April 7, 2010

Senior Thesis Final Report

Susquehanna Patient Tower Expansion

Williamsport, PA

Project 2012

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Construction Management
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Susquehanna Health
Patient Tower Expansion

Project Team

Owner:	SUSQUEHANNA HEALTH
CM Agency:	L.F. DRISCOLL CO. LLC.
Architect:	GRANARY ASSOCIATES
Structural Eng.:	O'DONNEL &NACCARATO
MEP Engineer:	PWI INC.
Civil Engineer:	LARSON DESIGN GROUP

Total Height	6 STORIES
Gross Area:	243,000 SQFT
GMP Amount:	$82,297,101.00
Construction Dates:	10/22/2009 - 9/19/2012

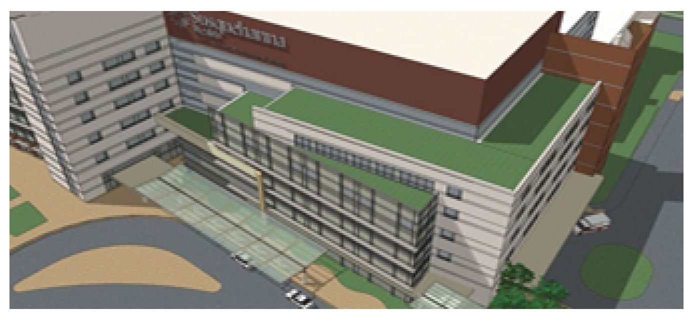
Structural System

Foundation System:	-150 psi PennDot 2A Stone -Conventional Spread/Column and Continuous Wall Footing Foundations With Bearing Capacity of 4,000 psf
Structure:	-6" 150 psi Slab on Grade -5" Conctrete Slab on 3" Steel Deck -Moment Steel Frame Design
Facade:	-Architectural Precast Panels -Precast Panels with Brick Veneer -Curtian Wall -Insulated Metal Panels
Roof :	-6 1/2" concrete Slab on 3" Steel Deck -Single-PLY Roofing Membrane -Vegitation on 4 of the 5 Roofs

Architecture

Designed to be the entrance for Williamsport regional medical center, the new patient tower faces and overlooks the city. This design shows the care Susquehanna Health has for the community because in previous years the building had pointed away from the city almost shunning it. The building was designed to become a visible landmark and to reach out to the community. This six-story 243,000 square foot tower features 84 single-occupancy rooms, increase privacy, and improved patient care. Private rooms provide an environment in which confidential patient history information is easily accessed and enables the isolation of patients to prevent transmission of infection.

The patent tower also features a two-story entrance for expanded emergency and imaging departments the Second floor houses new intensive care and critical care units and a high-tech education and innovation center. The third floor is comprised of surgical areas with new operating rooms. The fourth floor on the other hand houses orthopedics and spine research and surgical areas.



Mechanical / Electrical Systems

-8 Variable Air Volume Air Handling Units Ranging From 24,000-63,000 CFM
-2 3300 gpm Chillers and related Cooling Towers
-3 150 Gallon Boilers and related Steam & Hot Water Tanks
-2.0 MW Cogen Waste hot water heat recovery system (Natural Gas)
-2 Diesel Emergency Power Generators
-12.7KV Transformer on 3-Phase 480/277 4 Wire Circuit
-15 KV Feeder

Construction Logistics

This project will be completed in six different phases. The first phase of this project is the construction of the central utility plant located on the most western part of the site. The next phase of construction is a mechanical chase and pedestrian walkway connecting the central utility plant to the existing hospital. After all mechanical equipment has been installed and tested, the foundations for the patient tower expansion will constructed. The fourth phase of this project is the East Tower. After steel is erected and the metal deck is installed on the East Tower, construction on the West Tower can begin. The two towers will then be connected thus bringing the entire structure togehter. The sixth and final phase of this project will be the tying in of the East and West Towers to the existing hospital.

1.0 EXECUTIVE SUMMARY

This report will discuss and evaluate all findings from three analyses performed on the Susquehanna Health Patient Tower Expansion project in Williamsport, PA. This report will explore different possible design and construction changes as to produce a better quality project.

Analysis-1 Mobile Crane to Tower Crane Analysis

During this analysis two L.F. Driscoll projects similar in nature were compared to see which one erected the steel faster with either a tower crane or a mobile crane. After considering the possibility of utilizing a tower crane over a mobile crane, the better choice is by far the mobile crane. In terms of schedule, a total of only seven calendar days was saved from the total schedule. This schedule reduction wasn't even close to getting Susquehanna Health interested in swapping cranes. The total cost impact force Susquehanna Health to spend an additional $464,000 for a man hoist and tower crane. The man hoist was the really big factor in this analysis but even without it an additional $55,000 would have to be spent. Because Susquehanna Health is a non-profit organization and can't give proper justification for this change it is the recommendation of this analysis to keep the mobile cranes.

Analysis-2 Use of Prefabrication in Patient Rooms

In this analysis headwalls, footwalls, patient bathrooms will be prefabricated and then shipped to the site to reduce schedule and costs for the whole project. After reviewing all of the data in this pre fabrication analysis, it is clear to see that prefabrication could be utilized with great success. When first starting this analysis it was believed that the schedule savings would be the greatest advantage associated with this type of construction. However, the cost benefits proved to be just as substantial. After implementing prefabrication, the schedule was reduced by a total of 40 calendar days. In addition to the schedule savings, $432,161 was saved in general conditions and labor. As long all elements of the project team collaborate and coordinate effectively everyone can see the benefits of prefabrication. Prefabrication must start from day one and the project team must buy into it completely. As long as the assumptions can be met then prefabricating these elements is without a doubt a good investment.

Analysis-3 Value Engineering Roofing Systems and Providing alternatives

Because very little value engineering was done on this project, this analysis will focused on value engineering the expensive green roof and providing more cost effective alternatives. After value engineering the roofing systems and providing alternative systems it has been determined that the best option for Susquehanna Health is to eliminate the green roofs at roof level leaving only the one over the entrance. However, steel member should not be value engineering the steel should not be done. Choosing this option will also allow Susquehanna Health to determine if a photovoltaic array is still in the budget. Taking into consideration that the green roofs cost so much, Susquehanna Health would only need to come up with an additional $60,000 which seems pretty reasonable for such a large organization.

2.0 ACKNOWLEDGEMENTS

Academic Acknowledgements:

Penn State AE Faculty
Dr. Robert Leicht- CM Advisor

Industry Acknowledgements:

A Special Thanks To:

L.F. Driscoll Co., LLC

Susquehanna Health

Granary Associates

My Family And Friends

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3.0 PROJECT OVERVIEW

3.1 Introduction

Susquehanna heath is a three-hospital system that hasn't had a major renovation or construction project within the last 20 years. The patient tower expansion project is the fourth phase of Susquehanna Health's Project 2012 initiative. This $250 million initiative was launched in 2006 with the intent to update and renovate the outdated existing facilities as well as clean up the surrounding community. It is Susquehanna's vision to be up-to-date medical facility as well as being a beacon of healthcare.

Designed to be the entrance for Williamsport regional medical center, the new patient tower faces and overlooks the city. This design shows how much Susquehanna Health cares about the community because in previous years the building had pointed away from the city almost shunning it. The building was designed to become a visible landmark and to reach out to the community. This six-story 243,000 square foot tower features 84 single-occupancy rooms, increase privacy, and improved patient care. Private rooms provide an environment in which confidential patient history information is easily accessed and enables the isolation of patients to prevent transmission of infection.

The patent tower also features a two-story entrance for expanded emergency and imaging departments the Second floor houses new intensive care and critical care units and a high-tech education and innovation center. The third floor is comprised of surgical areas with new operating rooms. The fourth floor on the other hand houses orthopedics and spine research and surgical areas.

General Building Information	
BUILDING NAME	Susquehanna Health Patient Tower Expansion
LOCATION	724 Campbell Street, Williamsport, PA 17701
PRIMARY OCCUPANTS	Susquehanna Health, Healthcare
GROSS BUILDING AREA	243,000 SQFT
NUMBER OF STORIES	6 Stories Above Ground
CONSTRUCTION DATES	10/22/2009 - 9/19/2012
CONTRACTED GMP AMOUNT	$82,297,101.00
PROJECT DELIVERY METHOD	Single Prime GMP - Design-Bid-Build

Table 1 General Building Information

3.2 Client Information

Susquehanna Health is a three-hospital integral hospital system that provides world class health care to 11 counties. Founded in 1994, this affiliation incorporates The Williamsport Regional Medical Center, Divine Providence Hospital, and Muncy Valley Hospital. This non-profit organization reinvests all of its profits into their facilities and neighboring communities. Susquehanna Heath is a heath care leader that has been recognized at the national and state levels for quality of care, including the Blue Cross of Northeastern Pennsylvania's Blue Distinctions designation for cardiac care, spine surgery hip and knee replacement as well as the Data advantage Top 100 Hospitals in the Nation. This three-hospital integral hospital system offers a wide variety of services that include assisted living, paramedic/ambulance services, behavioral health, physical rehabilitation, orthopedics neurosurgery, cancer treatment gastrointestinal services, behavioral health and vascular care/heart surgery.

The Patient Tower Expansion in Williamsport moves Susquehanna Health into the fourth of five phases in its $250 million “Project 2012” initiative. Project 2012 reaches out to all three of its hospitals and took its first step with a state of the art Central Utility Plant for the Patient Tower Expansion project. This redevelopment program originated from a series of issues and challenges that have come to Susquehanna Health’s attention over the last couple of years. Some of these issues and challenges include aging current facilities, recruitment of healthcare professionals, and patient preference and expectations.

Project 2012 has many goals that are spread over the three hospitals. Some of these goals include “building green”, reducing operation costs, updating out of date facilities, improving Susquehanna Heath’s image, and giving back to the surrounding communities. More specifically the goals set out by Williamsport Regional Medical Center for its Patient Tower Expansion project include developing a south-facing marquee entrance from High Street, creating a park-like environment with green space and attractive landscaping, expanding surgical suites, emergency departments, the imaging center, and cardiovascular services. Other project goals include replacing the surgical suites, as well as the nursery and OB/GYN areas.

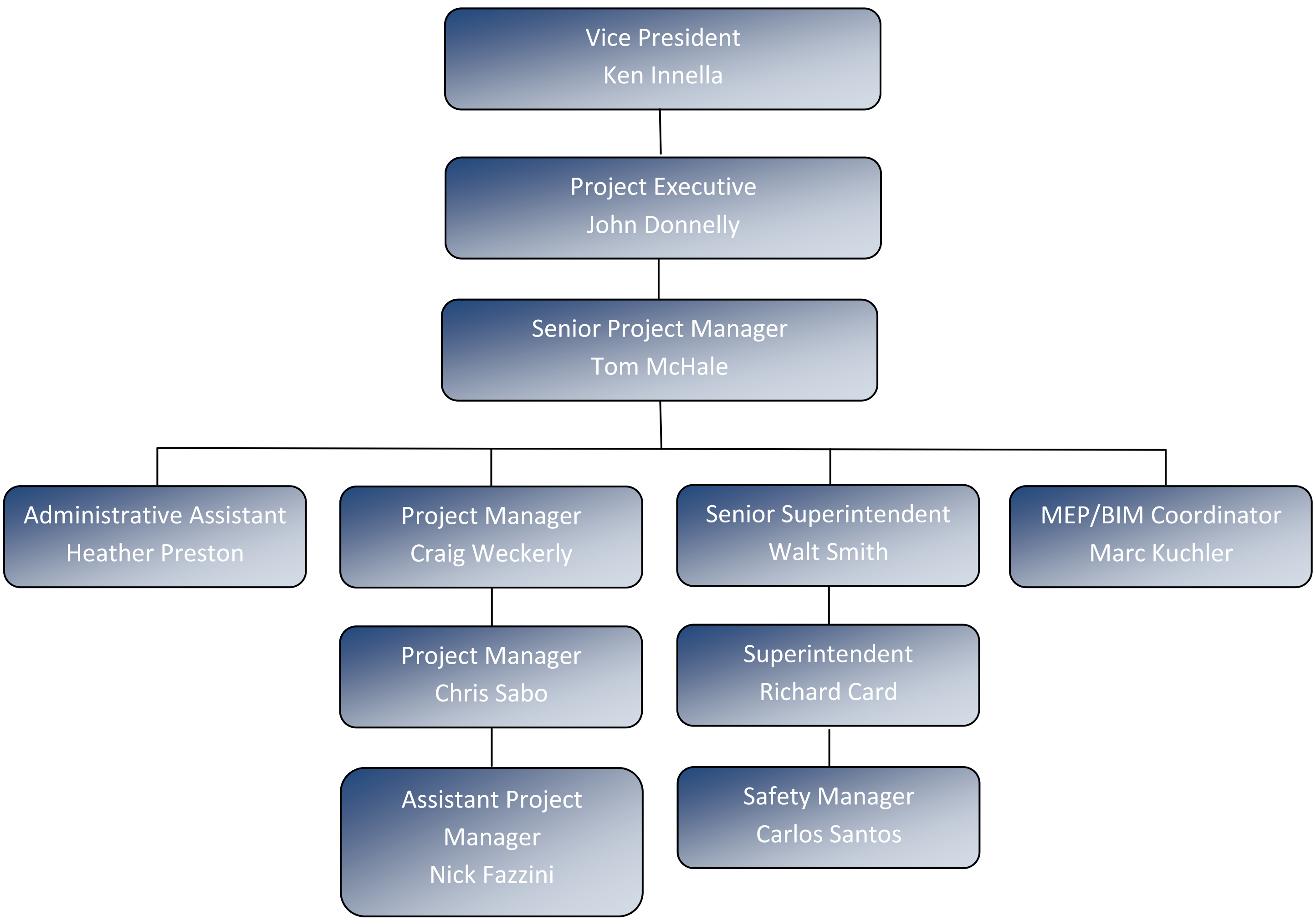
Susquehanna Health is funding their projects through a number of agencies and programs such as Blue Cross of Northeastern Pennsylvania, Count On Us For Life Capital Campaign, Department of Community and Economic Development Grant, and other Federal grants. However, the majority of the funding is coming new bond funds and Susquehanna capital. Even though the majority of this project is privately funded, some of the state and federal grants stipulate how the money must be spent. For example, the Pennsylvania Development awarded $1 million for the installation of a two megawatt cogeneration system that produces electricity by capturing and reusing waste heat to power heating and hot water systems that will supply the Williamsport Regional Medical Center as well as the new expansion project. This state of the art system will eliminate harmful and even poisonous gasses that are associated with producing electricity and heat. Susquehanna health was more than willing to put up $1.7 million of their own money to build this system when they realized that they would be saving an estimated $534,000 a year in operational costs. This kind of “green” building is carrying into all of their projects. The Patient Tower expansion project will be designed for LEED Certification for Healthcare. Due to the large costs associated with being LEED accredited, this project will never achieve the actual LEED certification. Susquehanna Health opted to take the money saved from not hiring LEED consultants and reinvest this money back into this project. This shows the level of quality and care that this organization has not only for its patients but also the community.

3.3 Project Delivery Method

The project delivery system for Susquehanna Health Patient Tower Expansion is a traditional Design-Bid-Build with a negotiated guaranteed maximum price (GMP). Susquehanna Heath has previously had good experiences with this type of project delivery method and hope to continue this tradition. L.F. Driscoll’s GMP with Susquehanna Health is set up with a contingency as well as room for negotiation due to the fact that the designs were not 100% complete. Within this GMP is also a mini GMP reserved for the Central Utility Plant that was constructed prior to the Patient Tower Expansion. In addition to their GMP with Susquehanna Health, L.F. Driscoll holds lump sum contracts with all of the subcontractors on the jobsite. This allows them to properly manage the job while also protecting themselves as well as the owner.

On the design side of this project all team members hold lump sum contracts with Susquehanna Health. Like most projects, the design team is led by the architect who is responsible for communicating and coordinating with the engineers and other designers. This project's architect is Granary Associates who has a long lasting relationship with Susquehanna Heath. In addition to the Patient Tower Expansion, Granary Associates have designed several projects for Susquehanna health. The civil engineer/landscape architect Larson Design Group has also worked on multiple with Granary Associates and Susquehanna Health. New to the design team are structural engineers O'Donnell & Naccarato and MEP Engineers PWI, Inc. Like the Architect, the engineers also have lump sum contracts with Susquehanna Health and coordinate with each other as well as L.F. Driscoll. To see the project delivery organizational structure reference Appendix A.

3.4 L.F. Driscoll Staffing Plan



This Project is being overseen by the Vice President of L.F. Driscoll as well as a Project Executive. Like most L.F. Driscoll projects, the Project Executive usually oversees 3-4 projects and gives status reports to the Vice President as well the President. This allows company management to successfully monitor all the projects and establish the health of the company and its projects. Unlike the Project Executive, the Senior Project Manager is only responsible for one project. It is the Senior Project Manager's job to successfully manage all aspects of the job and deliver a level of quality that meets L.F. Driscoll's expectations.

Office and managerial functions are divided up between project managers, assistant project managers, a clerk, and an administrative assistant. Project managers and assistant project managers divided bid packages up based on level of experience as well as work load. Bid packages are strategically planned and assigned to ensure that none of the personnel get overwhelmed throughout the entire life of the project. Another way that L.F. Driscoll lighted the work load was assign a MEP/BIM Coordinator to this project. Normally on L.F. Driscoll's projects, the responsibilities of the MEP/BIM Coordinator are handled by Project Managers.

Field work is managed by the Senior Superintendent who overseas and coordinates with all subcontractors. The Superintendent on this project serves much of the same function of the Senior Superintendent just on a smaller scale. Like all project L.F. Driscoll projects, this project has been assigned an experienced Safety Manager that ensures work is being done in a save manner.

4.0 DESIGN AND CONSTRUCTION OVERVIEW

4.1 Building Systems

4.1.1 Demolition

Even though this is an addition to an already existing building, very little demolition is being performed in L.F. Driscoll's GMP with Susquehanna Health. All site demolition was completed by another contractor before L.F. Driscoll was awarded the project. The only demolition that will be performed on the project will be where the three small walkways tie into the Williamsport Hospital and Medical Center. Demolition will consist of only the brick façade of the existing medical center. Because this is a hospital, infection control is of the upmost concern of Susquehanna Health and their patients. Infection Control Risk Assessment (ICRA) plans had to be developed by L.F. Driscoll and approved by Susquehanna Health before the first brick was removed. Luckily the façade that had to be demolished was near the mechanical rooms of the existing hospital and away from the patients. ICRA barriers were also assembled on the inside of the medical center to ensure that no infectious bacteria associated with the work would contaminate the building or the patients.

4.1.2 Cast in Place Concrete / Foundations

Cast-in place concrete makes up the continuous spread footings, wall footings, foundation walls, retaining walls, grade beams, piers, slabs on grade and slabs on metal deck. Concrete materials will be heavily recycled on this project and achieve LEED points. All cast-in-place concrete must minimum of 500lbs of cement per cubic yard as well as a minimum of 28 day compressive strength. The foundation for this project consists of steel reinforced continuous spread concrete footings that have a maximum bearing capacity of 4000 PSF. These footings range in size from 2'-0"W 32"H (CONT.) to 19'-0"X19'-

0 X 60". On top of these footings rests four different types of piers that help to distribute the load. These piers start from the core expansion and extend to the canopy. Like the foundations, the 6" slab on grade must also have a bearing capacity of 4000 PSF. All cast-in-place concrete was pumped from multiple concrete trucks.

4.1.3 Structural Steel

The Susquehanna Health Patient Tower Expansion project is a six story moment steel frame design with composite steel decks for the elevated slabs. Structural Steel on this project is fabricated in the state of Virginia and achieves LEED points for regional materials. All wide flange structural steel shapes for this project are ASTM A992. All other structural steel shapes besides the wide flange are ASTM A36. Beams and Columns are typically W-shaped; however, there are a few hollow structural section columns on the ground level. The majority of the steel columns range from W14X61 to W14X211. Beam and girder sizes vary greatly due to the fact that some areas of the hospital require that they be much larger to deal with vibration. Vibration plays a very important factor not only when constructing hospitals but also when designing them. Sensitive areas such as the neurosurgery rooms located on the 3rd floor require a more secure and stable design than other typical patient rooms. In addition to increased beam and girder sizes, all beam to girder connections require full depth double angle connections to satisfy the vibration criteria put together by a third party consultant. All steel on this project was erected by a 165 ton Demag AC 120 mobile crane. Steel erection started on the eastern side of the building and moved west. The crane had three distinct locations. The first location was on the eastern side of the building. The next location was in the center of the building on the southern façade. The last and final location of the crane was on the western side of the building.

4.1.4 Masonry

Masonry makes up a very small portion of this project and can only be found where the metal panels meet the curtain wall as well as where the base wall meets the precast panels. The base wall is constructed of 6" concrete masonry units filled with 3000 psi grout and insulated with 2" foam plastic board insulation. This particular type wall sits on top of the continuous spread footings and ties into the granite stone cladding wall as well as carrying part of the load of the precast concrete panels. The second masonry wall is located on top of the 4th floor and ties into the 3" insulated metal panels that make up part of the southern façade. These 8" concrete masonry units are insulated with 1" foam plastic board insulation and support a glazed aluminum curtain wall system.

4.1.5 Precast Concrete

In order to speed construction up, precast concrete panels make up the majority of the south, east, and west façade. Much like the steel, precast was manufactured within 500 miles of the project and also achieves LEED points for regional materials. This project incorporates two different types of precast panels that work together with the windows and curtain walls to give the Williamsport Hospital and Medical Center a more modern feel. The white towers on the southern and eastern are enclosed with 6" patterned architectural precast concrete panels. These panels are backed with 3" mineral-wool board insulation and a fire resistive joint system. The second type of precast panel can be found on the southwestern side of the building and is very similar to the patterned architectural precast panels. These panels are also 6" thick and backed with 3" mineral-wool board insulation and fire resistive joint system.

However, this type of panel is finished with a thin red brick faced veneer. The precast panels are typically connected to the structural steel using a lateral tie back system. All precast on this was casted by Universal Concrete in Stowe, Pennsylvania. To place the precast panels a 240 Ton Liebherr LTM 1200-5.1 track crane was utilized. Much like the steel erection, the crane moved from the eastern side of the building and worked its way around to the western side. The crane stopped and erected the precast panels in three different locations first the location was on the eastern side of the building where the white patterned precast is located. The next location was directly facing the south façade of the building right in front of the patterned precast tower which is located in the center of the building. The last and final location of the crane was on the western side of the building where the brick faced precast was installed.

4.1.6 Curtain Wall

The curtain walls in conjunction with the many windows which encompass the entire building, serve the vital function of providing natural light to the patients. This wedge shaped enclosure can be found on the southeastern exterior of the building. All windows and curtain walls for this project are either made of

1" insulated vision glass or 1" insulated spandrel and framed with aluminum members. Glazing on the curtain wall will be PPG Solarban z 50 with a visible light transmittance of 4%. This type of glazing qualifies for three LEED credits which include regional materials, low VOC's, and a high UL-rating. Even though the subcontractor is coordinating with the architect, it is the architect's responsibility to design the curtain wall system.

