_b = .0284$

$\rho_{all} = .01066 \approx .011$

$\rho_{all} = .011$ obtain from graph in appendix of Wilson's book

$$\frac{M_u}{\phi b d^2} = 590$$

Unit length of wall ($b = 12$ in), $\phi .90$

$$d = \sqrt{\frac{114{,}307 \times 12}{.9 \times 12 \times 590}}$$

$= 14.67 \approx 14.7 \rightarrow$ 1 inch diameter steel ∴ 2 inch cover over steel

$$\begin{array}{r} 14.7 \text{ in} \\ + \ 2.0 \text{ in. cover} \\ .5 \text{ in} = \tfrac{1}{2} \text{ diam. of rebar} \\ \hline 17.2 \end{array}$$

Make wall 24 in. thick at base of arm, to provide more overturning resistance

$d = \frac{14.7}{12} = 1.225$

Check shear d away from base

$P = \frac{1}{2} \times .333 \times 130 \times 10.93 \times 44.93$

$= 10{,}629.5$

$= 10{,}630$

$V_u = 1.7 \times 10{,}630$
$= 18070$

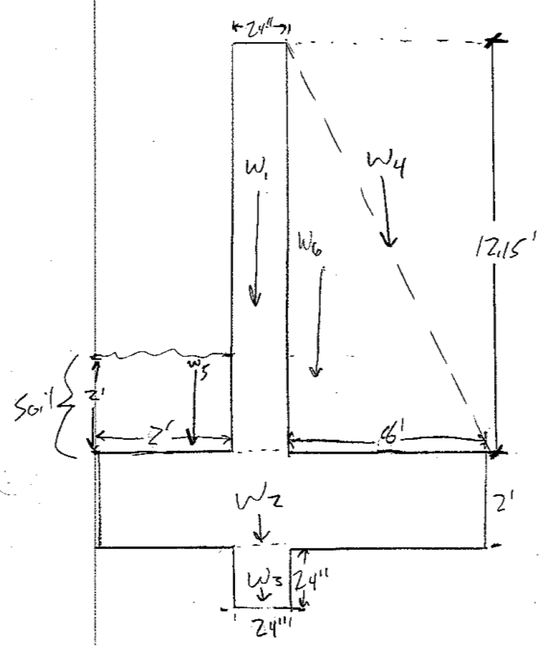
$\phi V_c = 2 \phi \sqrt{f'_c}\ bd$

$= 2.85 \sqrt{4000}(12)(24)$

$= 30{,}965.02$

$= 30{,}965$ lbs.

✓ passes shear test




| Component Weights | $W_{lb.}$ | $x_{ft}$ | $M_r$ ft-lbs |
|---|---|---|---|
| $W_1 = 2' \times 12.15 \times 150$ | 3645 | 3 | 10,935 |
| $W_2 = 2' \times 12' \times 150$ | 4200 | 6 | 25,200 |
| $W_3 = 2' \times 2' \times 150$ | 600 | 3 | 1800 |
| $W_4 = 12.15 \times 8 \times 130$ | 12,636 | 8 | 101,088 |
| $W_5 = 2' \times 2' \times 130$ | 520 | 1 | 520 |
| $W_6\ \frac{1}{2}(12.15 \times 8) \times 150)$ | 7290 | 6.64 | 6367 |
| Totals : | 21,601 | | 139,543 |

12

6291 4215



Total Soil Pressure

$$y = \frac{h^2 + 3hh'}{3(h+2h')}$$

$$P = .5(.333)(130)(14.15)(14.15+34)$$

$= 14{,}747$ lbs

$$= \frac{(14.15)^2 + 3(14.15)(17)}{3(14.15+34)}$$

$y = 6.38$

$M_o = 14{,}744 \times 6.38$

$= 94067$ ft lbs.

distance of resultant from front edge

$$a = \frac{139{,}543 - 94066}{21{,}601} = 2.11'$$

Resultant is outside middle third

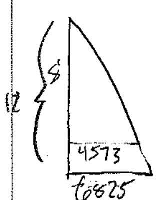
$$q = \frac{2R_v}{3a} = \frac{2(21{,}601)}{3(2.11)} = 6825 \text{ psf}$$

Factor of safety against overturning, $\frac{139{,}543}{94067} = 1.48$, amble.

within 1% of necessary

Continue since counterforts will help to resist lateral overturning

Resistance to sliding $f = .5$ or $\tan 30° = .577$



Friction, toe: $(6625 + 4573) \times .5 \times 2 \times .577 = 6576$

Friction, heel + key $4573 \times .5 \times 10 \times .5 = 13{,}193$

Passive earth pressure: $.5 \times 130 \times 4^2 \times 3.0 = 3120$

Total Resistance to sliding $= 22{,}889$

Factor of safety against sliding $\frac{22{,}889}{14{,}744} = 1.55$, adequate

External Stability of wall has been ascertained

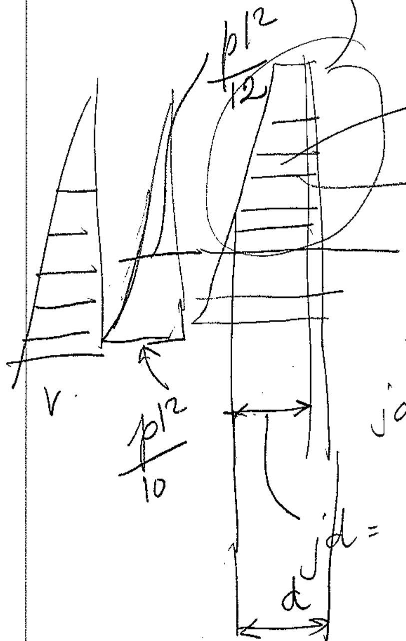
Concrete Take-off - Original Design

Spread footing — Wall Concrete — 3 Piers

$41.67' \times 6' \times 1.5' - 375.03\ ft^3 + 1.33 \times 33' \times 10.15 = 445.5\ ft^3 \quad 2' \times 2' \times 10.15 \times 3 = 121.8\ ft^3$

