Mercy Medical Center
Replacement Clinical Tower
Baltimore, Maryland

Nicole C Jenkins
Construction Management

Dr. David Riley
April 9, 2008
Final report

Mercy

In care of the sick, great tenderness above all things.
- Catherine McAuley, Founder, Sisters of Mercy

Replacement Clinical Tower
Baltimore, Maryland

Project Team

Owner: Mercy Health Services
Contractor: Whiting-Turner Contracting company
Construction Administration :Ellerbe Becket
Architect: Ellerbe Becket
MEP: Ellerbe Becket
Structural Engineer: Ellerbe Becket

Architecture

- The building will be precast with a brick veneer and a glass curtain wall.
- The design is a modern take on the previously built facilities.
- The hospital will utilize 2 bridge connections for patient and visitor access.

Structural

- Slab On Grade will be 6″ thick with waterproofing, over a 2″ mud slab: Underneath will be welded wire fabric placed on top of a 6″ layer of crushed stone, and a 10 mil thick vapor barrier.
- Foundation is to be drilled shaft, with an allowable bearing capacity of130 ksf.

Mechanical

- Chilled water system and steam system to be installed
- Chilled water will be purchased from Comfort Link
- 23 Ahu's will be used for the hospital, located in two mechanical rooms.

Building Information

- Building Name: Mercy Health Services
- Location: Baltimore, Maryland
- Size: 681,265 sq. ft
- Construction Dates: May 2007-Dec.2010
- Cost: 219,812,043
- Delivery: GMP/cost plus fee

Electrical /Lighting

- 480/277V three phase system
- The System will be used to feed new Tower as well as the mechanical loads and building loads.
- Exterior and interior lighting will be energy saving 3000kelvin T5 and T5HO compact fluorescent.
- Exterior lighting will be controlled by astronomic time clocks 365 days a year.

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http://www.engr.psu.edu/ae/thesis/portfolios/2008/ncj109

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Executive Summary

The Mercy medical Center has been analyzed to establish means for potential value engineering, schedule reduction and alternative building options. In this proposal four areas of research will be discussed, along with their relation with the analysis topics.

The critical research topic analyzed is the role of women in the construction industry. The research pertained to determining why there are so few women in the construction industry, and ways to create interest in the construction industry. Through the use of a survey, a better perspective on the industry was be established.. The solution established was to provide a workshop specifically targeting high school students and college students, where the exchange of ideas could occur. The workshop would occur once a year and would include industry members, and students.

My technical research problems focus on the site of the building with respect to the overall congestion of the site as well as the onsite ventilation. The level of congestion of the site can have a drastic effect on the delivery of site materials as well as the ease of the construction process. Because the hospital is being built on a site where there are adjacent buildings, the analysis will include the projects effect on adjacent buildings. The solution for the congested site was a re-analysis of the original site plan. A coordination between the contractors and subcontractors was proposed, based on the site plan.

Onsite ventilation is also a very important topic for medical facilities, especially since there are established hospital buildings around the new site. This poses the problem of cross-contamination from construction. Identifying the main causes of potential contamination is a major aspect of my analysis. These causes will then be used to make an effective list of ways to minimize contamination. All research tools will be obtained from ICRA. The final results of the research was a better understanding of the necessary steps for risk assessment.

The last topic refers to the use of a drilled shaft foundation system, versus a mat foundation system. The analysis involved researching the positive and negatives of each system, looking at both schedule and cost. The result of the analysis shows that a mat foundation would be a better application in this case. The schedule was reduced by 22 days and the cost showed a difference of almost 2 million dollars.

Acknowledgments

I would like to thank Whiting-Turner Contracting Company and Ellerbe Becket for providing the resources necessary for my project. I would also like to thank all participants in my survey on women in construction. Lastly I would like to thank my family and friends for their support during my years in school.

Project Cost Evaluation

***Model Type**: Hospital, 4-8 Story Face Brick with Concrete Block Back-up / R/Conc. Frame*
***Location:** BALTIMORE, MD*
***Stories:**6*
***Story Height (l.f.):**12*
***Floor Area (s.f.):**681,265*
***Data Release:** 2007*
***Wage Rate:** Union*
***Basement:** Not included*
Construction Cost
$101,123,500.00/681,265=$148.43/SF
Total Cost
$132,674,032/681,265=$194.7/SF

<u>Major Building Systems</u>

Mechanical
$20,135,500/SF=$29.5/SF
Electrical
$15,913,000/SF=$23.3/SF
Plumbing
$4,734,500/SF=$6.94/SF
Fire Protection
$1,502,000/SF=$2.2/SF
Structural
$14,169,500/SF=$20/SF
Exterior Brick and Curtain Wall
$5,653,500/SF=$8.29/SF
Interiors
$24,183,000/SF=$35.49/SF
Elevators
$3,585,500/SF=$5.26/SF
Equipment
$8,796,000/SF=$12.9/SF
Furnishings
$2,451,000/SF=$3.59/SF