4.1.7 MEP Systems

Mechanical systems in the Patient Tower Expansion project are powered by the two megawatt cogeneration system located in the Central Utility Plant. Also located in the Central Utility Plant, are two 3300 GPM chillers and related cooling towers, three 150 gallon boilers, and related steam and hot water tanks. The primary HVAC system for the Patient Tower Expansion is a variable air volume with mostly base mounted centrifugal fans. The eight air handlers for this project are located on the roof and range from 24,000-63,000 CFM. In addition to the air handlers the chillers for this project are also located on the roof and range from 180-24 GPM. The mechanical system also includes chilled water and chilled glycol system that cool the building. This energy efficient mechanical system achieves LEED points for performance. This hospital is also supported with an emergency system complete Type II sprinklers. The building itself contains nine electrical rooms accompanied by four mechanical rooms.

Like the mechanical system, the electrical system is powered by the cogeneration system located in the central utility plant. This system produces electricity by capturing and reusing waste heat to power the entire building. The power plant feeds the patient towers through a 15 KV feeder which then flows into a 3-phase 480Y/277 4 wire circuit. Like any hospital, electricity is the life line to many patients and must constantly be fed into the building no matter what. To ensure that facilities always have power, Susquehanna Health elected to install two 565 KW diesel powered emergency backup generators that are located in the Central Utility Plant.

4.2 Project Costs

The actual construction costs are based on the GMP contract amount between L.F. Driscoll and Susquehanna Health. All costs shown represent actual bid costs for the project. This project was awarded to L.F. Driscoll as a Single Prime Guaranteed Maximum Price (GMP) for $82,297,101. Included in this GMP was a mini GMP to build a central utility plant that would tie into the Williamsport Hospital and Medical Center as well as the Patient Tower Expansion. The Central Utility Plant was purchased for $3,529,000 and built prior to the Patient Tower Expansion. As previously stated, it is the intent of this report to mainly focus on the Patient Tower Expansion. Costs estimates for this report will be solely related to the Patient Tower Expansion. The Patient Tower Expansion was purchased for $78,797,101 with an actual construction cost of $77,364,901. The Tables below break down the cost of each major system. Note that these figures are based on actual contract values.

Type	Cost	Costs/SF
Construction	$77,364,901	$318.37
Construction Plus Fee	$78,797,101	$324.27

Table 2 Square Foot Cost Break Down

Major Building Systems		
	Contract Amount	Cost Per SF
Cast-In-Place Concrete	$3,351,150	$13.80
Masonry	$808,070	$3.33
Precast Concrete	$1,484,222	$6.11
Structural Steel	$4,719,000	$19.42
Curtianwall System/Windows	$2,106,464	$8.67
Mechanical/Plumbing	$12,732,000	$52.40
Electrical	$5,128,743	$21.12

Table 3 Cost Break Downs for Major Building Systems

4.3 Local Conditions

The Williamsport Hospital and Medical Center is located at 777 Rural Avenue Williamsport, PA. These facilities encompass six city blocks about 15 minutes away from downtown Williamsport. Most of the buildings around Williamsport are predominantly constructed out of structural steel with the occasional masonry supported building. This particular site doesn't have much vehicular or pedestrian traffic and is located in a suburban setting. However, as previously discussed, staff and patient parking is limited. Auxiliary lots handle most of the over flow and a temporary parking lot was established on site to help deal with this problem. As shown on the existing site plan L.F. Driscoll trailers and parking are established directly north of this temporary lot to help ensure that they are not in the way of any hospital activities. One area of concern however is located in the northeastern side of the site. Ambulances frequent this area and even have parking adjacent to the new construction. This poses an even bigger threat considering that all lay down and subcontractor trailers are on site.

The geotechnical site investigation for this project was conducted by CMT Laboratories, INC. The field investigation for the Patient Tower Expansion consisted of 10 borings that extended to depths ranging from 10-34 feet below the existing surface grade. These subsurface borings revealed that there was 3'-4' inches of topsoil followed by a dense layer of brown silty sand and gravel that extends 15' down. Past the brown silty sand and gravel extends a layer of very dense gray weathered shale. Ground water was recorded at varying depths; however, it never reached a depth above 24' deep. It is for this reason that standard continuous spread footings can be used for this project. However if there is ever a need to control groundwater conventional dewatering procedures can be used.

In Williamsport, PA the average cost for a dumpster per week costs about $400. Throughout the life of the project, it is estimated that at any given time the jobsite will require 2-3 dumpsters. In addition to these dumpsters, separated material dumpsters will also be needed. These dumpsters are used to separate material for recycling purposes. Separating and recycling material such as concrete earns LEED points for the project. Separated material dumpsters in Williamsport only cost $350 per week.

4.4 Detailed Schedule

The construction of this project was scheduled and sequenced to maximize the amount of manpower while at the same time providing the quickest turnover date. L.F. Driscoll officially signed their contract with Susquehanna Health on 12/30/2008 and began actual construction on 10/22/2009. Two months prior to signing their contract, L.F. Driscoll was issued all of the design documents and has only had two reissues since then. It is the intent of this of this report to focus mainly on the Patient Tower Expansion. However, to better understand L.F. Driscoll's scope of work, other activities prior to the Patient Tower will be briefly. Including the Central Utility Plant, this project will be completed in several major phases.

The projects that had to be completed prior to the Patient Tower Expansion include construction of a state of the art Central Utility Plant, a mechanical chase, and a pedestrian walkway. The Central Utility Plant was constructed first to replace the existing out of date plant. The second phase of construction was the mechanical chase and pedestrian walkway that connect the Central Utility Plant to the existing Williamsport Hospital and Medical Center. Constructing these three projects prior to the Patient Tower Expansion was imperative to ensure that all systems for both the existing hospital and the expansion worked together in harmony. Another factor that pushed the time and sequence of these projects was government funding.

After the Central Utility Plant and mechanical chase were completed, construction of the Patient Tower Expansion project could begin. The third phase of construction for the entire project is actually the first phase of the Patient Tower Expansion. The foundations were the first major activity on this job. The continuous spread footings first started on the eastern side of the site and then moved west towards the Central Utility Plant. All of the wall footings, foundation walls, retaining walls, grade beams and piers were also sequenced in the same fashion and can be seen in ***Figure 1***

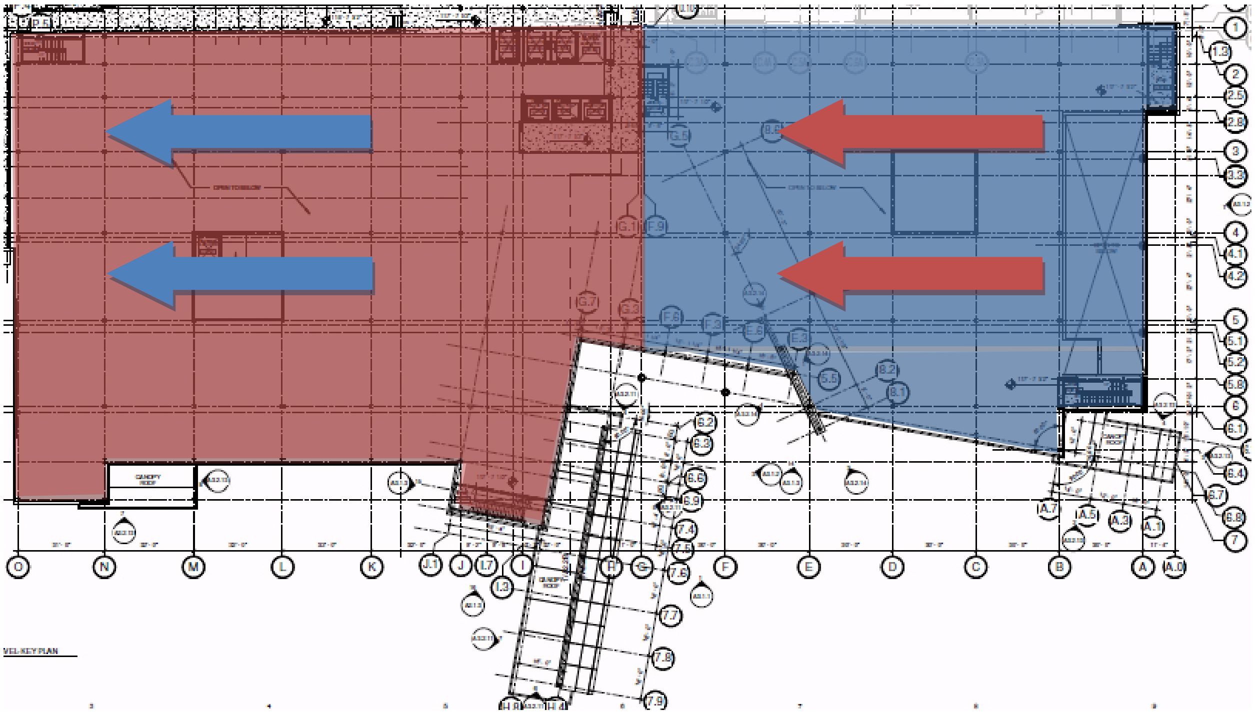


Figure 1 Steel Erection, Concrete, and Mechanical Sequence

The next major phase of construction is the erection of the structural steel. Like the footers, the structural steel starts on the eastern side of the building and moves west. However, structural steel stops mid-way through the building as shown on ***Figure 1.*** The blue zone represents the first phase of structural steel erection. The second phase is represented on ***Figure 1*** as the red zone. Much like the steel in the blue zone, this structural steel is also erected from east to west. The steel was erected in this manner so that concrete and HVAC trades could maximize the amount of manpower and materials they have on site. After metal decking is installed in the blue zone, concrete slabs will then start on the sixth level while structural steel is being erected in the red zone. The concrete slabs in the blue zone will then work their way up until they reach the roof. Metal decking and concrete will be sequenced in the red zone the same as in the blue zone. While the exterior skins are being installed, mechanical trades will then follow the same sequence as the concrete pours.

After all windows were installed and the building is sealed from the elements the interior fit outs can then begin. Fit outs will start on the entire 1st floor and then proceed to work up until the finish up with the 6th level (5th floor). While the fit outs on these floors are finishing up commissioning, punchlists, and inspections will take place. This project is scheduled to be turned over to the owner on 9/25/2012. See APPENDIX B for a detailed schedule.

4.4 Site Layout Planning

The Patient Tower Expansion is located adjacent to the Williamsport Hospital and Medical Center and ties into the newly constructed Central Utility Plant. Because hospitals need a vast amount of utilities, the subsurface investigation of all these lines becomes a bit of a problem. Gas, water, storm and sanitary lines run all throughout the site. All existing electrical lines run through the Central Utility Plant and ties in directly to the first floor electrical room of the Patient Tower's core. Although this is not the most active side of the Williamsport Hospital, the area in which the project is located is critical to the staff and patients that park there. Auxiliary parking around the hospital will be used to accommodate most motorists; however, L.F. Driscoll will provide some temporary parking to help alleviate some of the parking demands. One of the most critical traffic plans is the ambulance access to the emergency department located on the northeastern side of the Williamsport Hospital. Due to material deliveries and crane placement, the section of Walnut St. between Rural Ave. and Louisa St. must be closed off. This presents a couple complications that will later be addressed. All site deliveries are to be delivered from Walnut St. Because the front of the hospital is the most active zone, delivery trucks and subcontractors are not permitted to drive in front it. All site personnel are encouraged to use High St. as much as possible when entering the site and surrounding areas. For detailed site logistic plan see APPENDIX D.

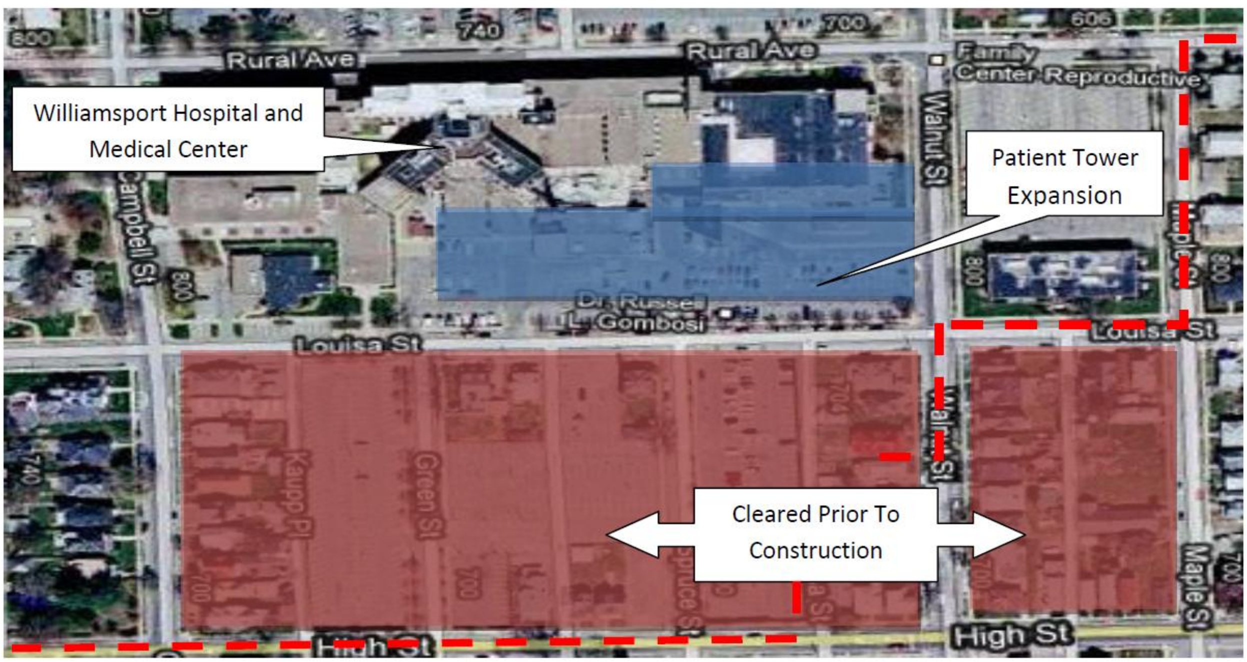


Figure 2 Site Layout and Planning

4.6 General Conditions Estimate

The general conditions for the Susquehanna Health Patient Tower Expansion are worth roughly $6.7 million, which accounts for 8.5% of the total project costs. Table 4 is a summary of the total general conditions estimate put together for this report. This estimate is based on approximations and does not reflect the actual contract values for this project. The actual contract amount for the general conditions is $6,730,989. This number is slightly higher than the one developed for this report due to the fact that the actual contract amount included such items as office furniture, trivial office supplies, and other nonimportant items. This estimate focuses on key general condition items and does not include smaller less important items.

LINE ITEM	UNIT RATE	UNIT	QUANTITY	COST
SUPERVISION AND PERSONNEL	$135,760.91	MONTH	35	$4,751,632.00
CONSTRUCTION FACILITIES & EQUIPMENT	$10,178.06	MONTH	35	$356,232.00
TEMPORARY UTILITIES	$5,058.00	MONTH	35	$177,030.00
MISCELLANEOUS COSTS	$40,266.40	MONTH	35	$1,409,324.00
TOTAL	$191,263.37	MONTH	35	$6,694,218.00

Table 4 General Conditions Estimate

It is the intent of this section of the report to provide a quick snap shot of the general conditions for this project. Therefore, this estimate was broken down into four major categories: Supervision and Personnel, Construction Facilities and Equipment, Temporary Utilities, and Miscellaneous Costs. ***The Supervision and Personnel*** section includes the weekly costs of the twelve major representatives from the construction manager L.F. Driscoll Co. The ***Construction Facilities and Equipment*** section includes the monthly and lump sum costs of the office rental, temporary storage, temporary fire extinguishers, dumpsters and final cleaning, etc. Most of the Temporary Utilities for this project are being provided by Susquehanna Health. As outlined in Technical Assignment One, Susquehanna Health has just purchased a state of the art cogeneration system that has saved them a significant amount of money when it comes to power and other utilities. This intern has driven down the cost of temporary utilities on this project.

As seen in Figure 3, supervision and Personnel accounts for the majority of the general conditions. A more in-depth look at general conditions can be found in APPENDIX C.

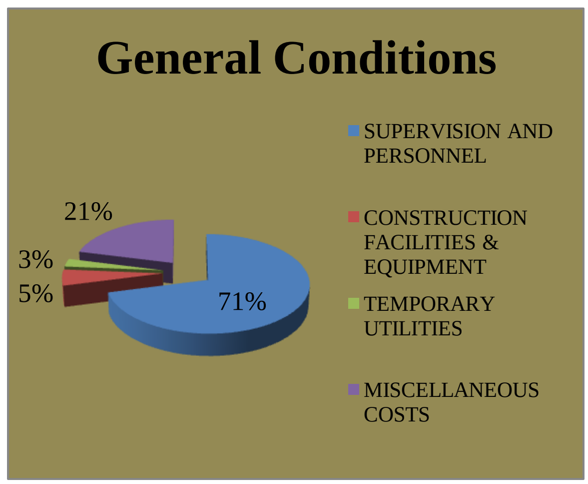


Figure 3 General Conditions Distribution

5.0 SHIFT FROM MOBILE CRANES TO TOWER CRANE

5.1 Problem Identification

As in most projects, the most critical target for the project's schedule was the watertight milestone. This problem was especially difficult because the patient tower expansion incorporates many different types of façades. Two different mobile cranes were used on this project and were critical to hitting the watertight milestone. The first mobile crane was a 165 ton Demag AC120 mobile crane that erected all of the structural steel. A delay in hitting the structural steel top out milestone would then delay the façade. Even though this project has five different facades, the precast panels represent the majority of the building's skin. The second crane, a 240 Ton Liebherr LTM 1200-5.1, was used to erect all precast panels. Due to the limited picking ability of these cranes they had to be continuously moved from one location to another. In addition to moving these cranes around, limited picking ability also complicated the site logistics of the project and forced the project team to close Walnut St. These inefficiencies lead to a decrease in production as well as increase in schedule.

5.2 Research Goal

The goal of this analysis will to be to investigate the production, cost, schedule, and site logistic impacts associated with utilizing a tower crane instead of the two mobile cranes. Additionally the cost impacts associated with the tower crane will be cross referenced with the expected faster building turnover date.

5.3 Methodology

- Determine what size of tower crane must be used to make all picks
- Contact L.F. Driscoll and determine the overall costs of the mobile cranes as well as the tower crane
- Analyze the impacts of man hoist
- Analyze the productivity of the tower crane for both structural steel and precast panels
- Determine the schedule impacts and how they affect the watertight milestone
- Perform cost comparison of predicted expansion income vs. costs incurred with tower crane

5.4 Background Information

After being awarded the project, L.F. Driscoll began contemplating weather they would use a tower crane or a mobile crane to construct the superstructure of the building. After getting quotes from various crane subcontractors the decision was made to use two mobile cranes. The first would erect the steel structure of the building and second would concentrate on rooftop mechanical equipment, precast panels, and metal panels for a short duration. Cost was the main driving force when selecting weather or not a mobile crane would be used over a tower crane. L.F. Driscoll determined that they could roughly save around $60,000 by using mobile cranes vs. one stationary tower crane.

5.5 Crane Selection Factors

When determining what type of crane would be the most beneficial a site it is important to consider various factors. The first and probably most obvious factor to consider is the overall height of the building or project. For example high rise buildings almost always use tower cranes because they are usually the only type of crane that can reach that high. The next thing that must be considered is site's logistic plan. Buildings with a very limited site area usually opt for tower cranes because they don't have to move around and they can fit in tight spaces much better than mobile cranes. The third thing that must be considered are the critical picks that must be made. This is one area where the tower crane has a distinct advantage over the mobile crane not because they usually have a greater lifting capacity but because they have a better vantage point of where the pick is being made. In terms of the Patient Tower Expansion either crane could have worked equally well for L.F. Driscoll's construction plan. The building is only six stories high and heaviest pick that had to be made would require a crane with only a 160 ton lifting capacity. This pick came in the form of the 5 air handling units that are located on the roof. Either mobile crane used could have made the pick but just to be on the safe side the 240 ton Liebherr LTM 1200-5.1 was used. In terms of the site either a tower crane or a mobile crane could have been used. One of the main advantage of this project has is that its site has plenty of room for lay-down area and movement.

5.6 Cost Break Downs

As previously mentioned, the decision was made over the issue of cost. The original goal of this analysis was to use L.F. Driscoll's price quotes for each type of crane and go from there. However, after nine months no one on site could seem to find the exact figures so new quotes would have to be developed. After shopping around for a few weeks it began to become clear that a big part of a crane contractors quotes were dependent on demand and coordination with other projects that were currently using their equipment. One contractor went so far as to say his quotes sometimes change monthly. Fortunately, numbers close to that of Driscoll's were eventually found. ***Table 5*** below gives a brief break down for the total costs of the two mobile cranes and a tower crane over the schedule that they would have to be used for. Note that crane figures may not have matched the exact crane type however their capacities were the same. These figures include operator and everything needed.

Crane Type	Duration Used	Crane Cost	Mobile vs. Tower
165 ton Demag AC120	6.5 months	$335,500	$978,500
240 Ton Liebherr LTM 1200	10 months	$750,000	
Potain Model HDT 180 Ton	16 months	$1,038,500	$1,033,500

Table 5 Crane Cost Data

5.7Additional Costs

One of the recommendations that L.F. Driscoll made regarding the tower crane vs. mobile crane analysis was that if the tower crane was chosen a material/man hoist would also have to be added to the project. This additional piece of equipment is another cost that would also have to be taken into consideration if a tower crane was to be selected. Below in ***Table 6*** is a detailed estimate of what a main hoist on this project would cost.

Concrete Pad and Removal	$1,5000
Erection and Dismantle	$25,000
Rental	$120,000
Labor	$224,000
Electrical and Carpentry	$20,000
Total	$404,000

Table 6 Material/Manhoist Cost Break Down

5.8Productivity Analysis

To analyze the productivity of the steel erection, a comparison was done with the steel schedule of another one of L.F. Driscoll's projects the Milton Hershey Children's Hospital in Hershey, PA. This project is also a hospital with very similar design features and characteristics of that of the Patient Tower Expansion. The very key difference between these two projects is that that the Children's Hospital used a tower crane instead of a mobile crane. When comparing the schedules it was clear to see that they were very close in terms of steel erection. After doing the steel quantity take offs for each project, it was determined the Hershey Children's Hospital averaged 34.17 LF/day more than the Patient Tower Expansion. Using the productivity from the Children's Hospital, a total of eight calendar days was saved from the schedule. This was a very marginal schedule reduction that in the end would only accelerate the watertight milestone by seven days.

Project	Total LF of Steel	Total Steel Schedule (Calendar days)	LF of Steel Erection Per Day	Using Tower Crane Erection Rate
Patient Tower Expansion	39,901	103 Days	387.40	95 Days
Hershey Children's Hospital	65,344	155 Days	421.57	

Table 7 Mobile crane vs. Tower Crane

When first developing this analysis, the two areas of construction that were taken into consideration the structural steel and the precast panels. After doing some research, and interviewing not only L.F. Driscoll but also the precast manufacturer it was determined that since each panel was lifted off of the trucks and not staged anywhere on site that the level of productivity was based on the deliveries and not the productivity of the crane.

5.9 Final Conclusion

After considering the possibility of utilizing a tower crane over a mobile crane, the better choice is by far the mobile crane. In terms of schedule, a total of only seven calendar days was saved from the total schedule. This schedule reduction wasn't even close to getting Susquehanna Health interested in swapping cranes. The total cost impact force Susquehanna Health to spend an additional $464,000 for a man hoist and tower crane. The man hoist was the really big factor in this analysis but even without it an additional $55,000 would have to be spent. Because Susquehanna Health is a non-profit organization and can't give proper justification for this change it is the recommendation of this analysis to keep the mobile cranes.