942.3 $ft^3$ of Conc in original + concrete in tiebacks

$M = \frac{pl^2}{12}$ ✓  $M = \frac{pl^2}{10}$ ✓ lower



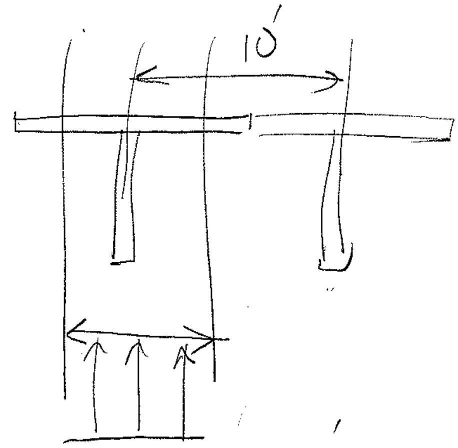

$M = \frac{pl^2}{10}$  ~~$b = \frac{M}{\phi A}$~~

$M = \frac{pl^2}{10}$  $A_s = \frac{M}{\phi f_y (jd)}$

$jd =$

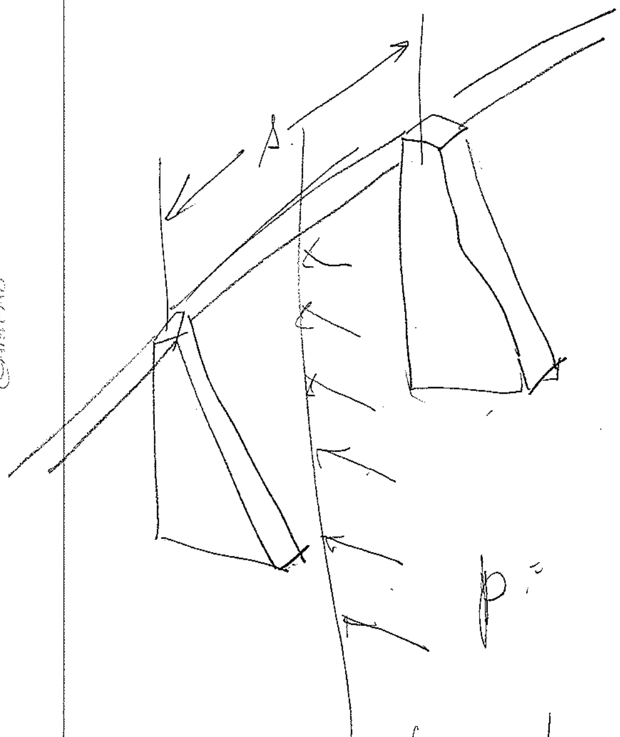
$jd = \cancel{0.85}\ 0.875d$

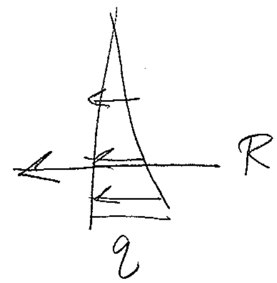
bars @

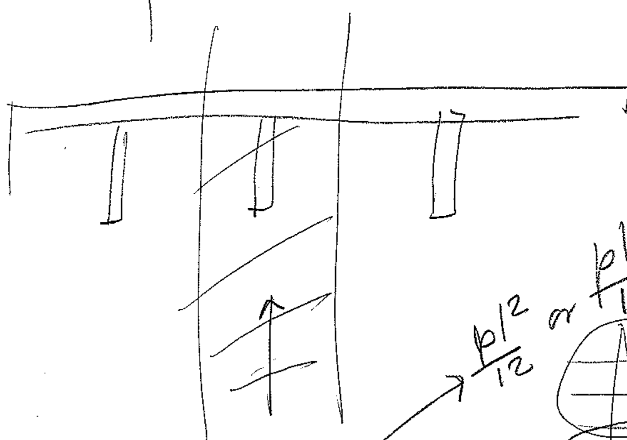


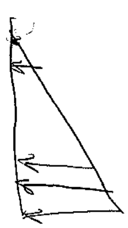

$p = p \times 10' =$ ← psf

6

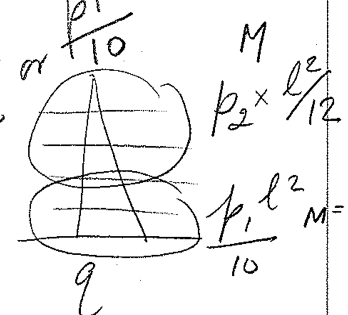




$\frac{pl^2}{12}$ or $\frac{pl^2}{10}$




$Ah = b =$

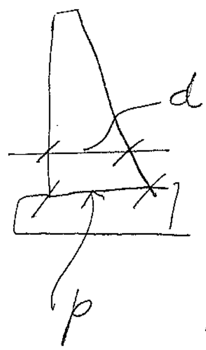
$\frac{Mu}{\phi \, fy \, (j d)} = Ah$ 0.875d

0.90

$e = Av = \frac{Vu}{\phi \, fy \, d}$ 7.9

0.85

# Counterforts




$M =$ total pressure @ bottom of wall $p$

$M = \frac{pl^2}{10} \sim \frac{pl^2}{12}$

## vertical bars d

Moments $= A_v = d = \dfrac{M_u}{\phi f_y (jd)}$, $jd = 0.875d$

$A_h =$ shear

$A_h = V_1 / \phi f_y d$, $\phi = 0.85$

$V_1 = V \pm \frac{M}{d}(\tan\theta + \tan\beta)$

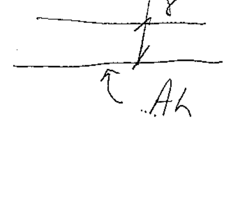
$= (7.9)$ eqn

$f =$ shrinkage steel $= 0.0035\, b \times d$

$b =$ width 1'-0"