Based on the results from RS Means 2007, the estimated cost of the building is lower than the estimated cost obtained by the contractor. This is due to a series of differences in the building used to estimate and the actual building. Although the proposed building is a hospital, the number of stories within the building is only 6 stories while the replacement tower contains 17 stories. This affects all major building systems costs, and the construction cost of the building. The results of the D4 Cost works estimate had a similar outcome. The project followed a similar format of the actual hospital, but there is a large difference in the estimated price. This could be for the following reasons:

• Change Orders were not included in the estimate in D4, which can contribute more cost to the estimated cost.

• All equipment was not specified in the estimate, the hospital requires special equipment such as operating areas, x-ray machines and various others. This void in the equipment reduces the total cost substantially.

• Also the furnishings of the building are not accounted for appropriately.

Difference Breakdown

*included in mechanical

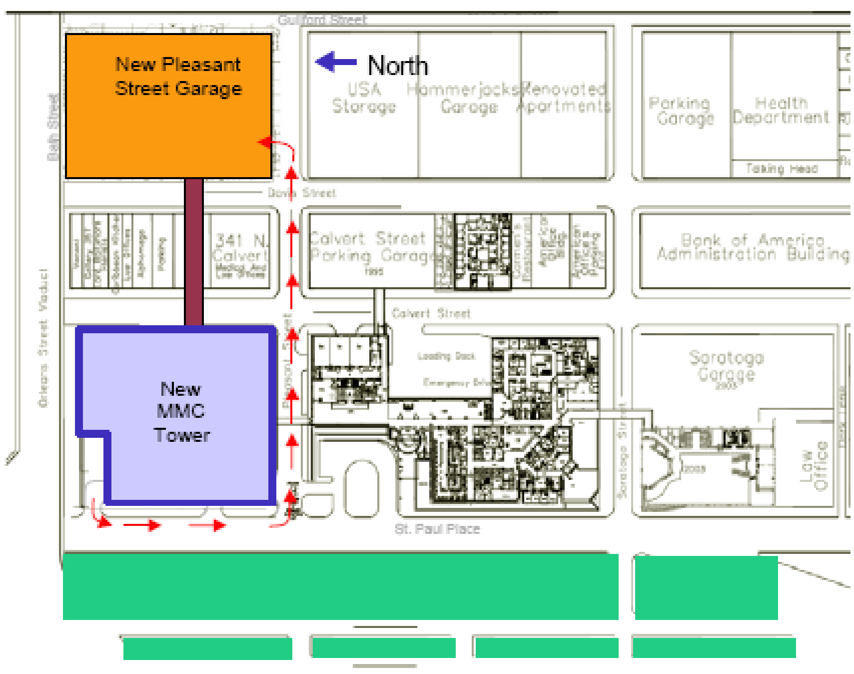
Building System	D4 Cost	RS means
Electrical	$15,288,851	$15,913,000
Mechanical	$27,061,191	$20,135,500
Structural	$10,733,569	$14,169,500
Plumbing	$9,779,005*	$4,734,500
Equipment	**$2,321,977**	**$8,796,000**
Furnishings	**$617,090**	**$ 2,451,000**

Table 1.A Difference Breakdown

ACTUAL COST: $ 158,381,990
RS MEANS COST: $132,674,032
D4 COST: $ 108,624,225

Local Conditions

The local conditions play an important role in the construction phase of the project. Because the building is located near the existing hospital, construction parking will be located away from the building site. The hospital has established a new parking area for patients, and visitors, and an access way to the hospital. The layout of the building is arranged in a way to provide effective use for the city of Baltimore. The Primary entrance is located on St. Paul Place, to make available accommodating vehicular drop-off for patients. The main entrance is located on Calvert Street along with a loading dock. In addition to these entrances another is located on the east side of the building on the third (lobby) level, with access from a new bridge connecting to the new Pleasant Street Garage.



The building is organized in a manner where each entrance provides specific access to designated areas. The primary entrance on St. Paul Place will be used for public access, while the secondary entrance on Calvert Street will be used for emergency access. Outpatient access areas will primarily be located on the lower floors while inpatient access will be located on the upper floors. Patient and public elevator access will be separated, to allow more privacy to the patient. Its location near the city center provides multiple opportunities for visiting families as well as the outpatients. The Replacement tower is located within walking distance of the city center, known for its variety of cuisine. Nearby is the Inner Harbor, this area is known for its historical culture and as well as its Harbor. The area is also home to various museums and sports arenas. The Mount Vernon Cultural District is known also for its museums and history as well.