6.0 CRITICAL INDUSTRY ISSUE- USE OF PREFABRICATION

6.1 Problem Identification

In addition to the water tight milestone, commissioning was also considered another major risk to the schedule. This long and drawn out process happens at the completion of each floor. Before the building could be fully turned over, final commissioning of the whole building had to take occur. Not hitting this date could would lead to serious delays. Because this activity happens at the completion of each floor and at the end of the project, nothing could be done afterwards to fix the schedule. To ensure that commissioning starts earlier, prefabrication could be used to complete each floor faster.

6.2 Research Goal

The goal of this analysis is to accelerate the schedule of each floor by prefabricating elements within typical patient rooms within the hospital. It is the hope that prefabrication will then allow for commissioning to take place sooner than originally proposed by L.F. Driscoll. Prefabricating items such as headwalls, footwalls, and bathrooms inside typical patient rooms was a critical industry issue proposed by Professor Bechtel at the 2010 PACE Roundtable conference. In addition to schedule acceleration, it is also the goal of this analysis to reduce the overall cost of the project.

6.3 Methodology

- Contact Skanska and establish the parameters they used for prefabricating rooms on their hospital projects
- Interview L.F. Driscoll to see if they have ever performed prefabrication of this magnitude
- Compare project parameters of the patient tower expansion with those of Skanska's project
- Research nearby prefabrication shops. If none are present then establish where these rooms are to be built on site and develop site logistics plan
- Re-sequence activities to allow for prefabricated rooms to be placed
- Develop new critical path
- Determine impacts to cost, schedule, and site logistics
- Perform an income evaluation of the expansions new turnover date
- Interview owner and evaluate whether or not this analysis would be favorable.

6.4 Background Information

As stated earlier in this report, the schedule was one of the most important if not the most important driving force of this project. Prefabrication has been used by the industry in a wide variety of applications to reduce schedule, increase productivity, and ensure quality control. Typical projects that implement prefabrication include hotels, office buildings, and other high rise buildings because they are modular in design and have many repeating elements. Large hospitals are good candidates for prefabrication because they have many repeating elements in typical patient rooms. However, hospital prefabrication is a relatively new concept that isn't widely practiced. In fact, Skanska is only one of a few companies that have used this building technique on a large scale. After interviewing multiple project managers from L.F. Driscoll it was clear that they didn't have much large scale experience with hospital prefabrication. For this reason, the basis of my research will be from Skanska and their Miami Valley Hospital Southeast Addition project.

Prefabricating the Miami Valley Hospital Southeast Addition (MVH) Project was first inspired by one of Skanska's projects in London, England. The key difference between this project and the one in England was the fact that all trades in the United States aren't under one employer. Skanska prefabricated headwalls, bathroom units, and overhead corridor utility racks which ultimately saved 1-2% off the cost of the $152 million MVH project. In addition to saving roughly $3 million, they were also able to shave more than two months from the schedule. Multi-trade prefabrication also has other advantages than just schedule or cost. Some of these advantages include increased safety, decreased waste, elimination of site congestion/turf wars, and increased productivity.

6.5 Project Comparison

Project Summary Comparisons		
Project Name:	Miami Valley Hospital Southeast Addition	Susquehanna Health Patient Tower Expansion
Location:	Dayton, Ohio	Williamsport, Pennsylvania
Construction Type	Healthcare Addition	Healthcare Addition
Size:	484,000 SF	243,000SF
Cost:	$152,000,000	$78,800,000
Site Layout	Small/Congested/Limited Lay-down Area	Non-Congested, Lay-down Area Available
Structure	Steel Moment Frame	Steel Moment Frame
Number of Stories	12	6
Typical Patient Rooms	178	104
Crane Type	Tower Crane	Mobile Crane
Façade	Unitized Curtain Wall	Precast Panels
		Metal Panels
		Unitized Curtain Wall
Prefabricated Elements	Headwalls, Footwalls, Bathroom Units, Overhead Corridor Racks	-

Table 8 Project Summary Comparisons: Susquehanna Health Patient Tower Expansion vs. Miami Valley Hospital Southeast Addition

As ***Table 8*** demonstrates these projects were neither designed nor constructed in the same manner. The biggest differences between these two projects as they pertain to prefabrication are sheer size, height, site lay-down areas, and crane type. Another key consideration was the façade and leaving important sections open so that the prefabricated units could easily be loaded onto each floor. The sheer size and height of the building comes into play when trying to figure out how much time each unit will take to hoist to the correct floor. The taller the building the more time it is going to take to hoist each unit into place. The MVH project has patient rooms on five of the upper floors whereas the Susquehanna Patient

Tower Expansion only has patient rooms located on the sixth floor. The main focus of this analysis will be prefabrication in these rooms. The MVH project incorporates many patient rooms in its design and has a large impact however the Susquehanna Patient Tower Expansion has more patient rooms per SF. The more patient rooms per SF, means that prefabrication will have an even greater impact on the entire project.

In addition to the design of the building, it is also important to consider the site logistics and the crane/cranes that will be hoisting the prefabricated elements to their correct floor. The site layout for the MVH project was a high-rise building with a very small and congested site layout. To make things worse the building's landlocked orientation made getting material and equipment in and out of the site difficult. This didn't allow Skanska to lay-down or stage the prefabricated units anywhere on site. The crane would have to lift all units directly off of the delivery truck. Due to theses constraints no additional cranes could be brought to the site. All prefabricated units had to be hoisted into place with tower crane that was still being used to erect steel and curtain wall panels. In order to elevate prefabricated units to their designated floor without affecting the steel schedule they would have to be hoisted into place on Saturdays. The schedule and sequencing will be covered later in this report.

The Susquehanna Patient Tower Expansion project has one distinct advantage over the MVH project in the fact that the site is less congested. As seen in Appendix D, L.F. Driscoll has more than enough to lay-down or stage prefabrication if necessary. Additionally there is also enough space to for an additional crane and or truck crane to hoist any material or equipment into place. The large lay-down area can be easily seen in ***Figure 4*** to the right. This area gives L.F. Driscoll different options and allows them to control exactly when the units are installed. Deliveries will not have to be on the critical path and having to have crews come in on Saturdays can be avoided if need be.

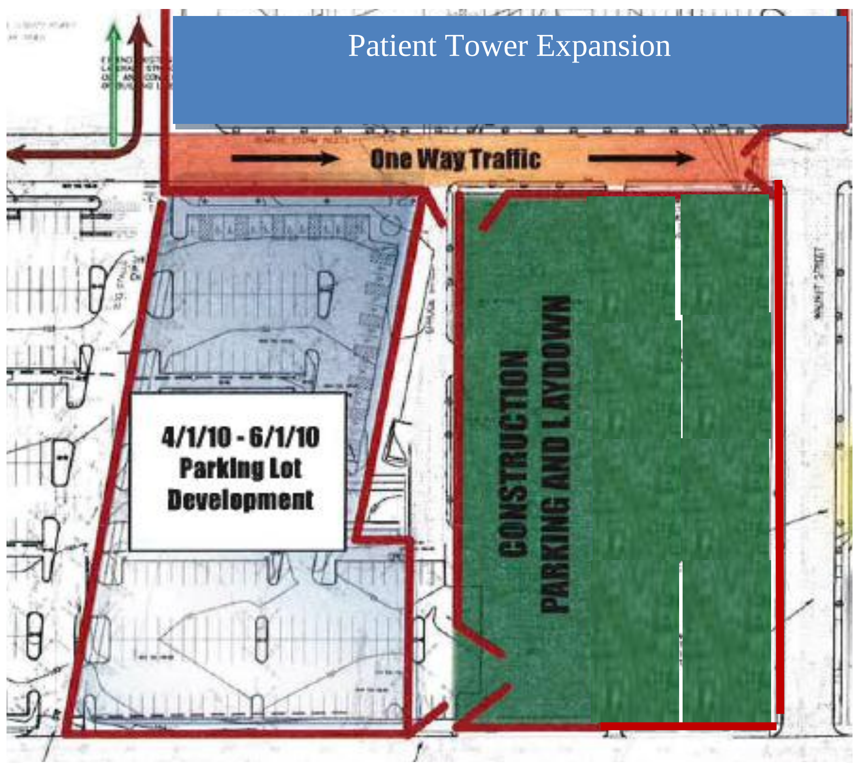


Figure 4 Snapshot of L.F. Driscoll Site Logistics Plan

6.6 Construction of Prefabricated Units

As earlier stated this analysis will be comprised of prefabricating headwalls, footwalls, and patient bathrooms. Each headwall and footwall is paired up back to back with another headwall or footwall as to make a mirror image with the room adjacent patient room. As with all mirror images certain elements will be opposite of its counterpart. For instance, things like door hardware will change from room to room depending on which room it is in. This type of design will enable labors in the field to increase productivity through repetition. Prefabricated units will include metal stud framing, all of the medical gas piping and connections, as well as all of the other MEP fixtures. For construction to go smoothly the design will have to be finalized and mock-ups approved earlier than originally intended. As in any hospital, the headwall is one of most complex elements for MEP coordination. It is difficult for all utilities to fit comfortably inside the very small cavity. Significant time is spent trying to coordinate not only between the trades but also with designers and hospital staff. For prefabrication to be successful it is critical to have a clear design and all trades in a controlled environment where they can freely communicate to each other. These walls will have none of the dry wall or interior finishes. Eliminating all of the finishes and drywall will allow these units to be temporarily stored outside or inside the building before it is watertight if need be. The bathroom units will be the only unit to have any kind of interior wall finish. Final finishes and paint will not be applied until units are installed and building is watertight. For a more detailed breakdown of all utilities and components that will make up the prefabricated units, see the quantity take off list in ***Appendix F***.

Once constructed the prefabrication is complete the bathroom units will look something like ***Figure 5*** to the right. Like the headwalls/ footwalls these units will be complete with all MEP tie-ins and the metal stud framing. However, bathroom pods are not all the same as is the case with the headwalls. Bathroom pods may be simple typical bathrooms or they may be ADA bathrooms which are slightly larger. This won't change prefabrication, but it is for this reason that each bathroom unit should be properly marked with a room designation to eliminate any and all confusion.

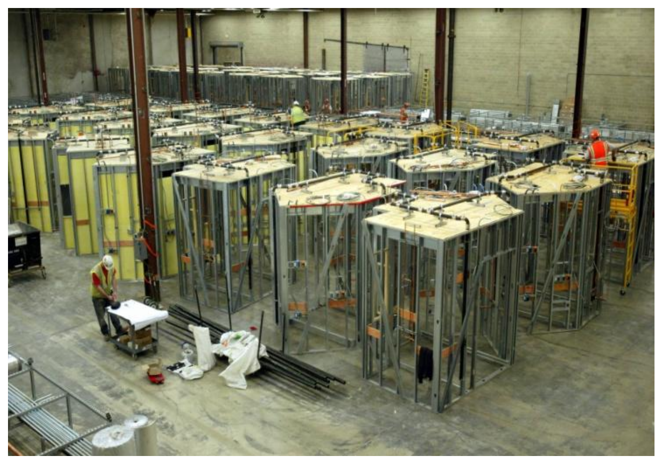


Figure 5 Miami Valley Hospital: Typical Prefabricated Bathroom Units

Unlike the MVH, this project will not be fabricating overhead corridor racks. The unitized corridor racks in the MVH was one of the main selling points for prefabrication. The Patient Tower Expansion does not utilize repetition with overhead corridor racks. It is for this reason that they will not be selected for prefabrication. The last thing that needs to be looked at for the construction of these units is supervision and safety within the warehouse. As it is there are three superintendents on the jobsite and after talking to Tom McHale (Senior Superintendent) one of the superintendents could go to the warehouse to look over operations. Fortunately all superintendents within the L.F. Driscoll Company are required to have as much safety training as safety supervisors. The superintendent going to the warehouse can also double as the safety manager.

6.6.1 Prefabrication Warehouse

All prefabrication on the MVH project was done in two warehouses approximately three miles away from the jobsite. The plan originally was only to use one warehouse that was 35,000 SF and cost between $2.00/SF and $2.50/SF yearly. However, due to delays with the foundations the structure was not ready to start installing prefabricated units when originally planned. This coupled with the fact that crews were fabricating units faster than anyone could have predicted lead to congestion within the warehouse. In some areas crews were able to increase productivity by over 300%. In an uncommon occurrence within the construction industry, this increase in production was actually a hindrance. Finished units quickly began to pile up and with nowhere to store them Skanska had no option but to lease another warehouse. From this point of view Skanska was a victim of their own success. To avoid making the same mistake twice, Skanska leased a second warehouse that was 70,000 SF and three miles away from the jobsite in the opposite direction.

Figure 6 Warehouse Used for Prefabrication in Williamsport, PA

Taking into consideration that everything Skanska has learned about prefabrication within a warehouse and general project information, a warehouse conducive to Patient Tower Expansion prefabrication needs can be selected. When considering a prefabrication warehouse the first and most important things that need to be considered includes the size and location of the building with respect to the job site. To reduce transportation costs and eliminate long delivery times the first criteria was to select a jobsite within 15 miles away. The second set of criteria is with regard to the area of the building. The largest prefabricated unit in the MVH project was the unitized overhead corridor racks. These units cluttered the warehouse more than any other elements. As stated earlier in this report, the only elements to be prefabricated where headwalls, footwalls, and bathroom pods. Not prefabricating 120 overhead corridor racks will significantly reduce the amount of area needed. Another thing when talking about warehouse size that needs to be considered is the rate of production. Even though the foundations and steel erection went smoothly with no delays, there is always the chance of something going wrong. In the case that prefabricated units couldn't be installed on time, there will need to be room to store them. Fortunately there is more than enough room to store prefabricated units on site if need be. As stated previously this is one of the distinct advantages the Patient Tower Expansion has over the MVH project. This will also play to L.F. Driscoll's advantage if productivity far exceeds their expectations. Unlike Skanska they will not be a victim of success. For these reasons a building around 35,000 SF should be more than enough area.

Warehouse Data	
Location	801 Foresman Ave, Williamsport, PA 17701
Distance To Jobsite	2.80 Miles
Warehouse Size	32,140 SF
Warehouse Type	Industrial
Price	$1.90/SF (Yearly)
Paved Lot Size	1 Acre
Amenities	Dual Loading Dock
	Office
	Trailer Parking

Table 9 Warehouse Data Used for Prefabrication in Williamsport, PA

Above is the data of a warehouse in Williamsport that would fit the previously mentioned criteria. This warehouse will be used for all the prefabrication needs of L.F. Driscoll. This warehouse also has extra amenities that will aid the prefabrication process. These amenities include an elevated loading dock, trailer parking, a small office and heating. Out of these amenities the elevated loading dock might be the most beneficial. Elevated loading docks will eliminate the need for fork trucks and other machinery to hoist the units onto the delivery trucks. Prefabricated units can be moved into place using small carts that will eventually be used to transport them to their final installation locations.

6.7 Installation of Prefabricated Units

The installation of prefabricated units can be done as soon as concrete decks have been poured and the top track installed. As stated earlier in this report the building is being completed in two sections as seen in ***Figure 1***. Units from the blue zone will have to constructed and installed first. Installing units in this fashion will help cut down on clutter in the warehouse and help cut down on the amount of manpower needed to install them. ***Table 10 is*** a time break down of the installation of each prefabricated unit.

		Installation Time (Figures Include Delivery Time)			
Prefabricated Unit	Number of Units	MVH Installation Time (Per 8 Hour Day)	Total Patinet Tower Expansion Installation Time (Using MVH Installation Time)	Projeted Patient Tower Expansion Installation Time (Per 8 Hour Day)	Total Patinet Tower Expansion Installation Time (Using New Installation Time)
Headwall	52	–	–	32 Units	1.63≈2days≈13 Hours
Footwall	56	–	–	32 Units	1.75≈2days≈14 Hours
Patient Bathrooms	104	33 Units	3.5 Days/ 25.5 Hours	36 Units	2.88≈3 Days≈23.11 Hours
				Total	6.5 Days

Table 10 Installation Time Table

Not shown on ***Table 10*** is a detailed delivery time schedule. Deliveries will be staged on site as not to affect the actual installation time. As stated earlier in this report, having ample lay-down area is one of the most distinct advantages over the MVH project. Prefabricated units will be staged one delivery ahead of the actual installation. This will not only aid in helping keep site congestion low but will also keep crews busy while going for the next delivery. Based on trailer dimensions (48’X 8 ½’) it was determined that a total of 20 deliveries would be needed. Delivery breakdowns can be seen in ***Table 11*** below. Note that only 20 deliveries would be needed because the remaining headwalls can be placed on the last load of bathrooms.

Prefabricated Unit	Units/Delivery	Deliveries Needed	Total Delivery Time (RS Means 1 Hour Round Trip Delivery)
Head Wall	36 Units	1.5	2 Hours
Footwall	56 Units	1	1 Hour
Bathrooms	6 Units	17.5	18 Hours
	Total	20	20 Hours ≈3 Days

Table 11 Prefabrication Delivery Breakdown

As with all prefabrication careful planning and pinpoint execution is needed to see all benefits. Preparing the project to accept the prefabricated units will start when the concrete decks are being poured. The concrete in the area that bathrooms are being installed will be depressed approximately one quarter of an inch. This will do two things for the installation crew when installing the bathrooms. The first thing it will do is allow the crew exactly where each unit is to be installed. The second thing depressing the area of the unit will do is it will allow for quicker drainage hook ups.

The actual installation process is very simple and straightforward. After units arrive to site they will be hoisted to the sixth floor with the mobile crane. Small carts with wheels will be placed under the unit and wheeled to the location of their installation. After placed in the correct location the bottom metal stud track will be screwed down into the concrete.

7.0 Impacts of Prefabrication

7.1 Schedule Impacts of Prefabrication

The major advantage in prefabrication is of course the schedule reduction. The first step taken was determining exactly how much time L.F. Driscoll would take to build each prefabricated unit. From the schedule developed by L.F. Driscoll, a rough breakdown of how long it would take to fabricate metal studs and all MEP work within the walls could be done. After a rough estimate per linear feet could be done, finding out how many units per 8 hour work day could be calculated. To complete each unit it would take a total of 100 days. This number could be used as a base line for calculating the reduced fabrication time. The MVH project reported having increased efficiency as high as 300% in some areas. For this analysis 20% and 50% where used as ***very*** conservative figures. Table 12 breaks down the total estimated savings. Based on these numbers it was determined that roughly 93 days (100 days- 6.4 installation days) could be cut from the schedule of the 6th floor's schedule. The telemetry section of the 6th floor was the last portion of the building to be completed and the estimated savings of this floor was 46 ½ days.

		Fabrication Time			
		(Figures Based on 15 Man Crew Size and 5 Day Week)			
Prefabricated Unit	Number of Units	Time to Fabricate Each Unit (Per 8 Hour Day)	Total Time to Fabricate	Total Time to Fabricate at (20% Increased Efficiency)	Total Time to Fabricate at (50% Increased Efficiency)
Headwall	52	2.1	25 Days	21 Days	16.5 Days
Footwall	56	2.5	23 Days	19.5 Days	14.5 Days
Patient Bathrooms	104	2	52 Days	41.5 Days	29 Days
		Total	100 Days	82 Days	60 Days
			Savings	18 Days	40 Days

Figure 12 Fabrication Time Tables

Since the 6th floor was the last floor to be finished it was the limiting factor when commissioning could be finished. With the savings of schedule reduction via prefabrication the new limiting factor would be the lobby of the 1st floor which was the next to last portion of the building to be finished. End of the lobby construction is exactly 43 days before the end of the original sixth floor construction this confirms that lobby construction is in fact the new limiting factor. Commissioning for the sixth floor can start roughly three days before commissioning for the 1st floor lobby. Commissioning and testing/balancing will take roughly 215 days which translates to about 43 days per floor. Commissioning contractor Fred Roznowski, said with the new 6th floor completion date that the overall commissioning/testing date could be accelerated by about 40 days. This would translate into a total schedule reduction of 40 days.

7.2 Cost Impacts of Prefabrication

Not only can prefabrication have significant impacts on schedule but it can also have enormous savings in terms of overhead and labor costs. As seen in ***Table 13*** using prefabrication has the potential to save about $174,151. Heating and electrical costs of the building are included in the rental rate of the

Added Cost		Cost Reductions	
Trucking	$296	General Conditions Savings	$197,564
Warehouse Rental (3 Months)	$15,267	Man Power Reduction (229 Hours)	$6,870
Dumpster	$1,200		
Extra Insurance	$13,520		
Additional Supervision	-		
Total	$30,283	Total	$204,434
Total Net Savings: $174,151			

Figure 13 Cost Impact Breakdown

building. Also note that a general insurance quote was put together by evaluating, value of the building, equipment, and materials. After this value was calculated, it was treated like its own mini project then using RS Means a general insurance value could be determined. This figure was just a rough generalization. In real life L.F. Driscoll could in all likelihood get a better price.

7.2.1 Income Evaluation Savings

For income evaluation please see data reference ***Appendix G***. The earlier turnaround date means that Susquehanna Health can start using the facilities a month and ten days earlier than originally planned. This schedule savings translates into earlier income for the Williamsport Hospital and Medical Center. According to the predicted income data shown in ***Appendix G***, Susquehanna Health will be able to net $258,010 in the time saved with prefabrication. This in conjunction with the cost data from the previous section, Susquehanna Health will save $432,161 by using prefabrication for meager investment of $30,283.

8.0 Assumptions and Considerations

One the major assumptions made in this analysis was that union and open-shop contractors will work together in the prefabrication warehouse. When MVH's Senior Project Manager John Corrado came back from Skanska's London project, he quickly realized one of the major challenges of using prefabrication in the same fashion would be getting union and open-shop contractors to work together. In London, all trades were under one employer's roof so there was no problem with multi-trade disciplines working together in the off-site warehouse. Prefabrication in the United States means dealing with union and open-shop contractors in the same building. Corrado said that there was a good bit of negotiation to sort out all tasks. The major union they had trouble with was the electricians but ultimately they were "OK" working with open-shop contractors.

Another key assumption/consideration that must be taken into account is that designers would have to speed up the design of headwalls and footwalls so that a mock-up could be produced roughly 3 weeks earlier than originally planned. This accelerated design will ensure that all trades would know their role and have a clear mission statement.

9.0 Final Conclusion

After reviewing all of the data in this pre fabrication analysis, it is clear to see that prefabrication could be utilized with great success. When first starting this analysis it was believed that the schedule savings would be the greatest advantage associated with this type of construction. However, the cost benefits proved to be just as substantial. After implementing prefabrication, the schedule was reduced by a total of 40 calendar days. In addition to the schedule savings, $432,161 was saved in general conditions and labor. As long all elements of the project team collaborate and coordinate effectively everyone can see the benefits of prefabrication. Prefabrication must start from day one and the project team must buy into it completely. As long as the assumptions can be met then prefabricating these elements is without a doubt a good investment.

7.0 VALUE ENGINEERING OF GREEN ROOF TO A STANDARD ROOF WITH PHOTOVOLTAIC PANELS

7.1 Problem Identification

As established in previous reports, very little value engineering was done on this project. This poses a problem because Susquehanna Health is a non-profit organization that relies much of its funding through government agencies as well as public donations. As stated earlier this project incorporates Green Roofs in its design. However, Green roofs are expensive and do not offer much return for the upfront costs associated with them. Two of the major goals of this project are to meet LEED Certification for Hospitals and to reduce the large operational costs associated with hospitals. The Green Roofs satisfy the LEED goals but do little in the way of reducing the operational costs.