$d =$

$s =$ equal ; 8" c/c

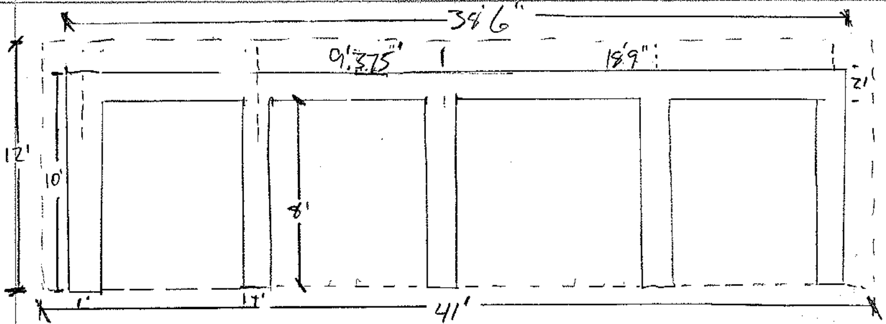


146,603,750 in lbs / 6075000

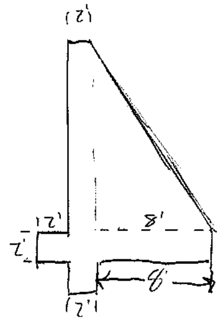
18,660,375

36 + 1'10" = 37'10" 8

386"




Counterfort Steel Design




$M_{total}$ at bottom of wall

$$M_u = \frac{\rho l^2}{10}$$

$$= \frac{14{,}744(9.375 \times 12)^2}{10}$$

Ave area vertical bars

$$= 18{,}660{,}375 \text{ lbf-in}^2$$

$$A_n = \frac{M_u}{\phi f_y(jd)}$$

129,585 / 306,250

no. 16 bars

for first 2' $A_n = \frac{146{,}660{,}375}{.9(60{,}000)(.875)(9.5)(12)} = 3.51 \text{ in}^2$ use no. 18 bars

---

$$M_u = \frac{\rho l^2}{12}$$

$$A_n = \frac{M_u}{\phi f_y(jd)}$$

$\rho = 14{,}744$ lbs

$l = 9.375(12)$

$l^2 = 12656.25$

$$M_u = \frac{14{,}744(12656.25)}{12}$$

$M_u = 15{,}550{,}312$ lbf in²

$$= \frac{15{,}550{,}312}{.9(60{,}000)(.875)(9.375)(12)}$$

5,315,625

$$= \frac{15{,}550{,}312}{5{,}315{,}625} = 2.92 \text{ in}^2$$ use no. 16 bars for top 10.15'

$A_V = V_1 / \phi f_y d$ .85

$V_1 = V + \frac{n}{d}(\tan\theta + \tan\phi)$ 25°

$= 18{,}070 + 165{,}870 \text{ lbs} (\tan\theta + \tan\phi)$

$= 18{,}070 - 222{,}147 (.466)$

$V_1 = 18{,}070 - 103{,}520 \text{ lbs}$

$= 85{,}450 \text{ lbs}$

$A_V = \frac{85{,}450}{.85(60{,}000)(8)}$

$= .209$ use

no. 5 bas @ 8" spacing

$f = .0035\ b \times d$

$= .0035 \times 1 \times 14.15$

$= .05$ no. 3 bars would work, but use no. 4

Steel for arm and key

24in arm - 2in. cover - .5 (for no. 8 bar

$M_u = 114{,}306.26$ ft. lbs

$\frac{M_u}{\phi b d^2} = \frac{114{,}306 \times 12}{.9(12)(21.5)^2} = \frac{114{,}306}{416} = 275$

$f_y = 60{,}000$ $f'_c = 4000$

steel ratio $\rho = .0049$ $A_s = .0049 \times 12 \times 21.5$

no. 9 bars on 8" Center to Center $= 1.26 \text{ in}^2/\text{ft}$

At about 6' you can switch to No 8 bars @ 16" on center due to the decreased moment at this height

use no. 6 vertical bars spaced at 24" on the front face of the wall and no. 8 bars vertically spaced @ 16" on center on the back face of the wall

Toe Slab

$$M_u = 1.7\left(\frac{6825}{2}\times 2^2 \times \frac{2}{3} + \frac{4573}{2}\times 2^2 \times \frac{1}{3}\right) - .9(300\times 2^2\times .5)$$

$$\left[3412.5\times 4 \times (.67) + \left(2287\times 4\times \tfrac{1}{3}\right)\right] - 540$$

$$\left[(9145.5) + (3018.8)\right] - 540$$

$M_u = 20,140$ ft-lbs

$$\frac{M_u}{\phi b d^2} = \frac{20140\times 12}{.9\times 12\times 20.5} = 53$$

Graph A.1b less then the required .0033

$A_s = .0033\times 12\times 20.5$ works with no. 9 on 12" centers
$= .82$

they will be continued 21 in. past face of wall

Check shear 1' from face of stem

$$V_u = 1.7\left[6825(.5)(1) + 6256(.5)(1)\right] - .9(300\times 1)$$

$$1.7\left[3412.5 + 3128\right] - 270$$

$V_u = 10,849$

✓ passes shear

$\phi V_c = 2\times .85\sqrt{4000}\times 12\times 20.5 = 26,450$ lbs

Heel Slab

$$M_u = 1.7\left(\cancel{0\times 8^2\times .5}\right) + 1.4\left[(4572.8\times 8^2\times .5) + (300\times 8^2\times .5)\right]$$

$$146,330 + 9600$$

$M_u = 218,302$

$$\frac{M_u}{\phi b d^2} = \frac{218,302\ \cancel{\times 12}}{.9\ \cancel{\times 12}\times (20.5)^2} = \frac{218,302}{378.2} = 577.2 \quad \text{A1.b}$$