7.2 Research Goal

It is the goal of this analysis to value engineer some of the Green Roofs and reduce the overall cost of the roof system. In lieu of the green roof, a standard roof with PV panels will be substituted in its place. In addition to these two alternatives, a simple standard EPDM roof with neither a green roof nor a PV panels. Through replacing the Green Roof, it is the overall goal of this analysis to achieve LEED points while reducing the operational costs of the hospital.

7.3 Methodology

- Obtain cost information for existing roof system
- Research and contact PV panel manufactures
- Evaluate which Green Roofs should be value engineered
- Determine the amount of panels that can be installed and the energy that they will produce
- Analyze the structural and electrical impacts of standard roof with PV panels vs. the original design
- Analyze where PV panel equipment should be installed
- Analyze potential drainage impacts
- Analyze architectural impacts of the PV panels
- Research Government incentives and rebates
- Perform a cost analysis, feasibility analysis on life-cycle cost, and payback period

7.4 Background Information

The major problems experienced by L.F. Driscoll and the engineers on this project were last minute design changes by Granary Associates. The two major design changes include raising the curtainwall to the roof level and alternating which parts of the roof would incorporate a green roof. Originally the entire roof was to be a green roof and the structural steel was designed accordingly. Now the only portions of the roofs that will implement green roof design are the ones in front of the parapet wall. With the original design the green roofs served the purpose of promoting a green and healthy environment for patients. However, after the curtain wall was moved to roof level this relationship between the green roof and the patients went away making the green roof design ultimately useless. Currently Granary

Associates and L.F. Driscoll are considering the possibility of doing away with the green roof and simply using an EPDM roof. The green roof can be value engineered, however the design change came too late for the structural steel that supports the roof to be changed without causing major delays. The structural steel in the roof is overdesigned for the EPDM roofing system. Overdesigned steel is typically more expensive than a lighter system designed accordingly.

As previously mentioned, very little value engineering was done on this project. The only two items value engineered were the windows and the vapor barriers. This is potentially a problem because Susquehanna Health is a non-profit organization and cash flow is always a concern. To make things worse hospitals have very high operational costs. These high operational costs are the main reason that the mechanical systems of the building are top of the line. From the beginning of Susquehanna Health's Project 2012 initiative, energy reduction and building "Green" have been among some of their top goals. One example of this is the cogeneration waste heat recovery system located in the central utility plant. At a price tag of roughly $2.7 million, this system predicted to save over $500,000 yearly in electricity and is to put a huge dent in operational costs. A photovoltaic system is another type of system that should cut energy consumption and save Susquehanna Health money in the long run. It would also help them achieve LEED points and continue their mission to reduce the impacts they have on the environment.

7.5 Current Green Roof Design

7.5.1 Architectural Features and Impacts

The current design incorporates three different green roofs which are all located in front of the parapet walls. Originally the design called for the entire roof systems to incorporate some form or another of vegetation. However, the design was changed resulting in only the five roofs in front of the parapet to be green roofs. ***Figure 7*** shows the step back features of four out of the five green roofs. The key design feature the Granary Associates were trying to communicate was the relationship between a green

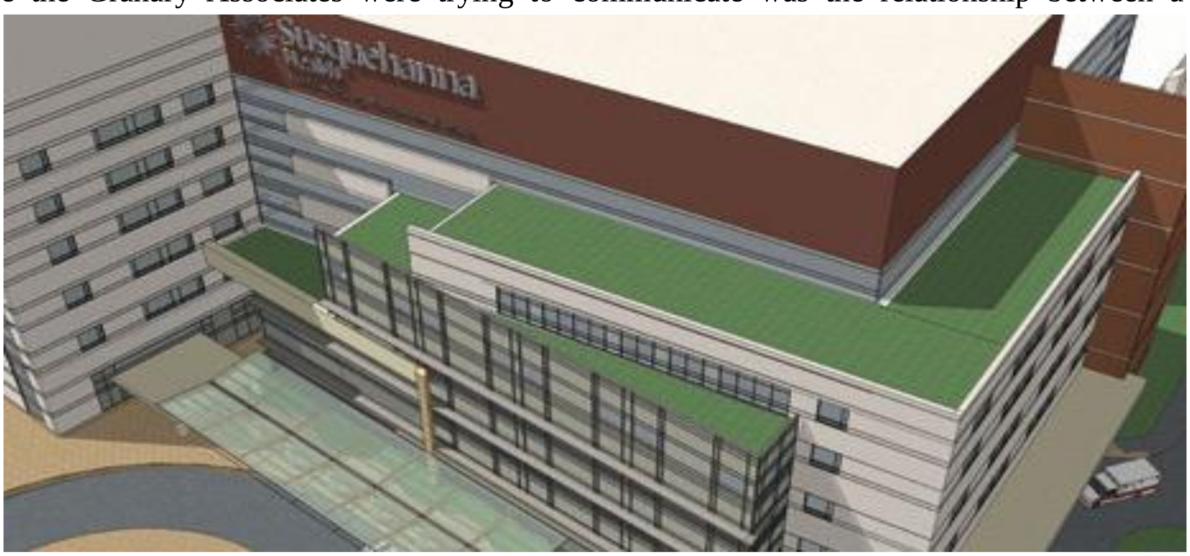


Figure 7 Second Preliminary Green Roof Design East

environment and healing. These green roofs are located just outside of patient rooms so that patients can look out and see them. Hospital design guidelines say that all patients must have some sort of natural lighting as to promote the healing process. However, studies have also been done that say patients heal faster and are able to better tolerate being in the hospital when they are living in a “green” and healthy environment. Improving the mental status of a patient can make all the difference in the world when confronting disease and illness and green roofs can help achieve this.

Despite the benefits of a green environment, the decision was made to raise the middle tier to roof level and extend the curtain wall accordingly. This change ultimately made the green roof a useless design choice. Green roofs on this project were never intended to serve any kind of drainage benefits. The roof was more than adequate to handle all storm water drainage without the aid of vegetation. This design change also affected the ribbon windows in the center of the building directly under the Susquehanna Heal logo. Two sections of ribbon glass replaced the three tiered sections. In addition to raising the curtain wall to the roof level, it was also decide to extend the wall east and encapsulate the windows. To see a side by side comparison of the second preliminary design and the current design, reference ***Appendix H***.

Throughout the course of design changes there was one green roof on the western side of the building that didn’t change. A rendering of this roof can be seen in ***Figure 7*** below. The only benefit of these roofs under this new design is the LEED points that they achieve. As previously stated this project is being designed to meet LEED Certification for Health Care. However, at this time the project will never achieve an official LEED status.

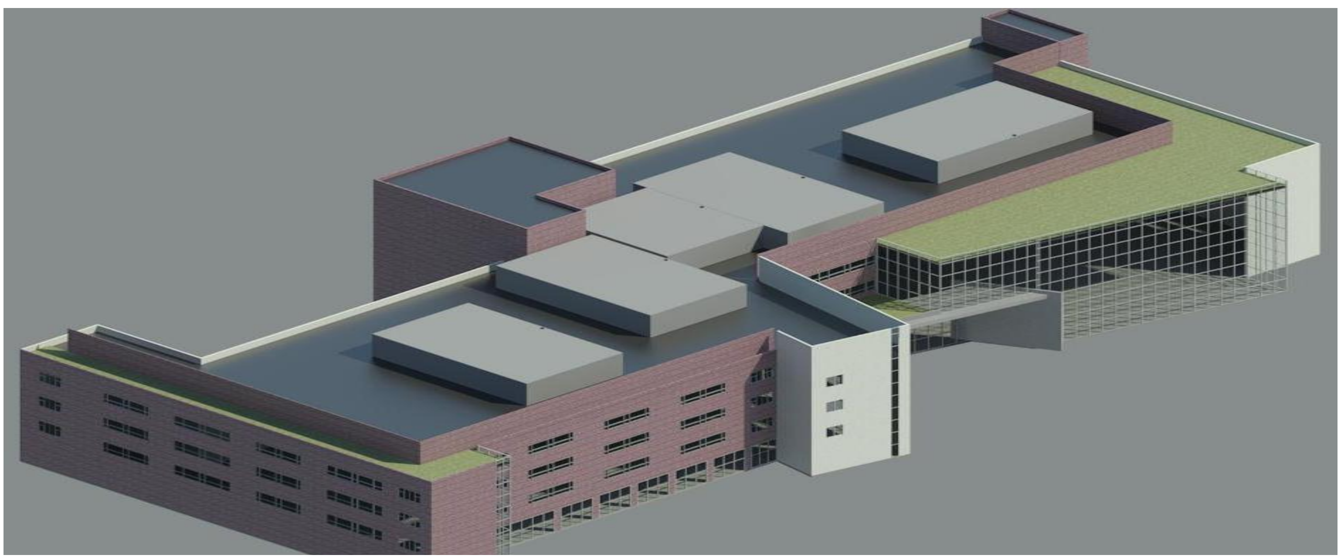


Figure 7 Western Rendering of Current Design

7.5.2 Green Roof Cost Impacts

Green roofs are expensive design choices that yield very little return on the large upfront costs associated with them. In addition to the costs directly associated with the vegetation mats, the cost of the steel that supports them also increases. As you put more load on the steel, the size of each member will increase resulting in a more expensive design. ***Table 14*** is a breakdown the direct costs associated with the current green roof system. Note that rates on material and labor are figures from the roofing subcontractor on the job American Roofing. The EPDM roofing itself has a contract value of $934,315 which combined with the green roofs will bring the total to $1,053,039.

Roof Designation	Area (SF)	Unit Cost /SF	Material Cost	Labor Cost	Total Labor Cost	Total
Roof 1 East	8,002	$7.50	$60,015	$3.00/SF	$24,006	$84,021
Roof 2 Center	1,070	$7.50	$8,025	$3.00/SF	$3,210	$11,235
Roof 3 West	2,235	$7.50	$16,763	$3.00/SF	$6,705	$23,468
Total			$84,803			$118,724

Table 14 Green Roof Cost Data

7.6 Simple EPDM Roofing

7.6.1 Architectural Features and Impacts

As stated earlier the green roofs currently have very little impact on the overall architecture of the building. Therefore value engineering the green roofs to a simple EPDM roofing system can be done without disturbing the form or overall function of the building. After the various design changes, the current design will only be seen by rooftop maintenance personnel. However, all green roofs cannot be value engineered without impacting the design. As seen in ***Figure 8*** to the right, the central green roof can be seen and experienced by building occupants on all three sides. It is for this reason that whatever design change happens to the other roofs this roof will remain unaltered. This roof communicates healing and a healthy environment to the patients on the 5th floor as well as occupants traveling in the center hallway. It is especially important to the patients on the 5th floor because it is the only view of the outside that they will get. See ***Appendix J*** for new EPDM design.

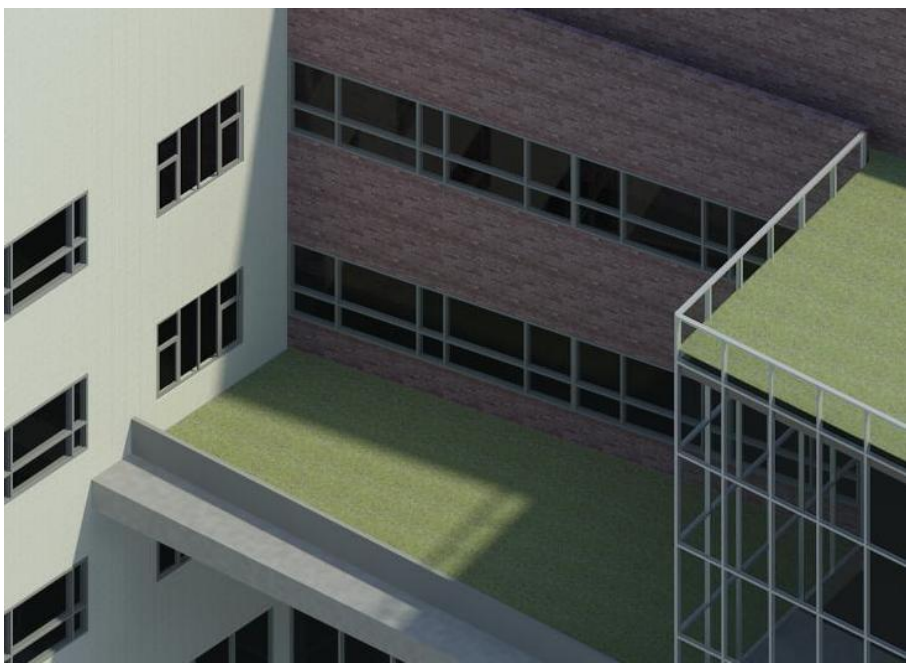


Figure 8 Central Green Roof

7.6.2 EPDM Structural Impacts

As stated earlier in this report decreasing the overall load that the building will have to support could potentially reduce the size of the steel members. After discovering that the green roof in the works was a very low profile vegetative mat with nylon entanglement, it was quickly realized that this roof system was going to have a very minimal impact to the structural steel. This mat vegetation will only add an extra 7.0 lb/SF. This value is the fully saturated value of the entire mat. As seen in ***APPENDIX L*** the W16X31 steel beams in typical bays cannot be reduced. However, the W24X76 girders running north and south in this bay can be redesigned to a W24X68. For all Structural calculations and figures reference ***APPENDIX L.***

7.6.3 EPDM and Central Green Roof Cost Impacts

As seen in ***Table 15*** reducing all instances of these girders within typical bays can reduce the total cost of the structural system by approximately $9186.50. Note that Cost/LF figures were produced by using RS Means Costworks. Although this method of estimating isn't perfect it does give the user a rough idea of costs.

Designation	Shape/Size	LF	Cost/LF	Total Cost
Original Design	W24X76	967	$92.00	$88,964.00
New Design	W24X68	967	$82.50	
			Total Savings	$9186.50

Table 15 Value Engineering of Structural Steel

Value Engineered System	VE Y/N	System Cost	Savings	Total Savings
Roof Steel	Yes	$79,777.50	$9186.50	$9,187
Roof 1 East	Yes	$84,021	$84,021	$84,021
Roof 2 Center	No	$11,235	-	-
Roof 3 West	Yes	$23,468	$23,468	$23,468
			Total Savings	$116,676

Table 16 Total Value Engineering Done for EPDM

In the greater scheme of things, ***Table 16*** shows a cost breakdown of this whole analysis. As stated earlier in this analysis the center green roof could not be value engineered. Minus not being able to value engineer this particular green roof, value engineering the rest of the green roof systems and the structural steel saved the project roughly $116,675.50.

7.7 EPDM Roofing With Photovoltaic Panels

7.7.1 Photovoltaic Design and Orientation

The first step in the design of this photovoltaic was eliminating the green roofs as was done in the previous analysis. However, the steel W24X76 girders will not be value engineered as they will be supporting the additional load of the photovoltaic panels. As seen in APPENDIX J photovoltaic panels were only used on the southern face above directly above the curtain wall and on the roof of the penthouse. These locations were chosen because not only do they face directly south but they absorb the sun's energy for the entire time it's out. The other areas of the roof would only get half of the sun's energy because they are being shaded by the metal panel parapet walls. For satellite information and general PV specifications reference ***Table 17***.

General Site Information	
City:	Williamsport
State:	Pennsylvania
Latitude:	41.27° N
Longitude:	77.05° W
Elevation:	243 m
Roof Orientation	Directly South
PV System Specifications	
DC Rating:	54.2 kW
DC to AC Derate Factor:	0.770
AC Rating:	41.7 kW
Array Type:	Fixed Tilt
Array Tilt:	41.3°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	9.6 ¢/kWh

Table 17 Station Information from PV Watts Calculator

PV panel rows are spaced 3' 6" from each other to ensure that none of the front rows shade the back rows. Panels located on the end of each row are spaced at least 4' from the end so that the 2' high edge of the building doesn't shade the panels in the early hours of the morning when the sun is in a more eastern position. All PV panels on the penthouse roof as well as the ones located above the curtain wall follow these guidelines as to prevent any shading. The only time these guidelines were ignored is when the mini parapet of the curtain wall was located directly in front of a few panels. After speaking with SunTech Power, they said this is not ideal but shouldn't have major impacts with the minimal area that could possibly be shaded.

The goal of this analysis is to reduce the operational coasts of the building not to single out any one system. Hospitals consume so much power that it is unrealistic to try and eliminate the power that they consume. Even to try single out patient room lighting or even half of it would be an unrealistic goal. The sizing of this array was based on the physical limitations of suitable roof area and the specifications. All together there are a total of 258 panels that are tilted 41.3° due to the flat nature of the roof and the latitude in Williamsport, PA. The solar panels

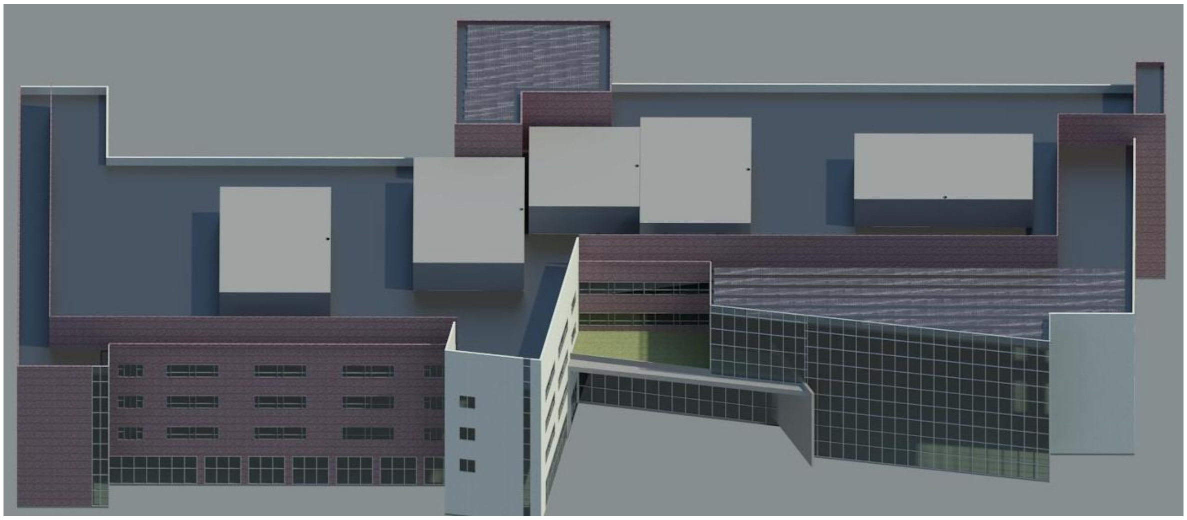


Figure 9 Southern View of Photovoltaic Array

being used in this analysis are SUNTECH STP210/Ud poly-crystalline panels. These panels were chosen due to the DC rating that could be achieved with them. Another reason they were used was due to their really low costs. Each panel costs $610/ea. This helped in keeping the system costs down and allowed for a quicker payback time. See APPENDIX # for product data and cut sheets.

Yearly Photovoltaic Energy Results			
Month	Solar Radiation (kWh/m^2/day)	AC Energy (kWh)	Energy Value ($)
1	3.06	4140	397.44
2	3.61	4350	417.60
3	4.50	5778	554.69
4	4.60	5467	524.83
5	5.15	6096	585.22
6	5.29	5945	570.72
7	5.38	6134	588.86
8	5.19	5957	571.87
9	4.61	5332	511.87
10	3.77	4571	438.82
11	2.58	3104	297.98
12	2.35	3011	289.06
Year	4.18	59884	$5748.86
PV Watts Factor = 1105			

Table 18 ***Yearly Photovoltaic Energy Results***

Utilizing the PVWatts calculator the yearly energy savings for the PV system was estimated to be $5,748.86. This value will later be used to help determine the payback period. Dividing the total AC energy produced over the year by the overall size of the system a PV watts factor of 1105. This value is useful for producing feasibly studies.

7.7.2 Photovoltaic Panel Structural Impacts

According to manufacturer recommendations and installation guides a total dead load of 6 pounds per square foot can be assumed for mounting brackets and the PV panels together. Going back to the structural analysis of the EPDM roofing, the roof system was designed with a green roof in mind. The green roof was designed to carry the a green roof of 7 psf. Because the green roof has been value engineered from the design, it can be assumed that current roofing system will be able to carry the 6 psf load of the PV panel system.

7.7.3 Photovoltaic Electrical Tie-ins

From both arrays, power is ran through two DC cable that then tie into the inverter before tying into the actual building. From the inverter, power is then ran to the meter box on the grid supply side. For hospitals this is a very important stage because this is where the generators tie into the system. After running through the meter power is then feed to the main distribution panel. The two generators in this building bypass the meter and connect to the main distribution panel. In the event that building loses grid power, these two generators will kick on. Even if the grid supply is down, power will still enter the building via the photovoltaic system. This is a very small amount of power and will in no way be enough to power emergency power. However it will provide some power to help aide the generators.

The inverter will be located adjacent to the penthouse for multiple reasons. The first reason is because the inverter will be hidden by the parapet wall, the penthouse, and even the adjacent hospital. The second reason is the amount of DC wire used will be reduced due to its proximity to the penthouse array. The third and final reason is because the main mechanical room/electrical room is located on the first floor directly under where the inverter is located at.

One disadvantage of having two separate arrays is the fact that you have to run larger amounts of DC cable which is not only expensive but can cause significant voltage. The amount of DC wire used to tie up the system was around 160'. It is for this reason that voltage drop must be calculated. For voltage drop calculations and wire sizing see APPENDIX K.

7.7.4 Photovoltaic Cost Impact and Payback Period

Below is a general breakdown of some of the main components of this PV array. Cost information is based from manufactures and RS Means. In addition to the cost of this system government incentives are also provided to reduce the total cost of the system. Note that installation costs are included on the wiring and mounting.

Photovoltaic Material Costs						
Material	Quantity	Cost Per Unit	Total Cost	Installation Cost/Unit	Total Installation Cost	Total
STP210-18/Ud	258	$610.00	$157,380	$7.00	$1,806	$159,186
Sunny Tower with 6 Sunny Boy 8000US	1	$20,816.80	$20,816.8	$500.00	$500	$21,317
4/0 Wire	160	$35	$5,600	-	-	$5,600
Mounting	258	$50	$12,900	-	-	$12,900
					Total	$199,003

Table 19 Photovoltaic Material Costs

Rebates and Government Incentives
- -Federal Tax Credit-30% of Gross Installation Costs
- -Federal PV Rebate-3-10 kW $7,500
- -PA Sunshine Rebate 10kW-100kW $25,000

Year	Energy Cost ($/kW)	Energy Savings (kWH)	Yearly Savings	Total Savings
1	$0.09	59884	$5,569.21	$5,389.65
2	$0.09	59884	$5,569.21	$10,958.86
3	$0.09	59884	$5,569.21	$16,528.07
4	$0.10	59884	$5,988.40	$22,516.47
5	$0.10	59884	$5,988.40	$28,504.87
6	$0.10	59884	$5,988.40	$34,493.27
7	$0.10	59884	$5,988.40	$40,481.67
8	$0.10	59884	$5,988.40	$46,470.07
9	$0.10	59884	$5,988.40	$52,458.47
10	$0.11	59884	$6,587.24	$59,045.71
11	$0.11	59884	$6,587.24	$65,632.95
12	$0.11	59884	$6,587.24	$72,220.19
13	$0.11	59884	$6,587.24	$78,807.43
14	$0.11	59884	$6,587.24	$85,394.67
15	$0.11	59884	$6,587.24	$91,981.91
16	$0.12	59884	$7,186.08	$99,167.99
17	$0.12	59884	$7,186.08	$106,354.07
18	$0.12	59884	$7,186.08	$113,540.15
19	$0.12	59884	$7,186.08	$120,726.23
20	$0.12	59884	$7,186.08	$127,912.31
21	$0.12	59884	$7,186.08	$135,098.39
22	$0.13	59884	$7,784.92	$142,883.31
23	$0.13	59884	$7,784.92	$150,668.23
24	$0.13	59884	$7,784.92	$158,453.15
25	$0.13	59884	$7,784.92	$166,238.07

Table 20 Year Look-Ahead for Photovoltaic Array

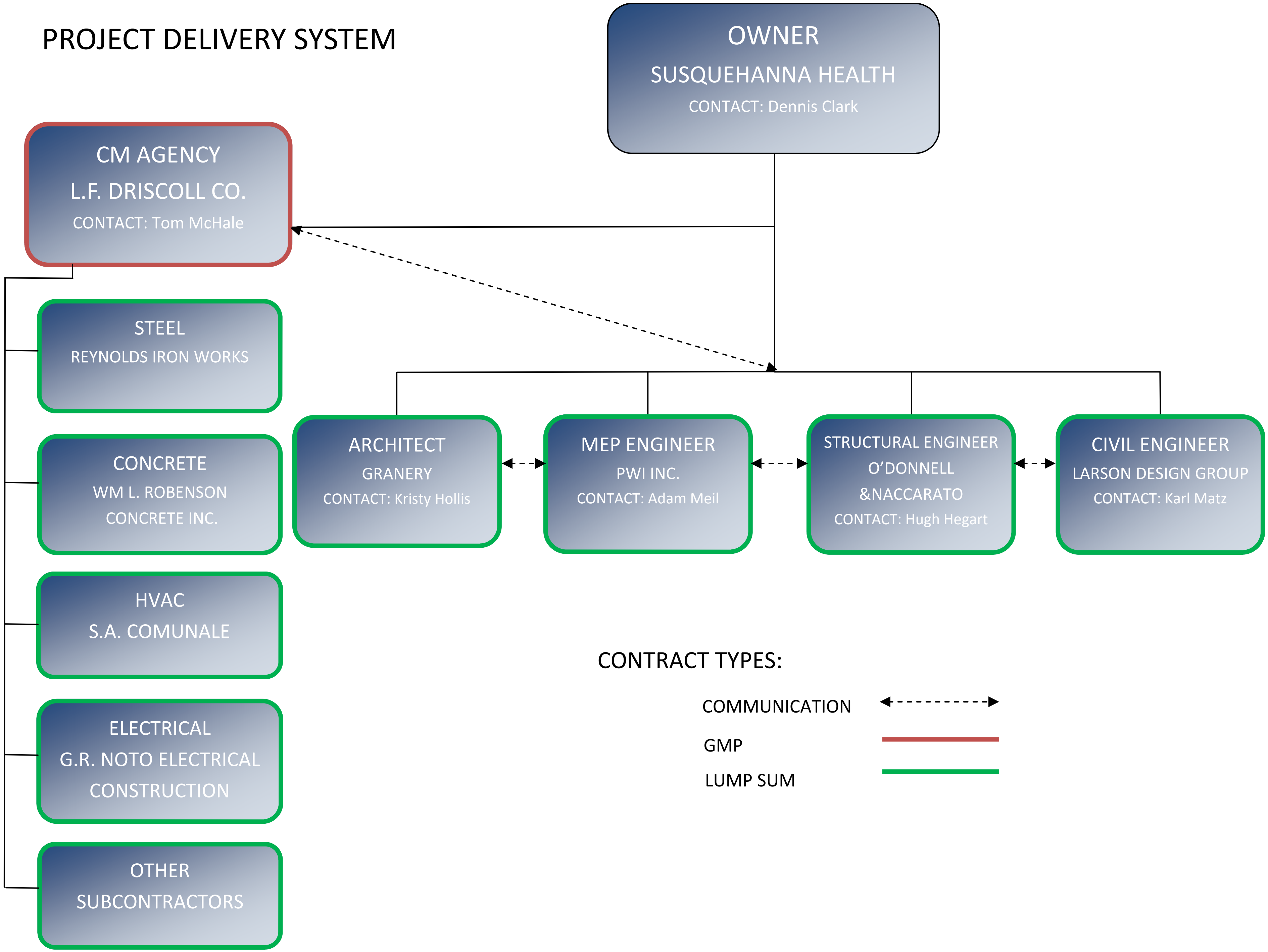
After Rebates and incentives the total photovoltaic array costs $165,661. Assuming that the cost of energy increases 1.5% each year, the payback period for this system would be 25 years. This is a fairly reasonable because the total system has a 25 year warranty and most PV arrays of this size usually have a payback period of 20-25years. After consulting with the Susquehanna Health, this is something they might be interested in. However, because Susquehanna Health is a non-profit organization, it is sometimes hard to come up with the necessary capital to invest in a system such as this. Spending this much money upfront would have to be voted on by the entire board of representatives and various other persons.

7.7.4 Final Conclusion

After value engineering the roofing systems and providing alternative systems it has been determined that the best option for Susquehanna Health is to eliminate the green roofs at roof level leaving only the one over the entrance. However, steel member should not be value engineering the steel should not be done. Choosing this option will also allow Susquehanna Health to determine if a photovoltaic array is still in the budget. Taking into consideration that the green roofs cost so much, Susquehanna Health would only need to come up with an additional $60,000 which seems pretty reasonable for such a large organization.

APPENDIX A: PROJECT DELIVERY METHOD

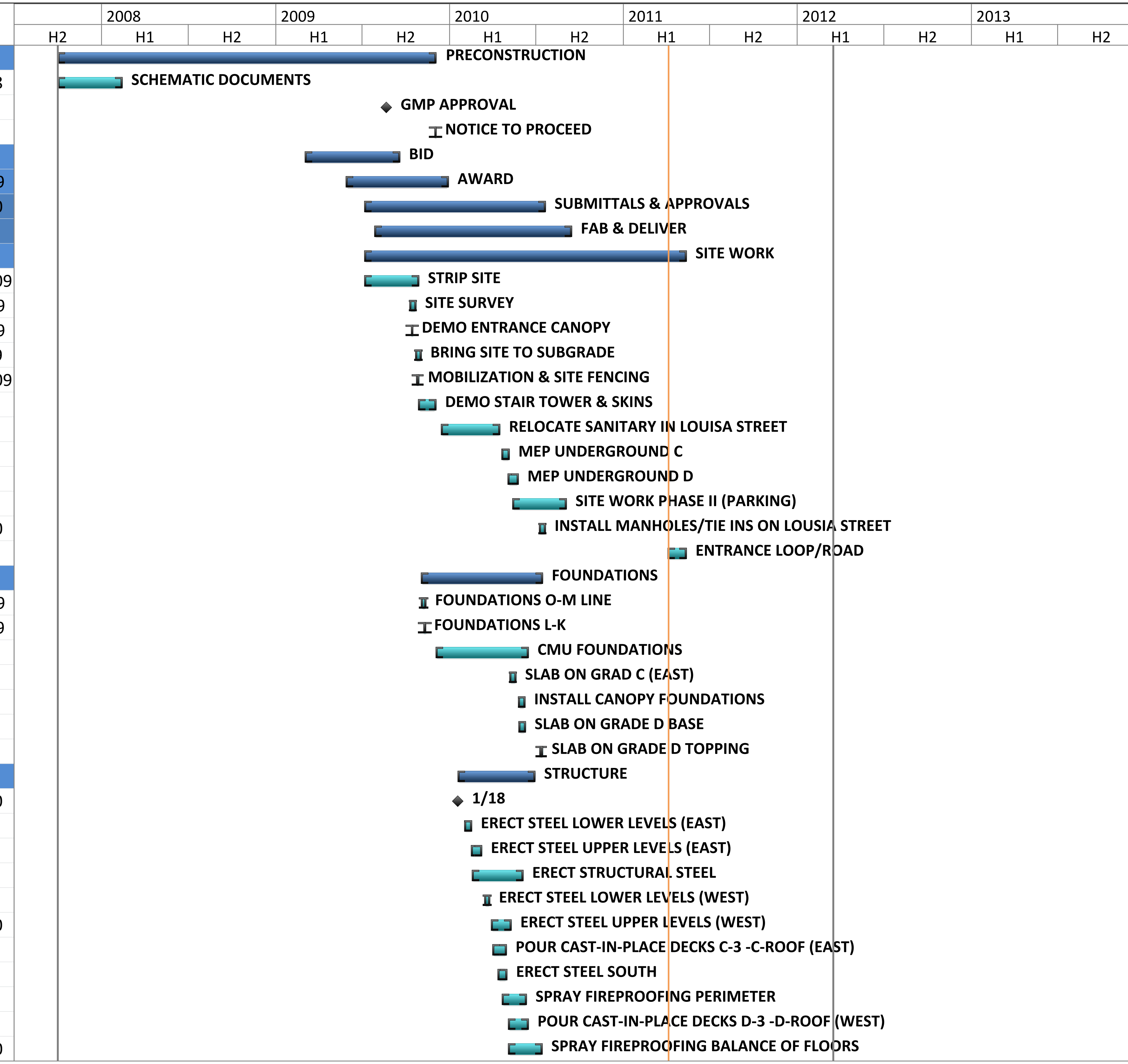
PROJECT DELIVERY SYSTEM



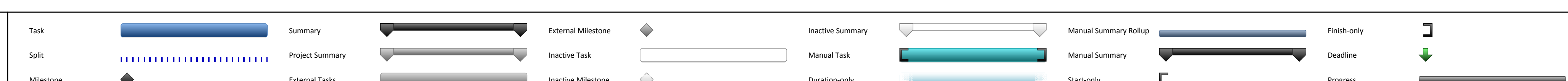
APPENDIX B: DETAILED SCHEDULE

ADAM LASHER CONSTRUCTION MANAGEMENT

ID	Task Name	Duration	Start	Finish
1	PRECONSTRUCTION	569 days	Mon 10/1/07	Thu 12/3/09
2	SCHEMATIC DOCUMENTS	98 days	Mon 10/1/07	Wed 2/13/08
3	GMP APPROVAL	0 days	Fri 8/21/09	Fri 8/21/09
4	NOTICE TO PROCEED	3 days	Tue 12/1/09	Thu 12/3/09
5	BID	144 days	Tue 3/3/09	Fri 9/18/09
6	AWARD	154 days	Thu 5/28/09	Tue 12/29/09
7	SUBMITTALS & APPROVALS	273 days	Mon 7/6/09	Wed 7/21/10
8	FAB & DELIVER	297 days	Mon 7/27/09	Tue 9/14/10
9	SITE WORK	485 days	Mon 7/6/09	Fri 5/13/11
10	STRIP SITE	83 days	Mon 7/6/09	Wed 10/28/09
11	SITE SURVEY	10 days	Fri 10/9/09	Thu 10/22/09
12	DEMO ENTRANCE CANOPY	3 days	Tue 10/13/09	Thu 10/15/09
13	BRING SITE TO SUBGRADE	9 days	Wed 10/21/09	Mon 11/2/09
14	MOBILIZATION & SITE FENCING	4 days	Fri 10/23/09	Wed 10/28/09
15	DEMO STAIR TOWER & SKINS	28 days	Tue 10/27/09	Thu 12/3/09
16	RELOCATE SANITARY IN LOUISA STREET	90 days	Mon 12/14/09	Fri 4/16/10
17	MEP UNDERGROUND C	13 days	Tue 4/20/10	Thu 5/6/10
18	MEP UNDERGROUND D	17 days	Mon 5/3/10	Tue 5/25/10
19	SITE WORK PHASE II (PARKING)	82 days	Thu 5/13/10	Fri 9/3/10
20	INSTALL MANHOLES/TIE INS ON LOUSIA STREET	10 days	Thu 7/8/10	Wed 7/21/10
21	ENTRANCE LOOP/ROAD	30 days	Mon 4/4/11	Fri 5/13/11
22	FOUNDATIONS	184 days	Mon 11/2/09	Thu 7/15/10
23	FOUNDATIONS O-M LINE	9 days	Mon 11/2/09	Thu 11/12/09
24	FOUNDATIONS L-K	2 days	Mon 11/9/09	Tue 11/10/09
25	CMU FOUNDATIONS	139 days	Thu 12/3/09	Tue 6/15/10
26	SLAB ON GRAD C (EAST)	10 days	Fri 5/7/10	Thu 5/20/10
27	INSTALL CANOPY FOUNDATIONS	11 days	Tue 5/25/10	Tue 6/8/10
28	SLAB ON GRADE D BASE	11 days	Wed 5/26/10	Wed 6/9/10
29	SLAB ON GRADE D TOPPING	5 days	Fri 7/9/10	Thu 7/15/10
30	STRUCTURE	117 days	Mon 1/18/10	Tue 6/29/10
31	MOBILIZATION/CRANE SET UP	0 days	Mon 1/18/10	Mon 1/18/10
32	ERECT STEEL LOWER LEVELS (EAST)	12 days	Mon 2/1/10	Tue 2/16/10
33	ERECT STEEL UPPER LEVELS (EAST)	17 days	Mon 2/15/10	Tue 3/9/10
34	ERECT STRUCTURAL STEEL	78 days	Wed 2/17/10	Fri 6/4/10
35	ERECT STEEL LOWER LEVELS (WEST)	10 days	Mon 3/15/10	Fri 3/26/10
36	ERECT STEEL UPPER LEVELS (WEST)	31 days	Mon 3/29/10	Mon 5/10/10
37	POUR CAST-IN-PLACE DECKS C-3 -C-ROOF (EAST)	22 days	Thu 4/1/10	Fri 4/30/10
38	ERECT STEEL SOUTH	16 days	Mon 4/12/10	Sat 5/1/10
39	SPRAY FIREPROOFING PERIMETER	38 days	Wed 4/21/10	Fri 6/11/10
40	POUR CAST-IN-PLACE DECKS D-3 -D-ROOF (WEST)	31 days	Tue 5/4/10	Tue 6/15/10
41	SPRAY FIREPROOFING BALANCE OF FLOORS	52 days	Tue 5/4/10	Wed 7/14/10

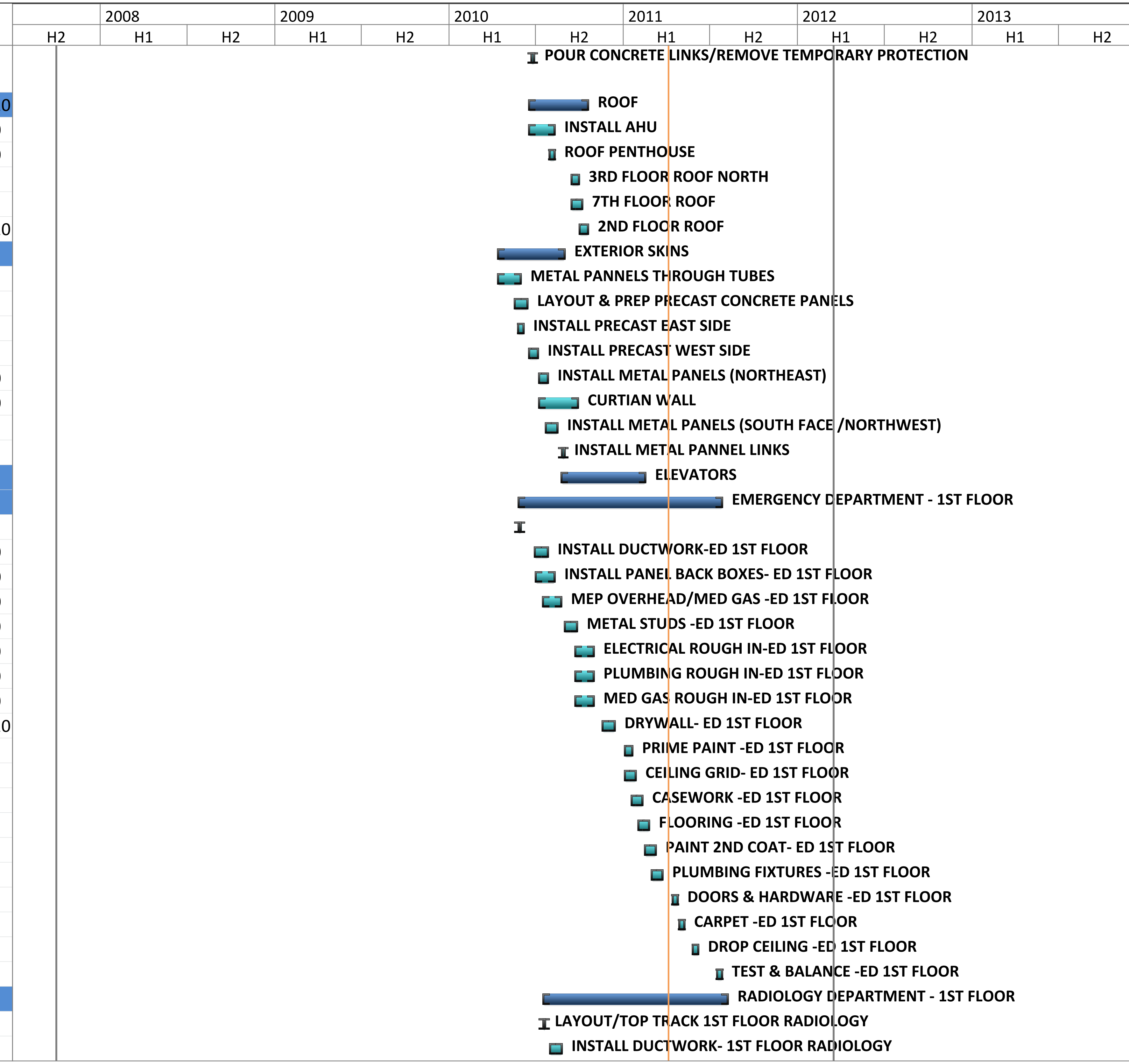


Project: PATIENT TOWER EXPANSION
Date: 4/7/2011



ADAM LASHER CONSTRUCTION MANAGEMENT

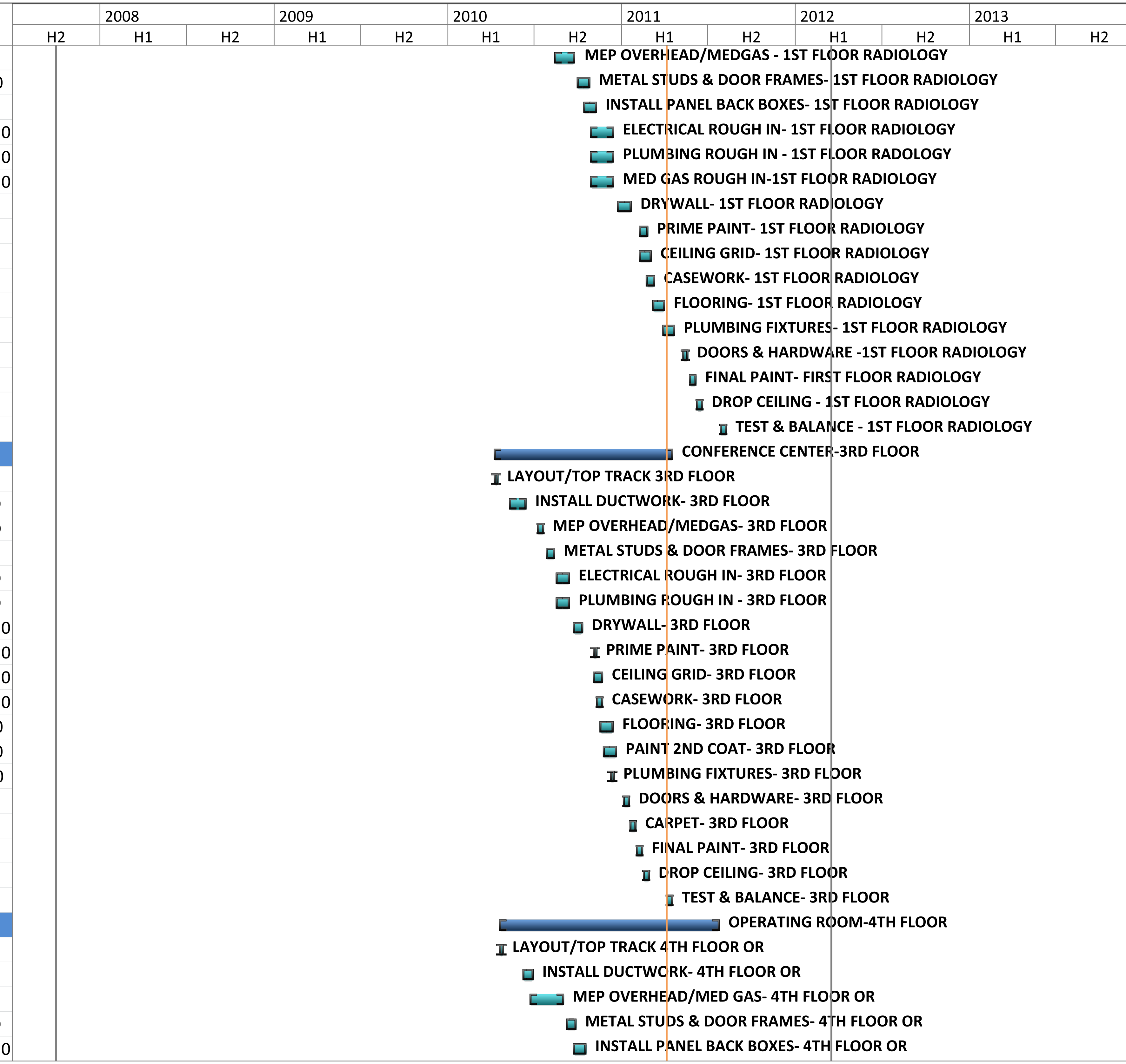
ID	Task Name	Duration	Start	Finish
42	POUR CONCRETE LINKS/REMOVE TEMPORARY PROTECTION	7 days	Mon 6/21/10	Tue 6/29/10
43	ROOF	91 days	Wed 6/16/10	Wed 10/20/10
44	INSTALL AHU	41 days	Wed 6/16/10	Wed 8/11/10
45	ROOF PENTHOUSE	10 days	Thu 7/29/10	Wed 8/11/10
46	3RD FLOOR ROOF NORTH	15 days	Mon 9/13/10	Fri 10/1/10
47	7TH FLOOR ROOF	20 days	Mon 9/13/10	Fri 10/8/10
48	2ND FLOOR ROOF	15 days	Thu 9/30/10	Wed 10/20/10
49	EXTERIOR SKINS	103 days	Mon 4/12/10	Wed 9/1/10
50	METAL PANNELS THROUGH TUBES	37 days	Mon 4/12/10	Tue 6/1/10
51	LAYOUT & PREP PRECAST CONCRETE PANELS	22 days	Mon 5/17/10	Tue 6/15/10
52	INSTALL PRECAST EAST SIDE	11 days	Mon 5/24/10	Mon 6/7/10
53	INSTALL PRECAST WEST SIDE	16 days	Wed 6/16/10	Wed 7/7/10
54	INSTALL METAL PANELS (NORTHEAST)	16 days	Wed 7/7/10	Wed 7/28/10
55	CURTIAN WALL	61 days	Wed 7/7/10	Wed 9/29/10
56	INSTALL METAL PANELS (SOUTH FACE /NORTHWEST)	20 days	Wed 7/21/10	Tue 8/17/10
57	INSTALL METAL PANNEL LINKS	7 days	Tue 8/24/10	Wed 9/1/10
58	ELEVATORS	129 days	Mon 8/23/10	Thu 2/17/11
59	EMERGENCY DEPARTMENT - 1ST FLOOR	308 days	Tue 5/25/10	Thu 7/28/11
60	LAYOUT/TOP TRACK ED 1ST FLOOR	6 days	Tue 5/25/10	Tue 6/1/10
61	INSTALL DUCTWORK-ED 1ST FLOOR	23 days	Mon 6/28/10	Wed 7/28/10
62	INSTALL PANEL BACK BOXES- ED 1ST FLOOR	31 days	Wed 6/30/10	Wed 8/11/10
63	MEP OVERHEAD/MED GAS -ED 1ST FLOOR	30 days	Thu 7/15/10	Wed 8/25/10
64	METAL STUDS -ED 1ST FLOOR	21 days	Mon 8/30/10	Mon 9/27/10
65	ELECTRICAL ROUGH IN-ED 1ST FLOOR	30 days	Tue 9/21/10	Mon 11/1/10
66	PLUMBING ROUGH IN-ED 1ST FLOOR	30 days	Tue 9/21/10	Mon 11/1/10
67	MED GAS ROUGH IN-ED 1ST FLOOR	30 days	Tue 9/21/10	Mon 11/1/10
68	DRYWALL- ED 1ST FLOOR	21 days	Wed 11/17/10	Wed 12/15/10
69	PRIME PAINT -ED 1ST FLOOR	15 days	Mon 1/3/11	Fri 1/21/11
70	CEILING GRID- ED 1ST FLOOR	20 days	Mon 1/3/11	Fri 1/28/11
71	CASEWORK -ED 1ST FLOOR	20 days	Mon 1/17/11	Fri 2/11/11
72	FLOORING -ED 1ST FLOOR	20 days	Mon 1/31/11	Fri 2/25/11
73	PAINT 2ND COAT- ED 1ST FLOOR	20 days	Mon 2/14/11	Fri 3/11/11
74	PLUMBING FIXTURES -ED 1ST FLOOR	20 days	Mon 2/28/11	Fri 3/25/11
75	DOORS & HARDWARE -ED 1ST FLOOR	10 days	Wed 4/13/11	Tue 4/26/11
76	CARPET -ED 1ST FLOOR	10 days	Wed 4/27/11	Tue 5/10/11
77	DROP CEILING -ED 1ST FLOOR	11 days	Wed 5/25/11	Wed 6/8/11
78	TEST & BALANCE -ED 1ST FLOOR	10 days	Fri 7/15/11	Thu 7/28/11
79	RADIOLOGY DEPARTMENT - 1ST FLOOR	278 days	Fri 7/16/10	Tue 8/9/11
80	LAYOUT/TOP TRACK 1ST FLOOR RADIOLOGY	5 days	Fri 7/16/10	Thu 7/22/10
81	INSTALL DUCTWORK- 1ST FLOOR RADIOLOGY	20 days	Fri 7/30/10	Thu 8/26/10