$\rho = .0108$

$A_s = .0108\times 12\times 20.5 = 2.67$

∴ use no 16 bars @ 12" centers

Check Shear

$$V_u = 1.7(\cancel{0 \times 8}^{\,0}) + 1.4(2140 \times 8)$$

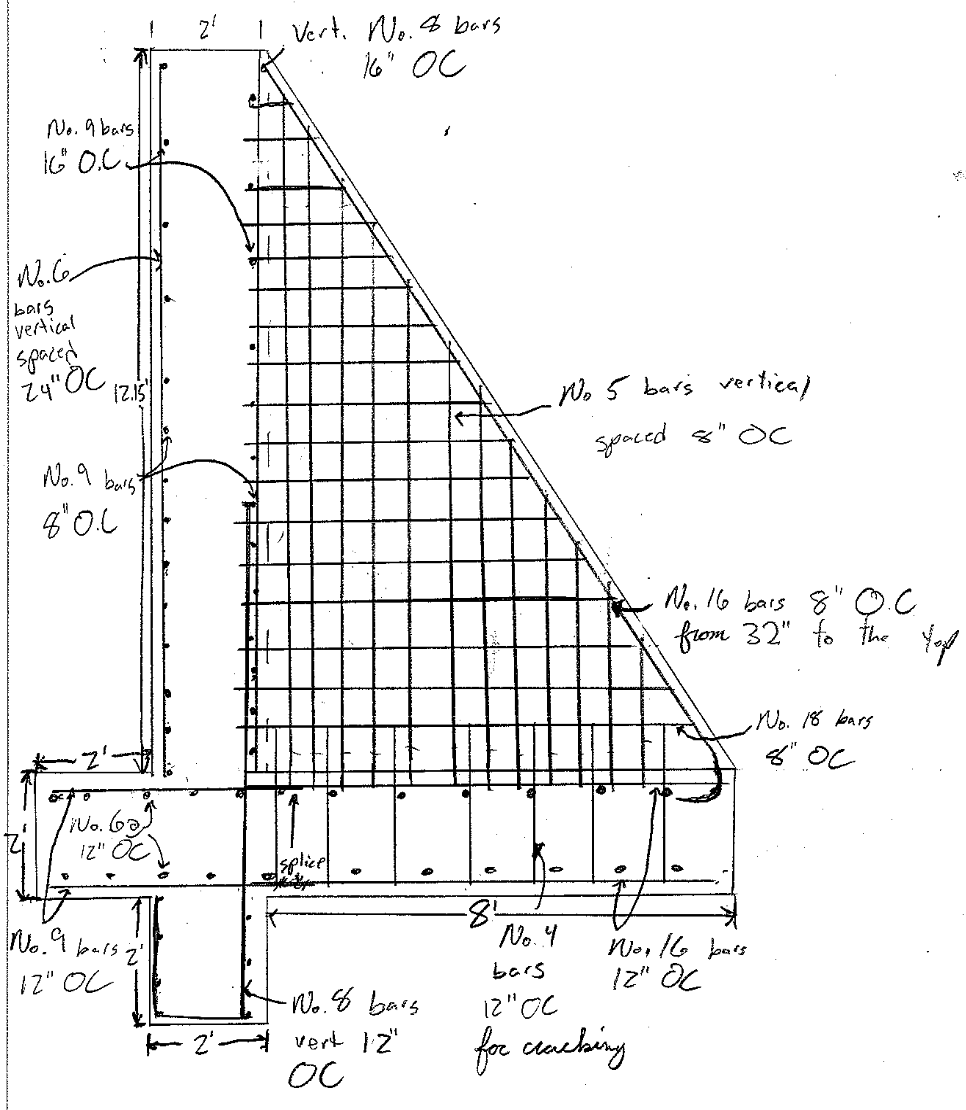
$$= 23,968$$

$\phi V_c = 26,450$ ✓ passes shear test

No. 6 bars 12 in O.C for crack control

1 block = 6"

Reinforcement diagram



10

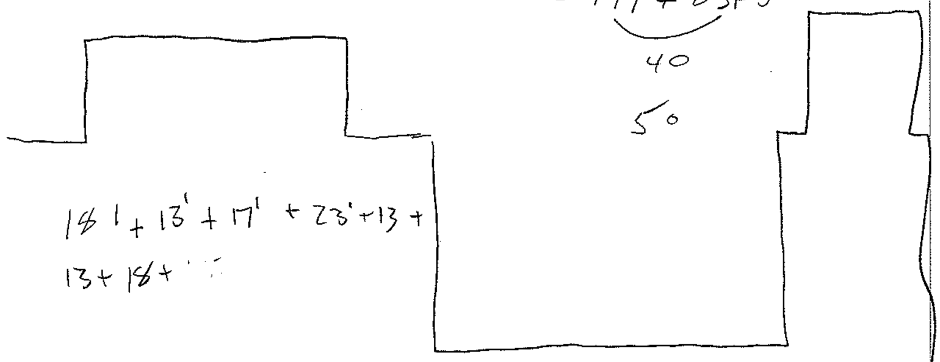
13

15+18+2.5+7

5+17+23+5

40

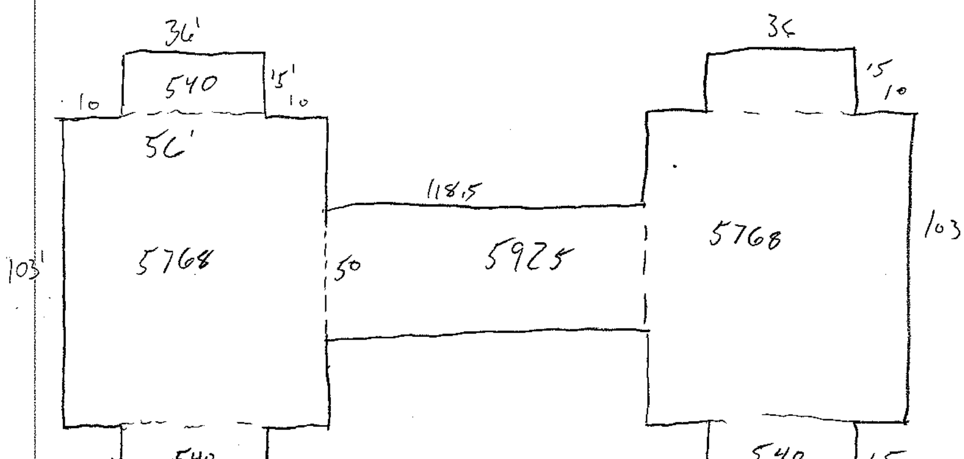
50



18'+13'+17'+23'+13+

13+18+

$$\begin{array}{r} 20,000 \text{ sf} \\ \times \quad 4 \\ \hline 80,000 \text{ sf} \end{array}$$