Project: PATIENT TOWER EXPANSION
Date: 4/7/2011

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

ID	Task Name	Duration	Start	Finish
82	MEP OVERHEAD/MEDGAS - 1ST FLOOR RADIOLOGY	31 days	Fri 8/13/10	Fri 9/24/10
83	METAL STUDS & DOOR FRAMES- 1ST FLOOR RADIOLOGY	20 days	Wed 9/29/10	Tue 10/26/10
84	INSTALL PANEL BACK BOXES- 1ST FLOOR RADIOLOGY	20 days	Wed 10/13/10	Tue 11/9/10
85	ELECTRICAL ROUGH IN- 1ST FLOOR RADIOLOGY	36 days	Wed 10/27/10	Wed 12/15/10
86	PLUMBING ROUGH IN - 1ST FLOOR RADOLOGY	36 days	Wed 10/27/10	Wed 12/15/10
87	MED GAS ROUGH IN-1ST FLOOR RADIOLOGY	36 days	Wed 10/27/10	Wed 12/15/10
88	DRYWALL- 1ST FLOOR RADIOLOGY	22 days	Thu 12/23/10	Fri 1/21/11
89	PRIME PAINT- 1ST FLOOR RADIOLOGY	15 days	Mon 2/7/11	Fri 2/25/11
90	CEILING GRID- 1ST FLOOR RADIOLOGY	20 days	Mon 2/7/11	Fri 3/4/11
91	CASEWORK- 1ST FLOOR RADIOLOGY	15 days	Mon 2/21/11	Fri 3/11/11
92	FLOORING- 1ST FLOOR RADIOLOGY	20 days	Mon 3/7/11	Fri 4/1/11
93	PLUMBING FIXTURES- 1ST FLOOR RADIOLOGY	20 days	Mon 3/28/11	Fri 4/22/11
94	DOORS & HARDWARE -1ST FLOOR RADIOLOGY	10 days	Mon 5/9/11	Fri 5/20/11
95	FINAL PAINT- FIRST FLOOR RADIOLOGY	11 days	Mon 5/23/11	Mon 6/6/11
96	DROP CEILING - 1ST FLOOR RADIOLOGY	10 days	Tue 6/7/11	Mon 6/20/11
97	TEST & BALANCE - 1ST FLOOR RADIOLOGY	10 days	Wed 7/27/11	Tue 8/9/11
98	CONFERENCE CENTER-3RD FLOOR	268 days	Thu 4/8/10	Mon 4/18/11
99	LAYOUT/TOP TRACK 3RD FLOOR	7 days	Thu 4/8/10	Fri 4/16/10
100	INSTALL DUCTWORK- 3RD FLOOR	26 days	Mon 5/10/10	Mon 6/14/10
101	MEP OVERHEAD/MEDGAS- 3RD FLOOR	10 days	Thu 7/8/10	Wed 7/21/10
102	METAL STUDS & DOOR FRAMES- 3RD FLOOR	15 days	Mon 7/26/10	Fri 8/13/10
103	ELECTRICAL ROUGH IN- 3RD FLOOR	21 days	Mon 8/16/10	Mon 9/13/10
104	PLUMBING ROUGH IN - 3RD FLOOR	21 days	Mon 8/16/10	Mon 9/13/10
105	DRYWALL- 3RD FLOOR	15 days	Tue 9/21/10	Mon 10/11/10
106	PRIME PAINT- 3RD FLOOR	7 days	Tue 11/2/10	Wed 11/10/10
107	CEILING GRID- 3RD FLOOR	15 days	Tue 11/2/10	Mon 11/22/10
108	CASEWORK- 3RD FLOOR	10 days	Tue 11/9/10	Mon 11/22/10
109	FLOORING- 3RD FLOOR	21 days	Tue 11/16/10	Tue 12/14/10
110	PAINT 2ND COAT- 3RD FLOOR	21 days	Tue 11/23/10	Tue 12/21/10
111	PLUMBING FIXTURES- 3RD FLOOR	7 days	Wed 12/8/10	Thu 12/16/10
112	DOORS & HARDWARE- 3RD FLOOR	10 days	Tue 1/4/11	Mon 1/17/11
113	CARPET- 3RD FLOOR	10 days	Tue 1/18/11	Mon 1/31/11
114	FINAL PAINT- 3RD FLOOR	10 days	Tue 2/1/11	Mon 2/14/11
115	DROP CEILING- 3RD FLOOR	10 days	Tue 2/15/11	Mon 2/28/11
116	TEST & BALANCE- 3RD FLOOR	10 days	Tue 4/5/11	Mon 4/18/11
117	OPERATING ROOM-4TH FLOOR	331 days	Mon 4/19/10	Mon 7/25/11
118	LAYOUT/TOP TRACK 4TH FLOOR OR	7 days	Mon 4/19/10	Tue 4/27/10
119	INSTALL DUCTWORK- 4TH FLOOR OR	17 days	Mon 6/7/10	Tue 6/29/10
120	MEP OVERHEAD/MED GAS- 4TH FLOOR OR	52 days	Tue 6/22/10	Wed 9/1/10
121	METAL STUDS & DOOR FRAMES- 4TH FLOOR OR	15 days	Tue 9/7/10	Mon 9/27/10
122	INSTALL PANEL BACK BOXES- 4TH FLOOR OR	20 days	Tue 9/21/10	Mon 10/18/10

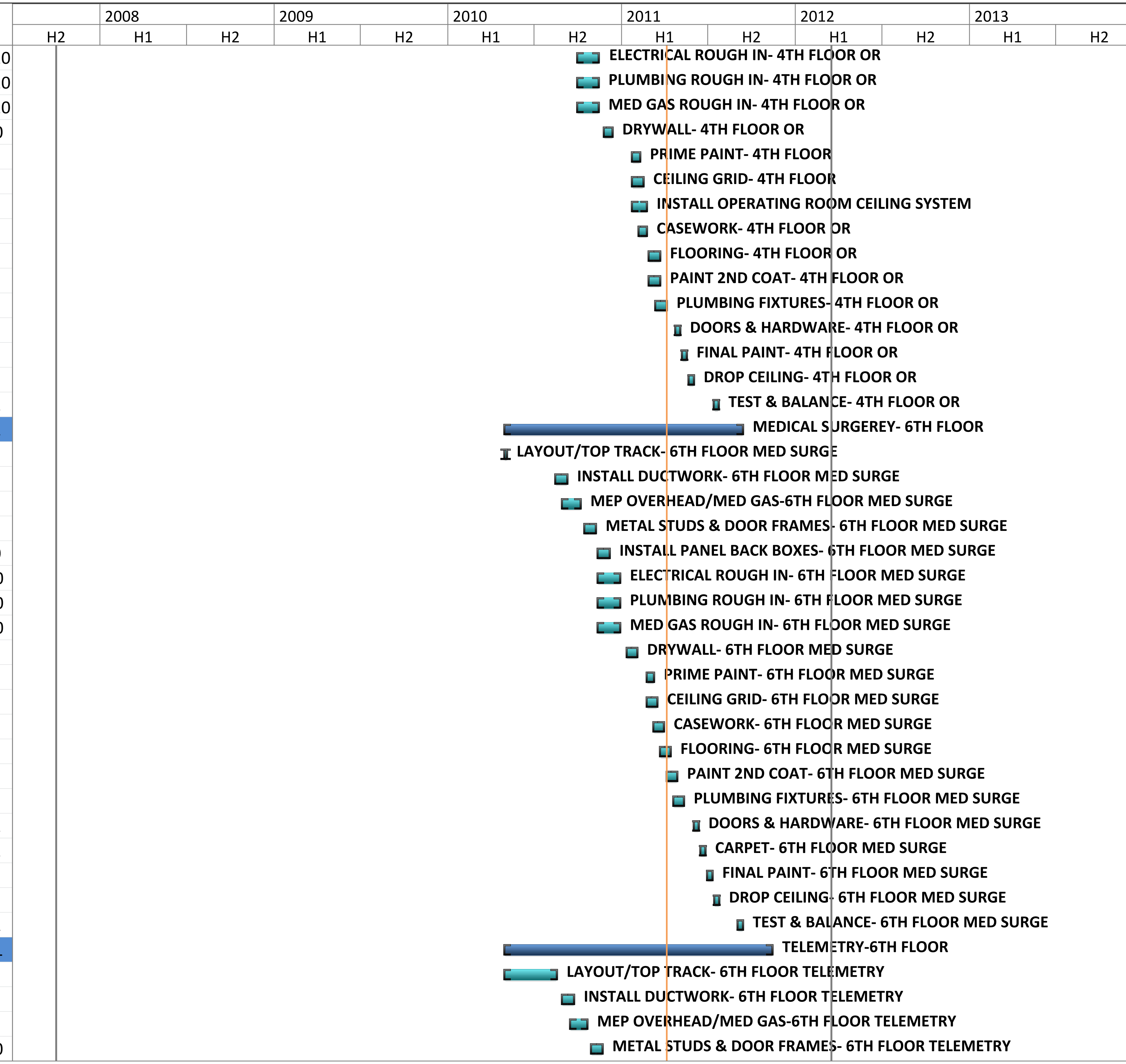


Project: PATIENT TOWER EXPANSION
Date: 4/7/2011

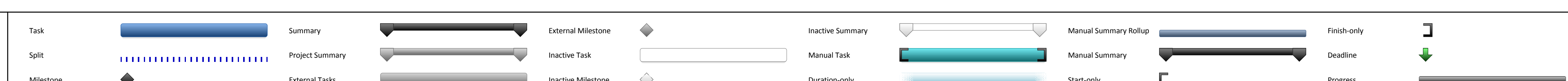
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress

ADAM LASHER CONSTRUCTION MANAGEMENT

ID	Task Name	Duration	Start	Finish
123	ELECTRICAL ROUGH IN- 4TH FLOOR OR	35 days	Tue 9/28/10	Mon 11/15/10
124	PLUMBING ROUGH IN- 4TH FLOOR OR	35 days	Tue 9/28/10	Mon 11/15/10
125	MED GAS ROUGH IN- 4TH FLOOR OR	35 days	Tue 9/28/10	Mon 11/15/10
126	DRYWALL- 4TH FLOOR OR	16 days	Tue 11/23/10	Tue 12/14/10
127	PRIME PAINT- 4TH FLOOR	15 days	Fri 1/21/11	Thu 2/10/11
128	CEILING GRID- 4TH FLOOR	20 days	Fri 1/21/11	Thu 2/17/11
129	INSTALL OPERATING ROOM CEILING SYSTEM	25 days	Fri 1/21/11	Thu 2/24/11
130	CASEWORK- 4TH FLOOR OR	15 days	Fri 2/4/11	Thu 2/24/11
131	FLOORING- 4TH FLOOR OR	20 days	Fri 2/25/11	Thu 3/24/11
132	PAINT 2ND COAT- 4TH FLOOR OR	20 days	Fri 2/25/11	Thu 3/24/11
133	PLUMBING FIXTURES- 4TH FLOOR OR	20 days	Fri 3/11/11	Thu 4/7/11
134	DOORS & HARDWARE- 4TH FLOOR OR	10 days	Fri 4/22/11	Thu 5/5/11
135	FINAL PAINT- 4TH FLOOR OR	10 days	Fri 5/6/11	Thu 5/19/11
136	DROP CEILING- 4TH FLOOR OR	11 days	Fri 5/20/11	Fri 6/3/11
137	TEST & BALANCE- 4TH FLOOR OR	10 days	Tue 7/12/11	Mon 7/25/11
138	MEDICAL SURGEREY- 6TH FLOOR	361 days	Wed 4/28/10	Wed 9/14/11
139	LAYOUT/TOP TRACK- 6TH FLOOR MED SURGE	7 days	Wed 4/28/10	Thu 5/6/10
140	INSTALL DUCTWORK- 6TH FLOOR MED SURGE	21 days	Fri 8/13/10	Fri 9/10/10
141	MEP OVERHEAD/MED GAS-6TH FLOOR MED SURGE	31 days	Fri 8/27/10	Fri 10/8/10
142	METAL STUDS & DOOR FRAMES- 6TH FLOOR MED SURGE	20 days	Wed 10/13/10	Tue 11/9/10
143	INSTALL PANEL BACK BOXES- 6TH FLOOR MED SURGE	21 days	Wed 11/10/10	Wed 12/8/10
144	ELECTRICAL ROUGH IN- 6TH FLOOR MED SURGE	37 days	Wed 11/10/10	Thu 12/30/10
145	PLUMBING ROUGH IN- 6TH FLOOR MED SURGE	37 days	Wed 11/10/10	Thu 12/30/10
146	MED GAS ROUGH IN- 6TH FLOOR MED SURGE	37 days	Wed 11/10/10	Thu 12/30/10
147	DRYWALL- 6TH FLOOR MED SURGE	20 days	Mon 1/10/11	Fri 2/4/11
148	PRIME PAINT- 6TH FLOOR MED SURGE	15 days	Mon 2/21/11	Fri 3/11/11
149	CEILING GRID- 6TH FLOOR MED SURGE	20 days	Mon 2/21/11	Fri 3/18/11
150	CASEWORK- 6TH FLOOR MED SURGE	20 days	Mon 3/7/11	Fri 4/1/11
151	FLOORING- 6TH FLOOR MED SURGE	20 days	Mon 3/21/11	Fri 4/15/11
152	PAINT 2ND COAT- 6TH FLOOR MED SURGE	20 days	Mon 4/4/11	Fri 4/29/11
153	PLUMBING FIXTURES- 6TH FLOOR MED SURGE	20 days	Mon 4/18/11	Fri 5/13/11
154	DOORS & HARDWARE- 6TH FLOOR MED SURGE	10 days	Tue 5/31/11	Mon 6/13/11
155	CARPET- 6TH FLOOR MED SURGE	10 days	Tue 6/14/11	Mon 6/27/11
156	FINAL PAINT- 6TH FLOOR MED SURGE	11 days	Tue 6/28/11	Tue 7/12/11
157	DROP CEILING- 6TH FLOOR MED SURGE	10 days	Wed 7/13/11	Tue 7/26/11
158	TEST & BALANCE- 6TH FLOOR MED SURGE	11 days	Wed 8/31/11	Wed 9/14/11
159	TELEMETRY-6TH FLOOR	405 days	Wed 4/28/10	Tue 11/15/11
160	LAYOUT/TOP TRACK- 6TH FLOOR TELEMETRY	82 days	Wed 4/28/10	Thu 8/19/10
161	INSTALL DUCTWORK- 6TH FLOOR TELEMETRY	21 days	Fri 8/27/10	Fri 9/24/10
162	MEP OVERHEAD/MED GAS-6TH FLOOR TELEMETRY	30 days	Mon 9/13/10	Fri 10/22/10
163	METAL STUDS & DOOR FRAMES- 6TH FLOOR TELEMETRY	20 days	Wed 10/27/10	Tue 11/23/10



Project: PATIENT TOWER EXPANSION
Date: 4/7/2011



ADAM LASHER CONSTRUCTION MANAGEMENT

ID	Task Name	Duration	Start	Finish
164	INSTALL PANEL BACK BOXES- 6TH FLOOR TELEMETRY	21 days	Wed 11/24/10	Wed 12/22/10
165	ELECTRICAL ROUGH IN- 6TH FLOOR TELEMETRY	38 days	Wed 11/24/10	Fri 1/14/11
166	PLUMBING ROUGH IN- 6TH FLOOR TELEMETRY	38 days	Wed 11/24/10	Fri 1/14/11
167	MED GAS ROUGH IN- 6TH FLOOR TELEMETRY	38 days	Wed 11/24/10	Fri 1/14/11
168	DRYWALL- 6TH FLOOR TELEMETRY	20 days	Mon 1/24/11	Fri 2/18/11
169	PRIME PAINT- 6TH FLOOR TELEMETRY	15 days	Mon 3/7/11	Fri 3/25/11
170	CEILING GRID- 6TH FLOOR TELEMETRY	20 days	Mon 3/7/11	Fri 4/1/11
171	CASEWORK- 6TH FLOOR TELEMETRY	20 days	Mon 3/21/11	Fri 4/15/11
172	FLOORING- 6TH FLOOR TELEMETRY	20 days	Mon 4/4/11	Fri 4/29/11
173	PAINT 2ND COAT- 6TH FLOOR TELEMETRY	20 days	Mon 4/18/11	Fri 5/13/11
174	PLUMBING FIXTURES- 6TH FLOOR TELEMETRY	20 days	Mon 5/2/11	Fri 5/27/11
175	DOORS & HARDWARE- 6TH FLOOR TELEMETRY	10 days	Tue 6/14/11	Mon 6/27/11
176	CARPET- 6TH FLOOR TELEMETRY	11 days	Tue 6/28/11	Tue 7/12/11
177	FINAL PAINT- 6TH FLOOR TELEMETRY	10 days	Wed 7/13/11	Tue 7/26/11
178	DROP CEILING- 6TH FLOOR TELEMETRY	10 days	Wed 7/27/11	Tue 8/9/11
179	TEST & BALANCE- 6TH FLOOR TELEMETRY	10 days	Thu 9/15/11	Wed 9/28/11
180	LOBBY-1ST FLOOR	287 days	Fri 8/27/10	Mon 10/3/11
181	LAYOUT/TOP TRACK- LOBBY	5 days	Fri 8/27/10	Thu 9/2/10
182	INSTALL DUCTWORK- LOBBY	16 days	Fri 9/3/10	Fri 9/24/10
183	MEP OVERHEAD- LOBBY	20 days	Mon 9/20/10	Fri 10/15/10
184	METAL STUDS & DOOR FRAMES- LOBBY	21 days	Wed 11/17/10	Wed 12/15/10
185	ELECTRICAL ROUGH IN- LOBBY	22 days	Thu 12/16/10	Fri 1/14/11
186	PLUMBING ROUGH IN- LOBBY	22 days	Thu 12/16/10	Fri 1/14/11
187	DRYWALL- LOBBY	15 days	Mon 1/24/11	Fri 2/11/11
188	INTERIOR GLAZING- LOBBY	5 days	Mon 2/14/11	Fri 2/18/11
189	TERRAZZO- LOBBY	18 days	Mon 3/7/11	Wed 3/30/11
190	PRIME PAINT- LOBBY	15 days	Thu 3/31/11	Wed 4/20/11
191	CEILING GRID- LOBBY	15 days	Thu 3/31/11	Wed 4/20/11
192	FLOORING- LOBBY	20 days	Thu 4/28/11	Wed 5/25/11
193	DOORS & HARDWARE- LOBBY	11 days	Fri 6/24/11	Fri 7/8/11
194	CARPET- 1ST FLOOR LOBBY	5 days	Mon 7/11/11	Fri 7/15/11
195	FINAL PAINT- 1ST FLOOR LOBBY	10 days	Mon 7/18/11	Fri 7/29/11
196	DROP CEILING TILE- 1ST FLOOR LOBBY	10 days	Mon 8/1/11	Fri 8/12/11
197	TEST & BALANCE- 1ST FLOOR LOBBY	10 days	Tue 9/20/11	Mon 10/3/11
198	COMMISSIONING	67 days	Thu 9/1/11	Fri 12/2/11
199	CORE EXPANSION COMPLETE	0 days	Fri 2/17/12	Fri 2/17/12
200	DOH/OCCUPANCY	20 days	Mon 2/20/12	Fri 3/16/12

Project: PATIENT TOWER EXPANSION
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Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

APPENDIX C: GENERAL CONDITIONS ESTIMATE

SUPERVISION & PERSONNEL				
LINE ITEM	UNIT RATE	UNIT	QUANTITY	COST
VICE PRESIDENT	$3,632.36	WEEK	120	$435,883.00
PROJECT EXECUTIVE	$1,164.13	WEEK	125	$145,516.00
SENIOR PROJECT MANAGER	$4,904.71	WEEK	135	$662,136.00
PROJECT MANAGER	$2,815.26	WEEK	152	$427,919.00
PROJECT MANAGER	$2,251.22	WEEK	152	$342,186.00
ASSISTANT PROJECT MANAGER	$2,135.68	WEEK	152	$324,624.00
SENIOR SUPERINTENDENT	$4,811.42	WEEK	152	$731,336.00
SUPERINTENDENT	$4,176.44	WEEK	152	$634,819.00
SAFTEY MANAGER	$2,597.68	WEEK	152	$394,848.00
MEP/BIM COORDINATOR	$2,951.13	WEEK	110	$324,624.00
PROJECT SCHEDULER	$627.79	WEEK	95	$59,640.00
ADMINISTRATIVE ASSISTANT	$1,763.82	WEEK	152	$268,101.00
			TOTAL	$4,751,632.00

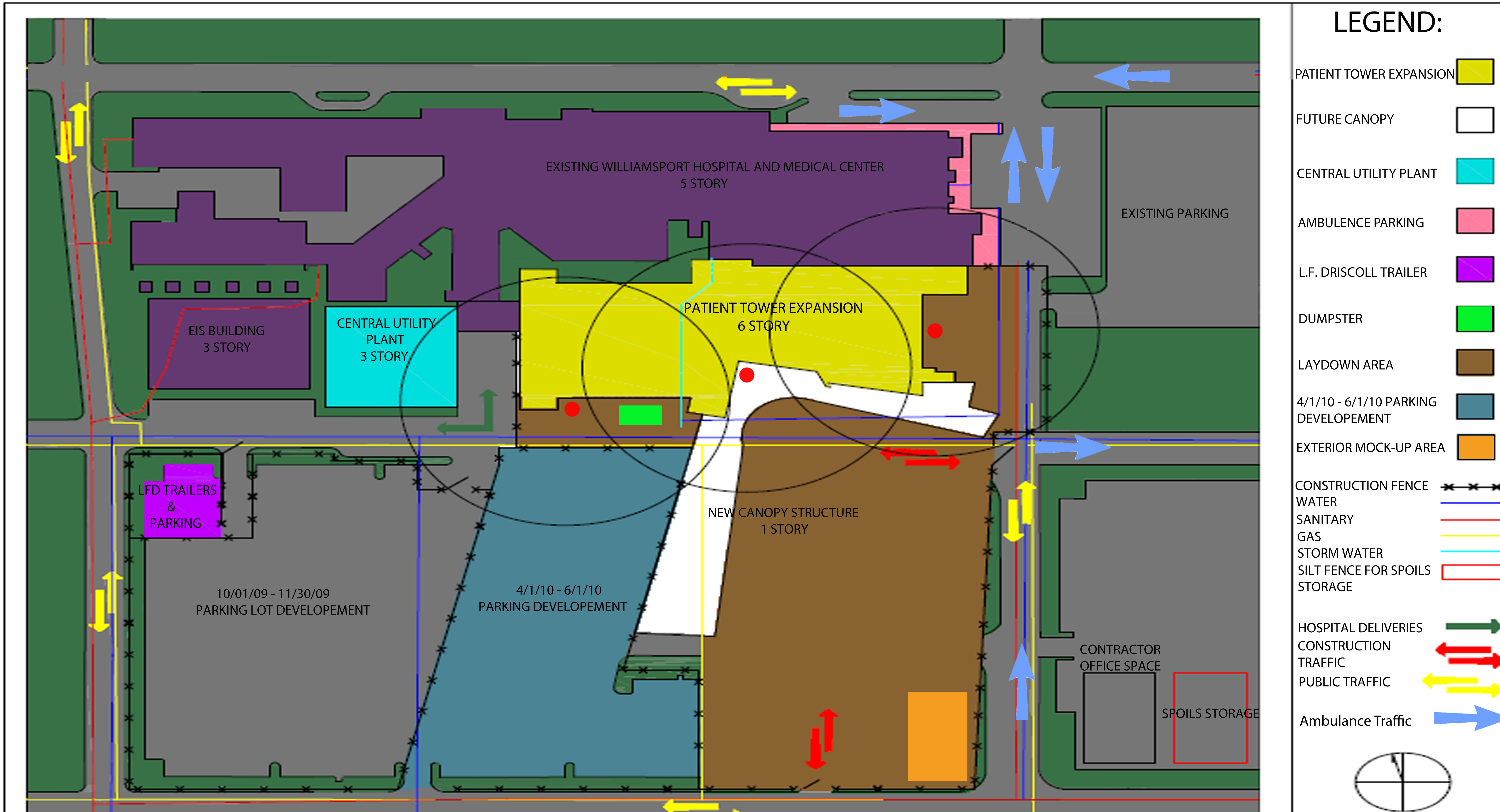
CONSTRUCTION FACILITIES & EQUIPMENT				
LINE ITEM	UNIT RATE	UNIT	QUANTITY	COST
TRAILER/OFFICE RENTAL	$2,800.00	MONTH	35	$98,000.00
TEMPORARY SHANTY/STORAGE	$14,800.00	LS	1	$14,800.00
SINAGE	$7,550.00	LS	1	$7,550.00
TEMPORARY FIRE EXTINGUISHERS	$200.00	MONTH	18.5	$3,700.00
TOOLS	$686.00	MONTH	26.5	$17,982.00
FIELD XEROX MACHINE	$2,400.00	MONTH	18.5	$44,400.00
DUMPSTERS & FINAL CLEANING	$425.00	EA	230	$97,750.00
SILT FENCE	$205.71	MONTH	35	$7,200.00
CONSTRUCTION SITE FENCE	$1,285.71	MONTH	35	$45,000.00
JERSEY BARRIERS WITH FENCE	$357.14	MONTH	35	$12,500.00
SAFETY SUPPLIES	$7,350.00	LS	1	$7,350.00
RADIOS	$114.29	MONTH	35	$4,000.00
			TOTAL	$360,232.00

TEMPORARY UTILITIES				
LINE ITEM	UNIT RATE	UNIT	QUANTITY	COST
DRINKING WATER	$264.29	MONTH	35	$9,250.00
ELECTRICAL	$2,158.00	MONTH	35	$75,530.00
TEMPORARY WATER	$158.57	MONTH	35	$5,550.00
TELEPHONE SERVICE	$951.43	MONTH	35	$33,300.00
TEMPORARY TOILETS	$1,277.14	MONTH	35	$44,700.00
SECURITY SYSTEM	$105.71	MONTH	35	$3,700.00
FIELD IT SET-UP	$1,666.67	WEEK	3	$5,000.00
			TOTAL	$177,030.00

MISCELLANEOUS COSTS				
LINE ITEM	UNIT RATE	UNIT	QUANTITY	COST
ICRA PROTECTION	$11,208.00	MONTH	35	$392,280.00
PERMITS	$734.29	MONTH	35	$25,700.00
TRAVEL EXPENSES	$3,839.54	MONTH	35	$134,384.00
MISC. FIELD EXPENSES	$229.34	MONTH	35	$8,027.00
WINTER PROTECTION	$13,333.33	MONTH	15	$200,000.00
BLUEPRINTING	$3,571.03	MONTH	35	$124,986.00
PROGRESS PHOTOS	$628.57	MONTH	35	$22,000.00
DELIVERY/SHIPPING EXPENSES	$350.00	MONTH	35	$12,250.00
INSURANCE	$13,991.34	MONTH	35	$489,697.00
			TOTAL	$1,409,324.00

GENERAL CONDITIONS SUMMARY				
SUPERVISION & PERSONNEL	$135,760.91	MONTH	35	$4,751,632.00
CONSTRUCTION FACILITIES & EQUIPMENT	$10,178.06	MONTH	35	$356,232.00
TEMPORARY UTILITIES	$5,058.00	MONTH	35	$177,030.00
MISCELLANEOUS COSTS	$40,266.40	MONTH	35	$1,409,324.00
	$191,263.37		TOTAL	$6,694,218.00

APPENDIX D: SITE LOGISTICS



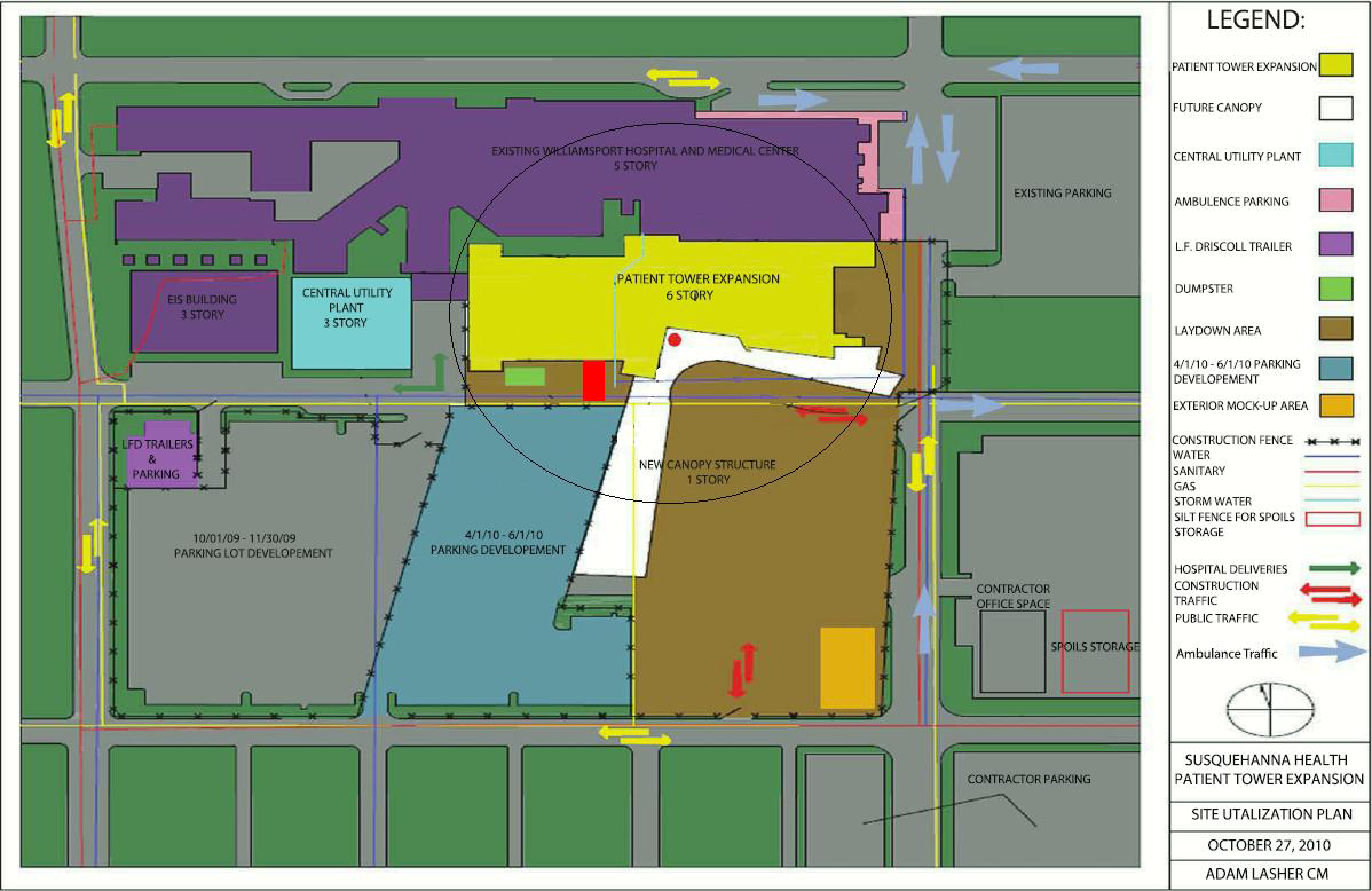
SUSQUEHANNA HEALTH
PATIENT TOWER EXPANSION

SITE UTALIZATION PLAN

OCTOBER 27, 2010

ADAM LASHER CM

APPENDIX E: TOWER CRANE SITE LOGISTICS



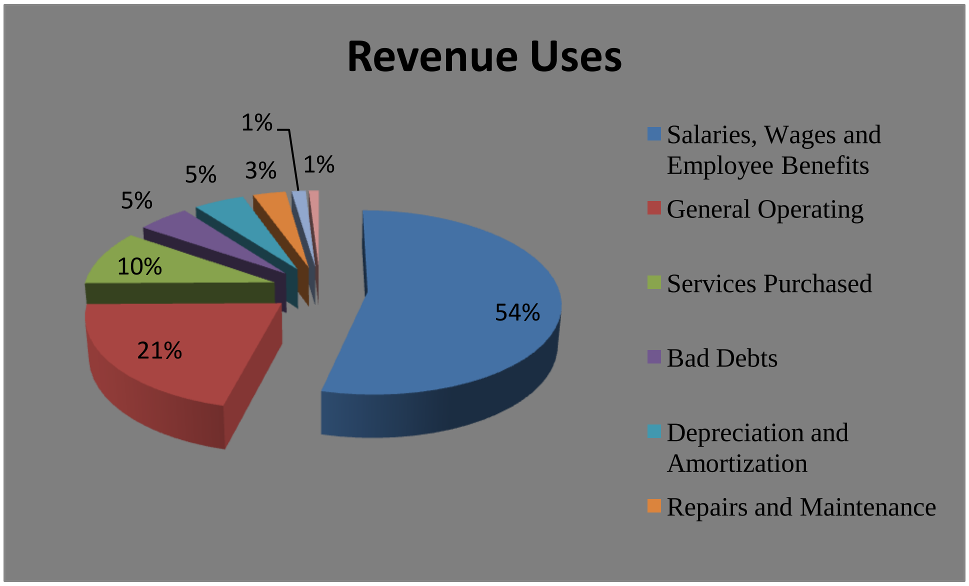
EXISTING WILLIAMSPORT HOSPITAL AND MEDICAL CENTER
5 STORY
EXISTING PARKING
PATIENT TOWER EXPANSION
6 STORY
EIS BUILDING
3 STORY
CENTRAL UTILITY
PLANT
3 STORY
LFD TRAILERS
&
PARKING
NEW CANOPY STRUCTURE
1 STORY
10/01/09 - 11/30/09
PARKING LOT DEVELOPEMENT
4/1/10 - 6/1/10
PARKING DEVELOPEMENT
CONTRACTOR
OFFICE SPACE
SPOILS STORAGE
CONTRACTOR PARKING
LEGEND:
PATIENT TOWER EXPANSION
FUTURE CANOPY
CENTRAL UTILITY PLANT
AMBULENCE PARKING
L.F. DRISCOLL TRAILER
DUMPSTER
LAYDOWN AREA
4/1/10 - 6/1/10 PARKING
DEVELOPEMENT
EXTERIOR MOCK-UP AREA
CONSTRUCTION FENCE
WATER
SANITARY
GAS
STORM WATER
SILT FENCE FOR SPOILS
STORAGE
HOSPITAL DELIVERIES
CONSTRUCTION
TRAFFIC
PUBLIC TRAFFIC
Ambulance Traffic
SUSQUEHANNA HEALTH
PATIENT TOWER EXPANSION
SITE UTALIZATION PLAN
OCTOBER 27, 2010
ADAM LASHER CM

APPENDIX F: QUANTITY TAKE OFFS FOR PREFABRICATED UNITS

Prefabricated Unit	Material To Be Installed	Quantity	
Headwall		15 LF	
Structural	Non-Rated	8 ½" Thick	
	3 5/8" Metal Studs	30 LF	
Utilities		Number of Outlets	Diameter
	Oxygen	1	¾"
	Med Gas	1	¾"
	Vaccume	1	½"
	Nurse Call	1	-
	Emergency Outlet	4	-
	Code Blue	1	-
	Tele Data	3	-
	Electrical Outlet	5	-
Footwall			
Structural		12.5 LF	
	Non-Rated	4 7/8" Thick	
	3 5/8" Metal Studs	12.5 LF	
Utilites		Number of Outlets	Diameter
	HWS	1	½"
	CWS	1	½"
	Drainage	1	¾"
	Cable TV Outlet	1	-
	Tele Data	2	-
	Electrical Outlet	3	-
	Light Switch	1	-
Bathroom			
Structural		25 LF	
	Non-Rated	4 7/8" Thick	
	3 5/8" Metal Studs	25 LF	
Utilities		Number of Outlets	Diameter
	HWS	1	½"
	CWS	1	½"
	Drainage	1	4"
	HWS	1	2"
	CWS	1	2"
	Drainage	1	2 ½"
	Nurse Call	1	-
	Electrical Outlet	1	-
	Emergencty Ground Fault Interrupter	1	-

APPENDIX G: PATIENT TOWER EXPANSION PROJECTED INCOME EVALUATION

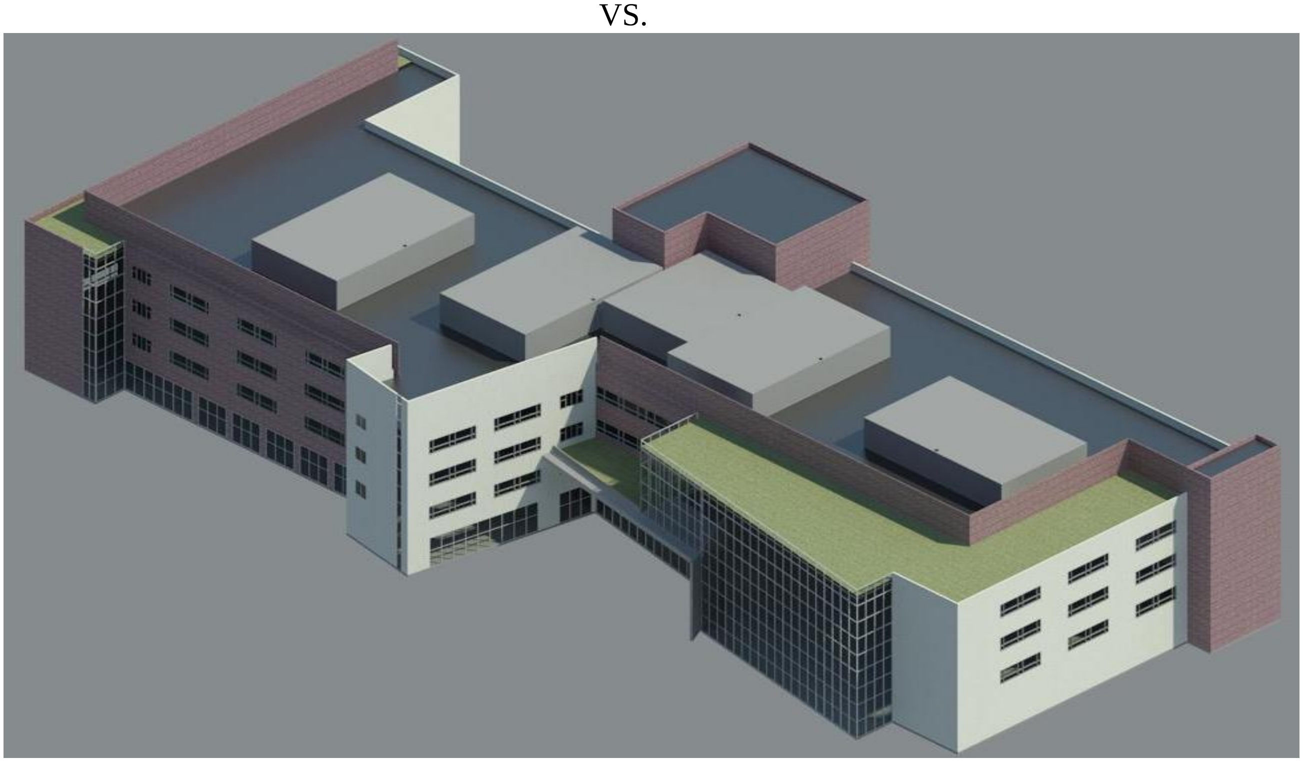
Revenue	Fiscal Year 2010
Net Patient Service Revenue	$118,762,530
Other Revenues	$6,444,969
Total Revenue	$125,207,500
Operating Expenses	
Salaries, Wages and Employee Benefits	$63,636,937
General Operating	$24,730,165
Services Purchased	$11,498,909
Bad Debts	$5,939,009
Depreciation and Amortization	$5,776,055
Repairs and Maintenance	$3,744,312
Insurance and Taxes	$1,611,855
Interest	$1,125,363
Total Expenses	$118,062,605
Yearly Total Net Revenue	$7,144,894
Monthly Total Net Revenue	$595,408
Predicted Monthly Net Revenue For Patient Tower Expansion (Based On 2010 Fiscal Year)	$198,469



APPENDIX H: PRELIMINARY DESIGN VS. CURRENT DESIGN

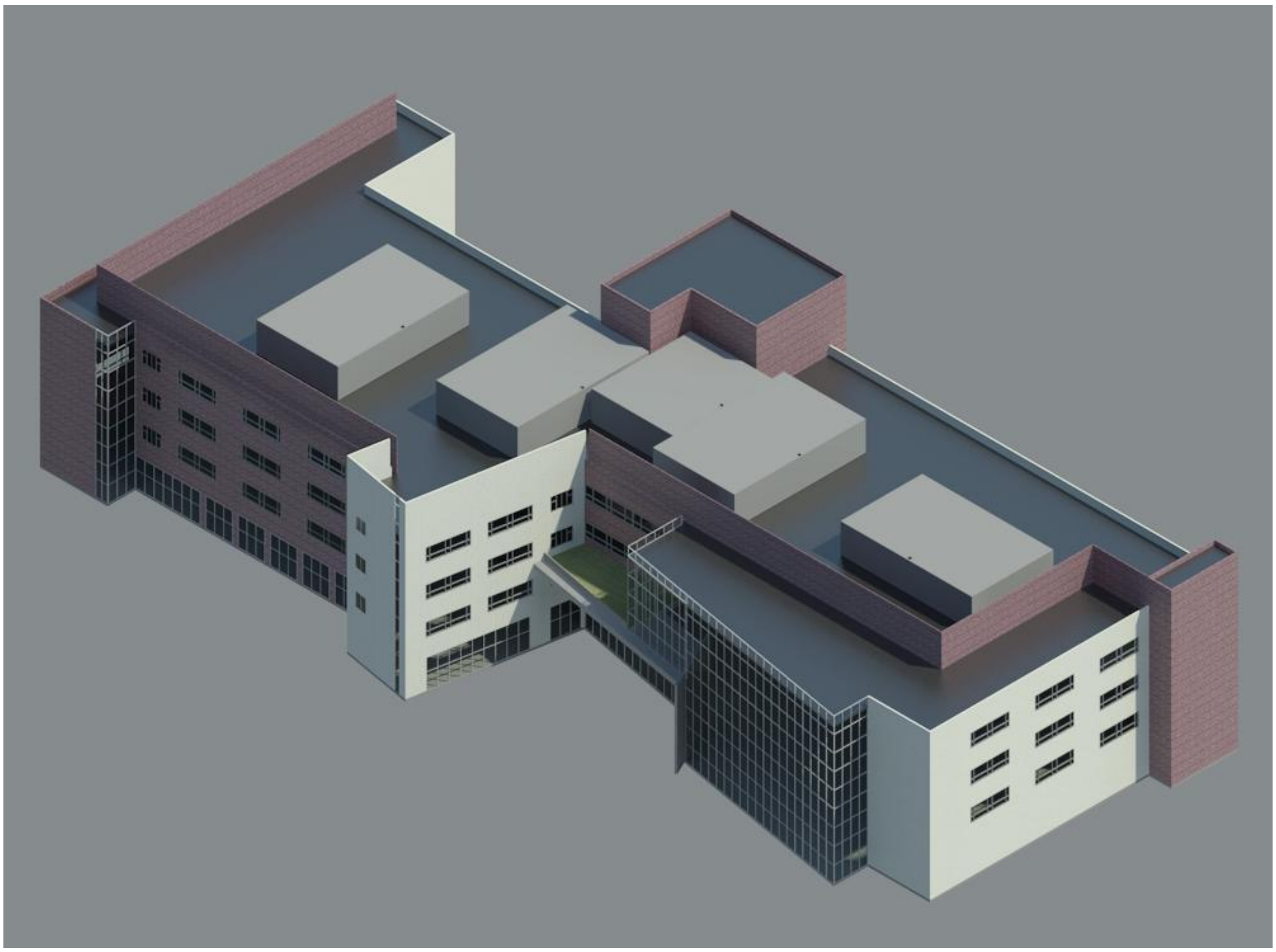
Second Preliminary Design
Figure Provided By L.F. Driscoll

VS.