22,300 lbs/ft
/ 120

- Go to trailer and find out how it was built
  pictures, new plans

lemondropkid @ earthlink.net
north of Orlando, FL

W10x33 Column - 36' tall - effective height due to bracing

13' $KL/r$ = $\frac{13 \times 12}{1.94}$ = 6.75' - round down to be conservative

effective height - 6' - 395 kips

3 colums x 395 kips - max allowed load

38'8" ≈ 39'

$\frac{1185 \text{ kips}}{39}$ =

PL Steel 300 tons

Concrete - 2000 CY

Concrete - 150 tons

$\frac{300{,}000 \text{ lbs}}{2000}$

1.4D + 1.7L =

1050 + 9860

DL - 650 tons

LL - 100 psf
+ 5
+ 10
20
135 psf
x 60,000

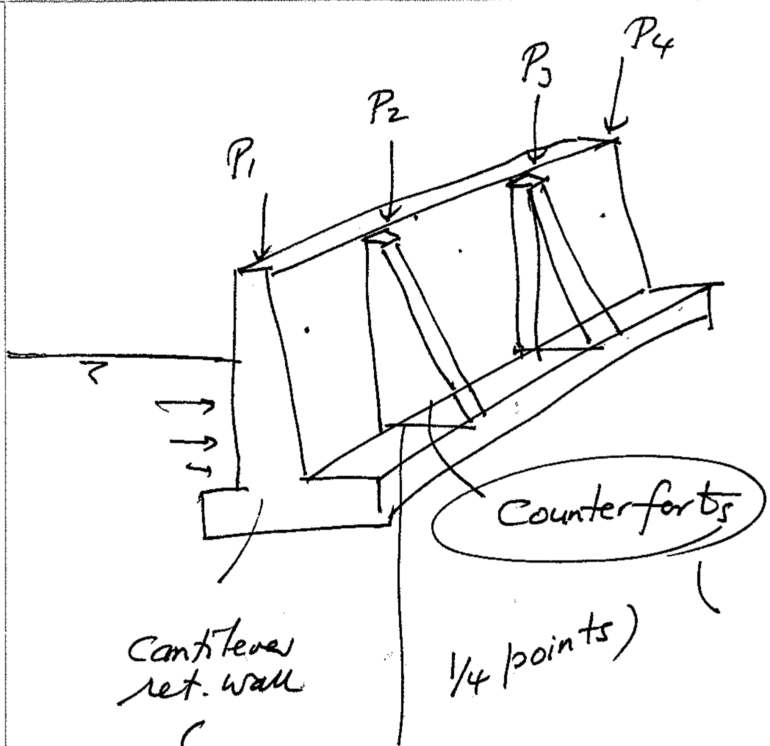
LL = 10,800,000

LL = 5400
+ 400
5800
+ 750

10,910 tons x2000

21,820,000 = 290 kips/Column

3 colums x 290,000




1. Charles E. Reynolds
RC Design Handbook
(British)

foundations

use $\rho_b = \frac{0.85 f'_c}{f_y} (\beta_1) \left(\frac{87000}{87000 + f_y}\right)$

3000 ($f'_c$)
Eq 3.4.4
3.4.5
(p. 41)
60000 ($f_y$)
60,000

$\rho_{all} = \left(\frac{\rho_b}{2}\right) 0.75$

$= 0.375 \rho_b$

$2' + 11.5 = 13.5$

$f'_c = 3000 \quad f_y = 60,000$

$f'_c = 4000$ psi

Arthur H. Nielson

Winter + Nielson

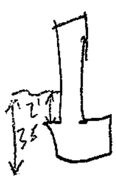
Ferguson - Reinforced

Columns - ~~W8x10~~ W10x33

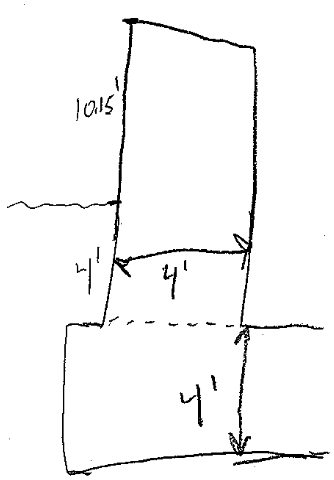
$11.5$
$3.5$

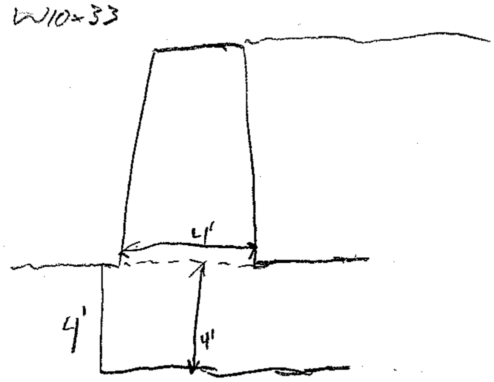
$15$
$-1.5$

$13.5$
$-1.5$
$12'$



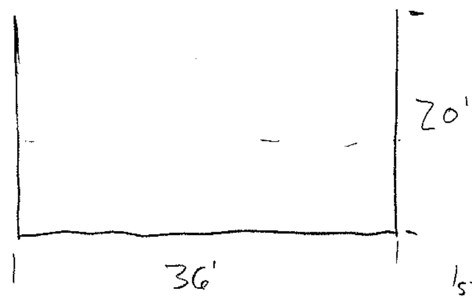

14'



| | 131 + 180 | 7+7 14" | 17 |
|---|---|---|---|

Amount Excavated




1st dig − 36×21×8.17

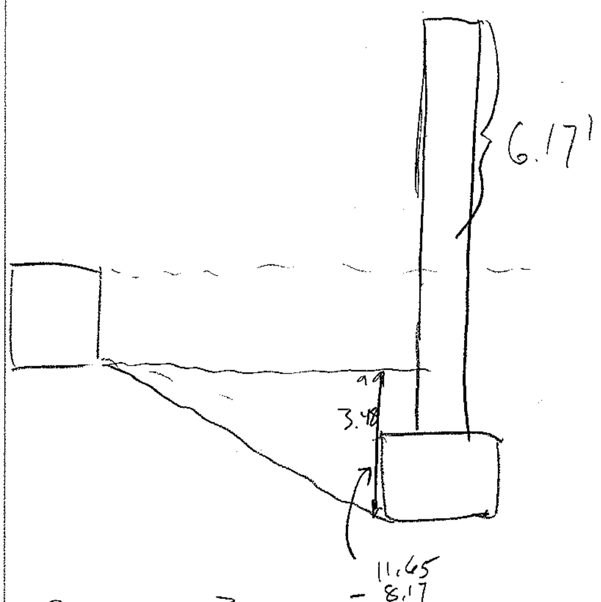
= 6176.52 ft³ / 27 ft³/yd³

= 228.76 yd³

2nd dig

$36 \times \left[\frac{1}{2}(3.48 \times 8.83)\right]$

553.11 ft³ / 27 ft³/yd³ 20.5 yd³




673.60 × 3 = 2020.80 + 765 + 130 + 54 + 7.65

Drilling − 101 Bolts 16.70 × 4 − 66.8

6.49
418.76

249.2 yd³
− 13.7

235.5 yd³

Square Tube − 350 × 2 = 700

300 × 2 = 600

# Appendix R: December 12th, 2007 Progress Photos


WORCESTER
CONSERVATION
COMMISSION
File #07-20



GP
DENSGLASS GOLD

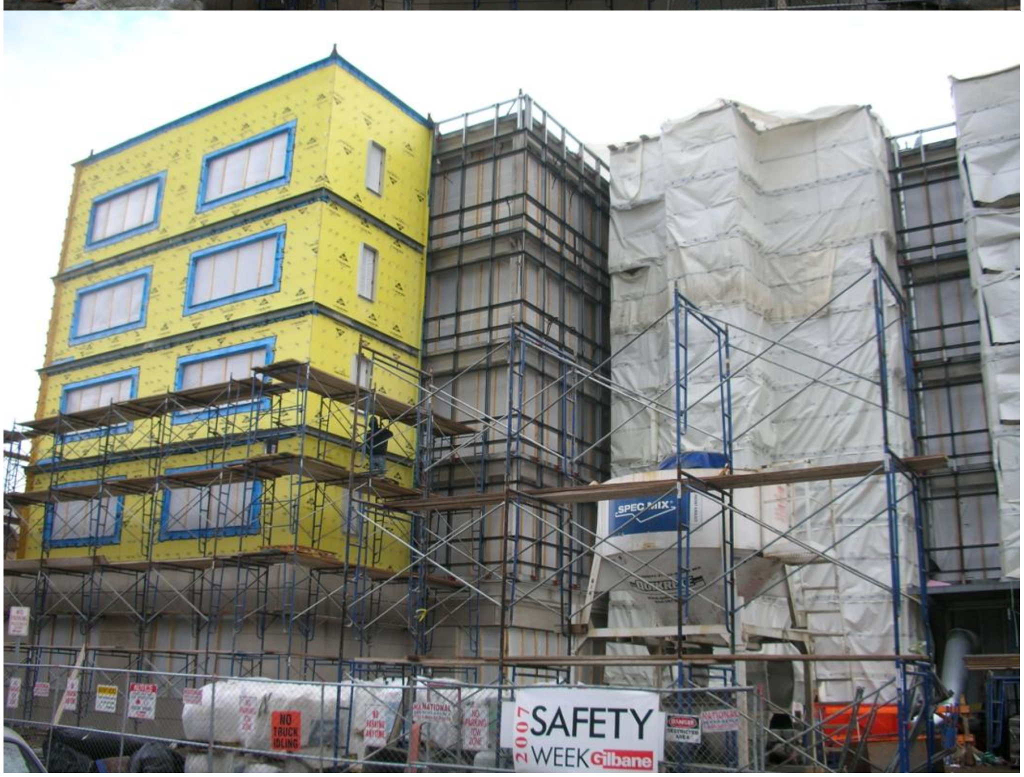

Genie GS-5390
1-800-UR-RENTS


Genie GS-5390
1-800-UR-RENTS
CCW-705


DRYWALL
CCW-705


GP
DENSGLASS GOLD

# Appendix S: January 30th, 2008 Progress Photos


2007
SAFETY
WEEK Gilbane
NO TRUCK IDLING


SPEC MIX


GROVE
NO
TRUCK
IDLING


GROVE


GROVE
WPI Residence Hall Project
Gilbane is recycling 93.00%
of construction debris.