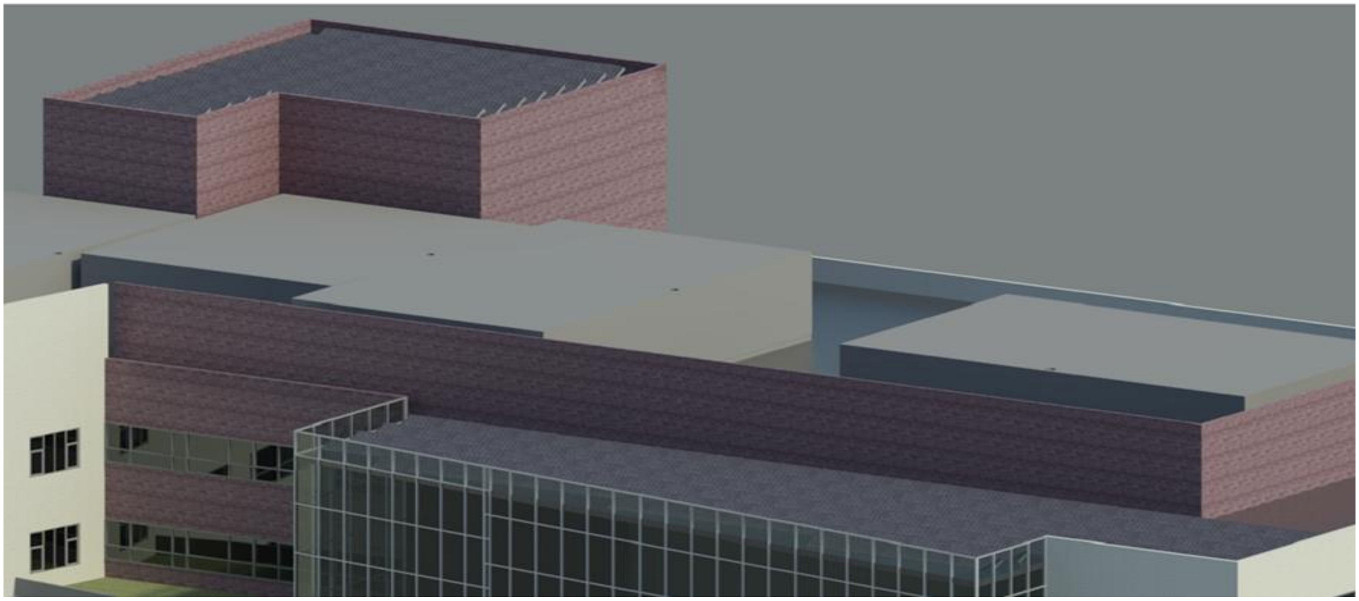


Current Design

APPENDIX I: REDESIGN EPDM ROOFING WITH CENTER GREEN ROOF



APPENDIX J: REDESIGN EPDM WITH PHOTOVOLTAIC PANELS



APPENDIX K: VOLTAGE DROP CALCULATIONS AND WIRE SIZEING

$L = 160'$

$V = 26.4\ V$

$I = 7.95$

Assume
$\frac{3}{4}$" PVC Conduit

Try #6

$$VD = \frac{2LRI}{1000'} = \frac{2(160)(0.167)(.49)(7.95)}{1000} =$$

$$VD = 0.208$$

$$\%VD = \frac{0.208}{26.4}$$

Try 4/0

$$VD = \frac{2LRI}{1000} = \frac{2(160)(0.135)(.203)(7.95)}{1000}$$

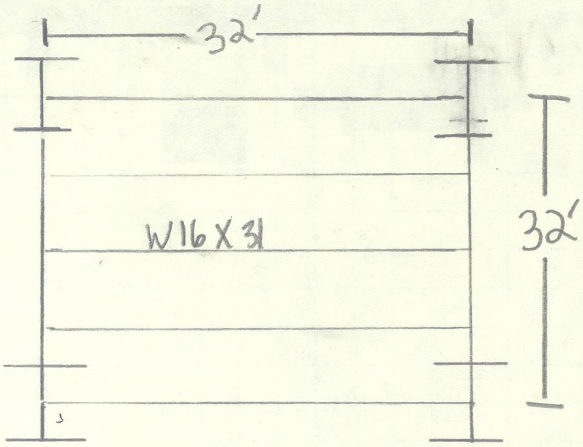
$$VD = 0.0697$$

$$\%VD = \frac{.0697}{\cancel{26.4}} = 2.6 < 3\% \checkmark$$

$$= \boxed{\text{Use } 4/0}$$

APPENDIX L: STRUCTURAL IMPACTS

Typical Bay



3 VL 120

DL = 75 psf MISC DL = 10
LL = 95 psf Sat. Green Roof
SDL = 9 psf
$7\frac{1}{2}$ N.W. Concrete

* Original Design
↳ W16X31

$T_{DL} = 85$ psf

Total Load = 85 psf + 95 psf = 180 psf

Max Spacing = 8'10"
↳ Use 8' Spacing

180 psf < 286 psf ✓

$L = 95(.25 + \frac{15}{\sqrt{2(32)(8)}}$

$= 86.7$ psf

$W_u = 1.2(75 + 10 + 7) + 1.2(86.7)$
$= 110.4 + 104.4$ psf
$= 214.44$ psf

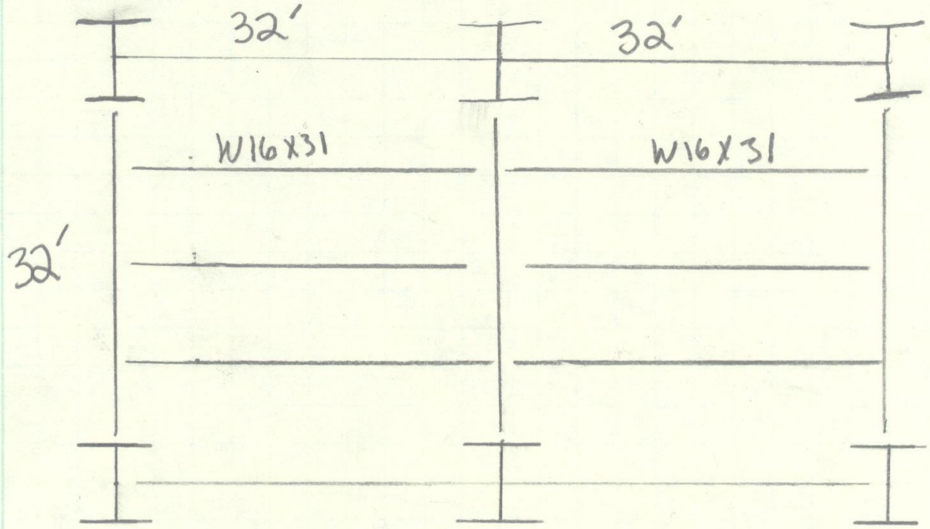
$w_u = 214.44 \text{ psf } (8)/1000$
$= 1.72$ plf

$M_u = 1.72(32)^2/4\text{psf} = 195.70$ ft·K

$V_u = 1.72(32)/2 = 27.52$ K

W16X31
↳ $\phi M_n = 203$ kip·ft > 195.70 ft·K
$\phi V_n = 131 > 27.5$ K

* Beams Cannot be Reduced



$$L = 45\left(.25 + \frac{15}{\sqrt{2(32)(32)}}\right)$$

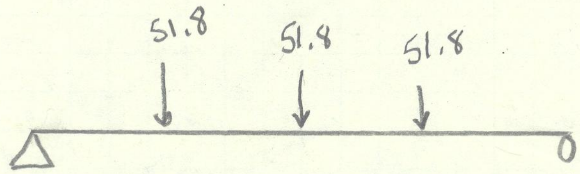
$L = 52.24$ psf

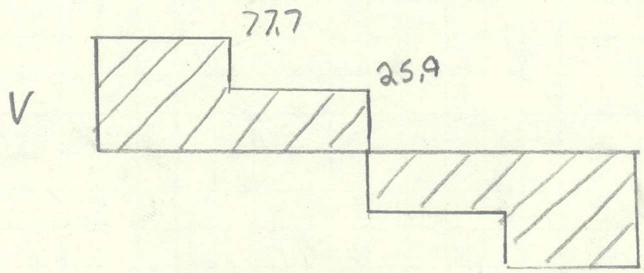
Girder

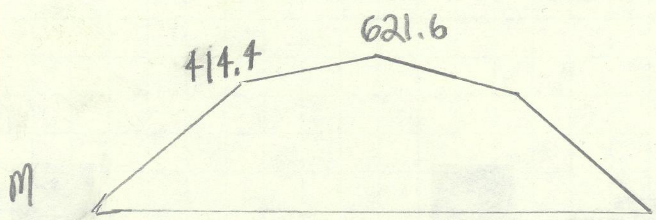
$w_u = 1.2(75\text{ psf} + 10\text{ psf} + 7\text{ psf} + 3) + 1.6(55.24\text{ psf})$

$= 202.4$ psf

$P_u = 202.4(8)(32)/1000 = 51.8$ K







$M_u = 621.6$ ft·K

W24X68

↳ $\phi M_n = 664 > 621.6$ ft·K ✓

$\phi V_n = 294 > 77$ Kips ✓

*Girders can be reduced

APPENDIX L: SOLAR PANEL CUTSHEETS

STP200 -18/Ud
STP210 - 18/Ud
STP190 - 18/Ud

Solar powering a green future™

210 Watt Maximum Power
POLY-CRYSTALLINE SOLAR PANEL

Features

- High conversion efficiency based on leading innovative photovoltaic technologies
- High reliability with guaranteed +/-3% power output tolerance, ensuring return on investment
- Attractive appearance
- Withstands high wind-pressure and snow load, and extreme temperature variations
- Easy to install

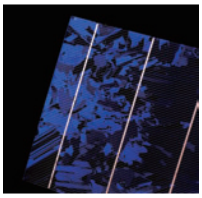
Quality and Safety

- 25-year power output transferable warranty with PICC insurance
- Rigorous quality control meeting the highest international standards
- ISO 9001:2000 (Quality Management System) and ISO 14001:2004 (Environmental Management System) certified factories manufacturing world class products
- IEC61215, Safety tested IEC61730, conformity to CE, UL listings: UL1703, cULus, Class C fire rating

Recommended Applications

- On-grid utility systems
- On-grid commercial systems
- Off-grid ground mounted systems

certifications in progress

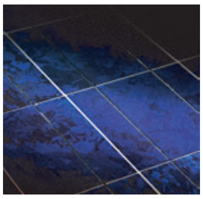


Suntech's technology yields improvements to BSF structure and anti-reflective coating to increase conversion efficiency

Thermal isolation between the lamination and an advanced specially designed J-box delivers improved performance stability. It also provides complete interconnection between modules and inverters ensuring that the efficiency of the modules can be fully utilized.

Suntech was named Frost and Sullivan's 2008 Solar Energy Development Company of the Year

Unique design on drainage holes and rigid construction prevents frame from deforming or breaking due to freezing weather and other forces



The panel provides more field power output through an advanced cell texturing and isolation process, which improves low irradiance performance

STP-DS-STD-N01.01 Rev 2008

SUNTECH

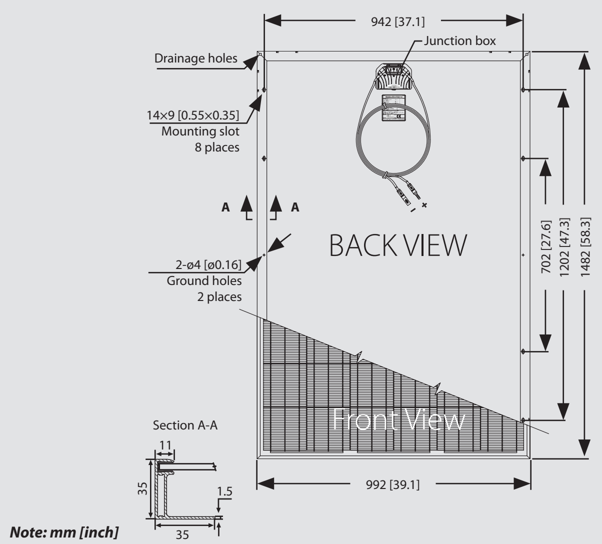
Solar powering a green future™

STP200 - 18/Ud
STP210 - 18/Ud
STP190 - 18/Ud

Electrical Characteristics

Characteristics	STP210-18/Ud	STP200-18/Ud	STP190-18/Ud
Open - Circuit Voltage (Voc)	33.6V	33.4V	33V
Optimum Operating Voltage (Vmp)	26.4V	26.2V	26V
Short - Circuit Current (Isc)	8.33A	8.12A	7.89A
Optimum Operating Current (Imp)	7.95A	7.63A	7.31A
Maximum Power at STC (Pmax)	210Wp	200Wp	190Wp
Operating Temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Maximum System Voltage	1000V DC	1000V DC	1000V DC
Maximum Series Fuse Rating	20A	20A	20A
Power Tolerance	±3 %	±3 %	±3 %

STC: Irradiance 1000W/m², Module temperature 25ºC, AM=1.5



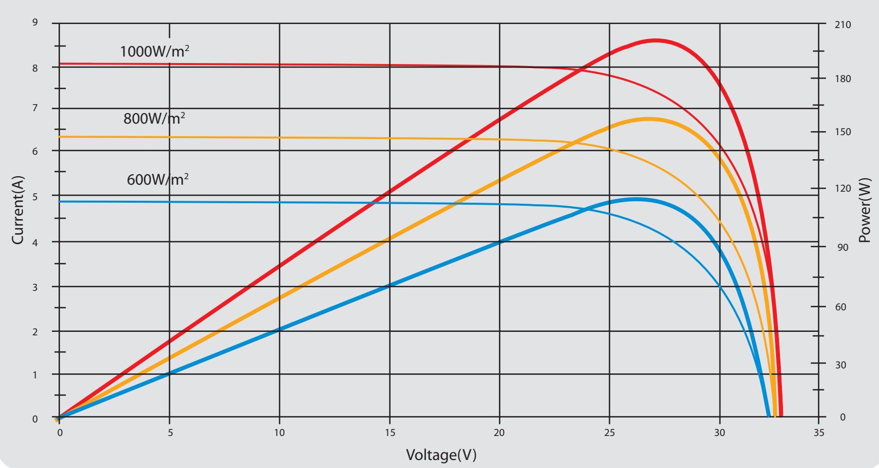
Mechanical Characteristics

Solar Cell	Poly-crystalline 156×156mm (6inch)
No. of Cells	54 (6×9)
Dimensions	1482×992×35mm (58.3×39.1×1.4inch)
Weight	16.8kg (37.0lbs.)
Front Glass	3.2 mm (0.13inch) tempered glass
Frame	Anodized aluminium alloy
Junction Box	IP67 rated
Output Cables	RADOX® SMART cable 4.0mm² (0.006inch²), symmetrical lengths (-) 1000mm (39.4inch) and (+) 1000mm (39.4inch), RADOX® SOLAR integrated twist locking connectors

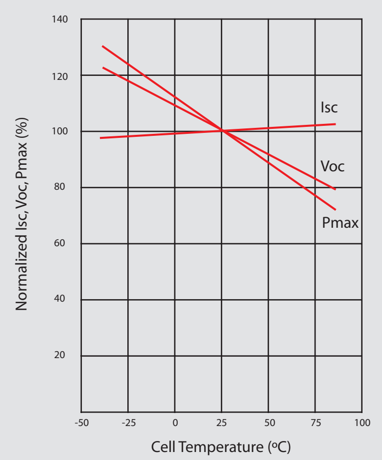
Temperature Coefficients

Nominal Operating Cell Temperature **(NOCT)**	45±2°C
Temperature Coefficient of Pmax	-(0.47 ± 0.05) %/°C
Temperature Coefficient of Voc	-(0.34 ± 0.01) %/°C
Temperature Coefficient of Isc	(0.055 ± 0.01) %/°C

Current-Voltage & Power-Voltage Curve (200W)



Temperature Dependence of Isc, Voc, Pmax



- 10 year standard warranty
- Prewired at factory for 3-phase utility interconnection
- Integrated load-break rated lockable AC/DC disconnect switch
- Internet-ready with Sunny WebBox
- Improved CEC efficiency
- Integrated fused series string combiner
- Sealed electronics enclosure & Opticool™
- Ideal for commercial applications
- Rugged stainless steel outdoor-rated enclosure
- UL 1741/IEEE-1547 compliant

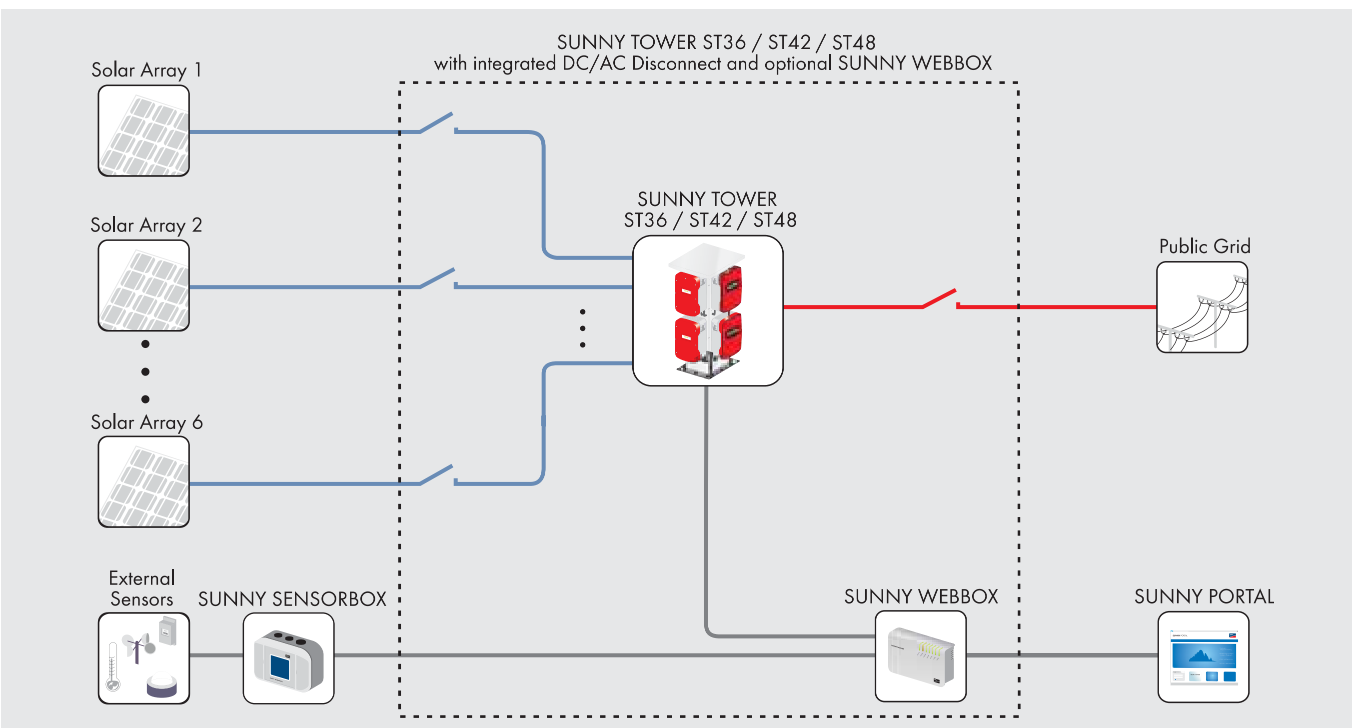
SUNNY TOWER 36 / 42 / 48

The flexible solution for commercial PV systems

SMA brings you the best in commercial inverter solutions: the Sunny Tower. Designed with the installer in mind, we've combined ease of installation, lowest specific cost ($/watt), and the highest efficiency to maximize rebates and power production while minimizing your payback period. The Sunny Tower combines all the advantages of string inverters with the installation advantages of central inverters. The Sunny Tower offers you the flexibility and reliability you've come to expect from SMA.

Technical Data

	Sunny Tower with 6 Sunny Boy 6000US	Sunny Tower with 6 Sunny Boy 7000US	Sunny Tower with 6 Sunny Boy 8000US
Recommended Maximum PV Power (Module STC)	45.0 kW	52.5 kW	60 kW
DC Maximum Voltage	600 V	600 V	600 V
Peak Power Tracking Voltage	250 – 480 V	250 – 480 V	300 – 480 V
DC Maximum Input Current	150 A	180 A	180 A
Number of Fused String Inputs	24 x 15 A (AC / DC disconnect)	24 x 15 A (AC / DC disconnect)	24 x 15 A (AC / DC disconnect)
PV Start Voltage (Adjustable)	300 V	300 V	365 V
AC Nominal Power / Maximum Power*	36.0 kW / 36.0 kW	42.0 kW / 42.0 kW	48.0 kW/ 48.0 kW
AC Maximum Output Current (3-Phase Only) (per phase @ 208 V, 240 V, 277 V)	100 A, 87 A, 44 A	117 A, 101 A, 51 A	N/A, 116 A, 58 A
AC Nominal Voltage Range (3-Phase Only)	187 – 229 V @ 208 V Delta or WYE 211 – 264 V @ 240 V Delta 244 – 305 V @ 277 V WYE	187 – 229 V @ 208 V Delta or WYE 211 – 264 V @ 240 V Delta 244 – 305 V @ 277 V WYE	N/A @ 208 V 211 – 264 V @ 240 V Delta 244 – 305 V @ 277 V WYE
AC Frequency: nominal / range	60 Hz / 59.3 – 60.5 Hz	60 Hz / 59.3 – 60.5 Hz	60 Hz / 59.3 – 60.5 Hz
Power Factor (Nominal)	0.99	0.99	0.99
Peak Inverter Efficiency	97.0%	97.1%	96.5%
CEC Weighted Efficiency	95.5% @ 208 V, 240 V 96.0% @ 277 V	95.5% @ 208 V 96.0% @ 240 V, 277 V	N/A @ 208 V 96.0% @ 240 V, 277 V
Dimensions: W / H / D in inches	43.3 / 70.5 / 39	43.3 / 70.5 / 39	43.3 / 70.5 / 39
Weight: Tower / 6 Inverters / Total Shipping	330 lbs / 846 lbs / 1388 lbs	330 lbs / 846 lbs / 1388 lbs	330 lbs / 888 lbs / 1430 lbs
Ambient Temperature Range	−13 to 113 °F	−13 to 113 °F	−13 to 113 °F
Power consumption at night	0.6 W	0.6 W	0.6 W
Topology	LF transformer	LF transformer	LF transformer
Cooling Concept	OptiCool™, forced active cooling	OptiCool™, forced active cooling	OptiCool™, forced active cooling
Mounting Location: indoor / outdoor (NEMA 3R)	●/●	●/●	●/●
LCD Display	●	●	●
Communication: RS485 / wireless	❍/❍	❍/❍	❍/❍
Warranty: 10-year	●	●	●
Compliance: IEEE-929, IEEE-1547, UL 1741, UL 1998, FCC Part 15 A & B	●	●	●
NOTE: US inverters ship with gray lids.			
● Standard ❍ Optional			
Data at nominal conditions			
*ST48 is current limited to 46kW @ 240 V			
Type Designation	ST36	ST42	ST48



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