WPI Residence Hall Project
Gilbane is recycling 93.00% of construction debris.
WPI
Triumph
C30595


HANDY HOUSE


EOF32
345


NATIONAL
RENT-A-FENCE
NO PARKING TOW ZONE
NO PARKING ANYTIME
NO TRUCK IDLING


NATIONAL


CENTURY DRYWA


CENTURY


DRYWALL
NATIONAL


NATIONAL
NATIONAL

# Appendix T: Simplified Gilbane Construction Schedule

| | | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 1 | | **New ResHall Construction** | **463 days** | **Mon 10/30/06** | **Mon 8/18/08** |
| 2 | ✓ | Start Milestone | 0 days | Mon 10/30/06 | Mon 10/30/06 |
| 3 | | Substantial Completion | 0 days | Mon 8/18/08 | Mon 8/18/08 |
| 4 | | Owner Move-In and Occupy | 5 days | Thu 8/7/08 | Wed 8/13/08 |
| 5 | | **Other Construction** | **144 days** | **Mon 10/30/06** | **Wed 5/23/07** |
| 6 | | Site & Foundations | 60 days | Mon 10/30/06 | Thu 1/25/07 |
| 7 | | Steel/Detail/Deck/Slab Placement/ Spray | 49 days | Fri 1/26/07 | Wed 4/4/07 |
| 8 | | Exterior Wall Framing | 35 days | Thu 4/5/07 | Wed 5/23/07 |
| 9 | | **Steel Erection** | **135 days** | **Mon 10/30/06** | **Thu 5/10/07** |
| 10 | | Steel frame 4th 100% & 5th 50% | 135 days | Mon 10/30/06 | Thu 5/10/07 |
| 11 | | **Floor Construction** | **255 days** | **Mon 8/13/07** | **Thu 8/7/08** |
| 12 | | Roof | 155 days | Thu 9/6/07 | Mon 4/14/08 |
| 13 | | Level 1 | 242 days | Mon 8/13/07 | Mon 7/21/08 |
| 14 | | Level 2 | 231 days | Thu 8/23/07 | Wed 7/16/08 |
| 15 | | Level 3 | 237 days | Fri 8/24/07 | Fri 7/25/08 |
| 16 | | Level 4 | 241 days | Fri 8/31/07 | Thu 8/7/08 |
| 17 | | Level 5 | 240 days | Fri 8/31/07 | Wed 8/6/08 |
| 18 | | Floor Construction Start | 0 days | Mon 8/13/07 | Mon 8/13/07 |
| 19 | | **Exterior Walls** | **127 days** | **Thu 4/5/07** | **Fri 9/28/07** |
| 20 | | **All Building Elevations** | **53 days** | **Thu 4/5/07** | **Mon 6/18/07** |
| 21 | | **Architectural Pre-cast** | **53 days** | **Thu 4/5/07** | **Mon 6/18/07** |
| 22 | | Level-1: Install Tube for Pre-cast Support | 5 days | Thu 4/5/07 | Wed 4/11/07 |
| 23 | | Level-1:Spray Fire Proof (@precast) | 5 days | Thu 4/5/07 | Wed 4/11/07 |
| 24 | | North Elevation: Install Base Pre-cast | 7 days | Mon 4/9/07 | Tue 4/17/07 |
| 25 | | East Elevation: Install Base Pre-cast | 28 days | Tue 4/17/07 | Thu 5/24/07 |
| 26 | | South Elevation: Install Base Pre-cast | 7 days | Fri 5/18/07 | Mon 5/28/07 |
| 27 | | West Elevation: Install Base Pre-cast | 15 days | Tue 5/29/07 | Mon 6/18/07 |
| 28 | | **Exterior Sheathing** | **24 days** | **Fri 4/27/07** | **Wed 5/30/07** |
| 29 | | North Elevation: Exterior Sheathing | 7 days | Fri 5/11/07 | Mon 5/21/07 |
| 30 | | East Elevation: Exterior Sheathing | 9 days | Mon 5/14/07 | Thu 5/24/07 |
| 31 | | South Pod: Exterior Sheathing | 9 days | Fri 5/18/07 | Wed 5/30/07 |
| 32 | | South Elevation: Exterior Sheathing | 4 days | Fri 4/27/07 | Wed 5/2/07 |
| 33 | | Start Exterior Sheathing (4th 100% & 5th 50% fr) | 0 days | Thu 5/10/07 | Thu 5/10/07 |
| 34 | | North "Tight" for Elec. Roughin & Insulation | 0 days | Thu 5/24/07 | Thu 5/24/07 |
| 35 | | South "Tight" for Elec. Roughin & Insulation | 0 days | Wed 5/30/07 | Wed 5/30/07 |
| 36 | | **North Pod** | **77 days** | **Thu 5/17/07** | **Fri 8/31/07** |
| 37 | | **North Facade** | **70 days** | **Thu 5/17/07** | **Wed 8/22/07** |
| 38 | | North Elevation/North Pod: Veneer Ties | 3 days | Thu 5/17/07 | Mon 5/21/07 |
| 39 | | North Elevation/North Pod: Spray foam/Window Membrane | 2 days | Tue 5/22/07 | Wed 5/23/07 |
| 40 | | North Elevation/North Pod: Erect Staging | 3 days | Thu 5/24/07 | Mon 5/28/07 |
| 41 | | North Elevation/North Pod: Brick Veneer | 10 days | Tue 5/29/07 | Mon 6/11/07 |

| | | | | | |
|---|---|---|---|---|---|
| 42 | | North Elevation/North Pod: Washdown & Staging Removal | 5 days | Tue 6/12/07 | Mon 6/18/07 |
| 43 | | North Elevation/North Pod: Curtain Wall | 20 days | Thu 7/12/07 | Wed 8/8/07 |
| 44 | | North Elevation/North Pod: Punch Windows | 10 days | Tue 6/19/07 | Mon 7/2/07 |
| 45 | | North Elevation/North Pod: Curtain Wall Trim & Seal | 10 days | Thu 8/9/07 | Wed 8/22/07 |
| 46 | | **East Facade** | **62 days** | **Fri 5/25/07** | **Mon 8/20/07** |
| 47 | | East Elevation/North Pod: Veneer Ties | 6 days | Fri 5/25/07 | Fri 6/1/07 |
| 48 | | East Elevation/North Pod: Spray Foam/Window Membrane 50% | 2 days | Mon 6/4/07 | Tue 6/5/07 |
| 49 | | East Elevation/North Pod: Erect Staging 50% | 3 days | Wed 6/6/07 | Fri 6/8/07 |
| 50 | | East Elevation/North Pod: Brick Veneer | 18 days | Mon 6/11/07 | Wed 7/4/07 |
| 51 | | East Elevation/North Pod: Washdown & Staging Removal | 5 days | Thu 7/5/07 | Wed 7/11/07 |
| 52 | | East Elevation/North Pod: Punch Windows | 10 days | Thu 7/12/07 | Wed 7/25/07 |
| 53 | | East Elevation/North Pod: Curtain Wall | 20 days | Thu 7/12/07 | Wed 8/8/07 |
| 54 | | East Elevation/North Pod: Curtain Wall Trim & Seal | 8 days | Thu 8/9/07 | Mon 8/20/07 |
| 55 | | **West Facade** | **67 days** | **Thu 5/31/07** | **Fri 8/31/07** |
| 56 | | West Elevation/North Pod: Veneer Ties | 6 days | Thu 5/31/07 | Thu 6/7/07 |
| 57 | | West Elevation/North Pod: Spray Foam/Window Membrane 50% | 2 days | Fri 6/8/07 | Mon 6/11/07 |
| 58 | | West Elevation/North Pod: Erect Staging 50% | 3 days | Tue 6/19/07 | Thu 6/21/07 |
| 59 | | West Elevation/North Pod: Brick Veneer | 18 days | Fri 6/22/07 | Tue 7/17/07 |
| 60 | | West Elevation/North Pod: Washdown & Staging Removal | 5 days | Wed 7/18/07 | Tue 7/24/07 |
| 61 | | West Elevation/North Pod: Punch Windows | 10 days | Wed 7/25/07 | Tue 8/7/07 |
| 62 | | West Elevation/North Pod: Curtain Wall | 20 days | Wed 7/25/07 | Tue 8/21/07 |
| 63 | | West Elevation/North Pod: Curtain Wall Trim & Seal | 8 days | Wed 8/22/07 | Fri 8/31/07 |
| 64 | | North Pod Building "Tight" for Boarding | 0 days | Wed 8/22/07 | Wed 8/22/07 |
| 65 | | **South Pod** | **85 days** | **Mon 6/4/07** | **Fri 9/28/07** |
| 66 | | **East Facade** | **76 days** | **Mon 6/4/07** | **Mon 9/17/07** |
| 67 | | East Elevation/South Pod: Veneer Ties | 6 days | Mon 6/4/07 | Mon 6/11/07 |
| 68 | | East Elevation/South Pod: Spray Foam/Window Membrane 50% | 2 days | Tue 6/12/07 | Wed 6/13/07 |
| 69 | | East Elevation/South Pod: Erect Staging 50% | 3 days | Thu 6/14/07 | Mon 6/18/07 |
| 70 | | East Elevation/South Pod: Brick Veneer | 18 days | Thu 7/5/07 | Mon 7/30/07 |
| 71 | | East Elevation/South Pod: Washdown & Staging Removal | 5 days | Tue 7/31/07 | Mon 8/6/07 |
| 72 | | East Elevation/South Pod: Punch Windows | 10 days | Tue 8/7/07 | Mon 8/20/07 |
| 73 | | East Elevation/South Pod: Curtain Wall | 20 days | Thu 8/9/07 | Wed 9/5/07 |
| 74 | | East Elevation/South Pod: Curtain Wall Trim & Seal | 8 days | Thu 9/6/07 | Mon 9/17/07 |
| 75 | | **West Facade** | **81 days** | **Fri 6/8/07** | **Fri 9/28/07** |
| 76 | | West Elevation/South Pod: Veneer Ties | 6 days | Fri 6/8/07 | Fri 6/15/07 |
| 77 | | West Elevation/South Pod: Spray Foam/Window Membrane 50% | 2 days | Mon 6/18/07 | Tue 6/19/07 |
| 78 | | West Elevation/South Pod: Erect Staging 50% | 3 days | Wed 6/20/07 | Fri 6/22/07 |
| 79 | | West Elevation/South Pod: Brick Veneer | 18 days | Wed 7/18/07 | Fri 8/10/07 |
| 80 | | West Elevation/South Pod: Washdown & Staging Removal | 5 days | Mon 8/13/07 | Fri 8/17/07 |
| 81 | | West Elevation/South Pod: Punch Windows | 10 days | Mon 8/20/07 | Fri 8/31/07 |
| 82 | | West Elevation/South Pod: Curtain Wall | 20 days | Wed 8/22/07 | Tue 9/18/07 |
| 83 | | West Elevation/South Pod: Curtain Wall Trim & Seal | 8 days | Wed 9/19/07 | Fri 9/28/07 |
| 84 | | **South Facade** | **55 days** | **Tue 6/12/07** | **Mon 8/27/07** |
| 85 | | South Elevation/South Pod: Veneer Ties | 4 days | Tue 6/12/07 | Fri 6/15/07 |
| 86 | | South Elevation/South Pod: Spray foam/Window Membrane | 3 days | Mon 6/18/07 | Wed 6/20/07 |
| 87 | | South Elevation/South Pod: Erect Staging | 3 days | Thu 6/21/07 | Mon 6/25/07 |
| 88 | | South Elevation/South Pod: Brick Veneer | 10 days | Tue 6/26/07 | Mon 7/9/07 |
| 89 | | South Elevation/South Pod: Washdown & Staging Removal | 5 days | Tue 7/10/07 | Mon 7/16/07 |
| 90 | | South Elevation/South Pod: Punch Windows | 10 days | Tue 7/17/07 | Fri 7/27/07 |
| 91 | | South Elevation/South Pod: Curtain Wall | 20 days | Tue 7/17/07 | Mon 8/13/07 |
| 92 | | South Elevation/South Pod: Curtain Wall Trim & Seal | 10 days | Tue 8/14/07 | Mon 8/27/07 |