Client Information

The owner of the project is Mercy Health Services http://www.mdmercy.com. The mission of mercy health services is to "provides and promotes health services for the people of Baltimore of every creed, color, economic and social condition." Mercy Medical Center is a catholic based facility, with an affiliated university. Mercy medical center is an active part of the surrounding community, providing outreach programs as well as neighborhood health centers.

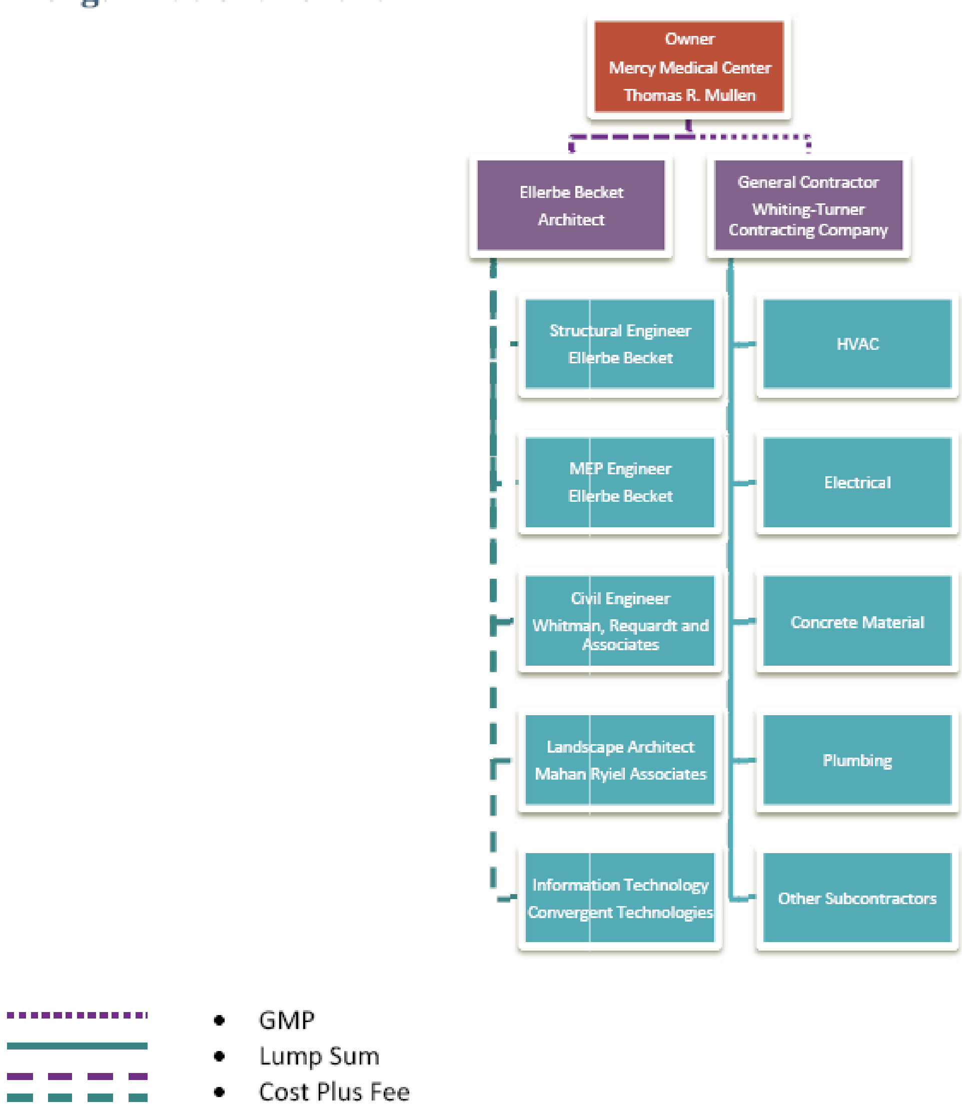
Mercy medical center was founded on November 11, 1874 in Baltimore, Maryland by the six sisters of mercy. The facility had formally been the Baltimore City Hospital, located near a school house on the corner of Calvert and Saratoga Streets, the building showed little promise. After 134 years of successful operation, Mercy medical center is recognized as one of the nation's top 100 hospitals, due to high quality, and high performance within the field of health services. They have also been named one of America's 10 Best Women's centers. Mercy offers health services such as internal medicine, obstetrics, gynecology, urology, pediatrics, gastroenterology, cardiology, cosmetic surgery, ophthalmology, rehabilitative care and emergency medicine.

The primary reason for the expansion of the mercy medical center is due to the growing population of the Baltimore city, and to provide adequate facilities for the growing population.The project construction will be completed in phases to allow patients to enter the building floor by floor, as the MEP systems are being installed. Adequate safety precautions need to be taken into consideration, when it comes to ventilation. Air will be circulated throughout the construction of the building to ensure that no contamination of air occurs. Completing this project to the owner's satisfaction will require that the patients needs be put first.

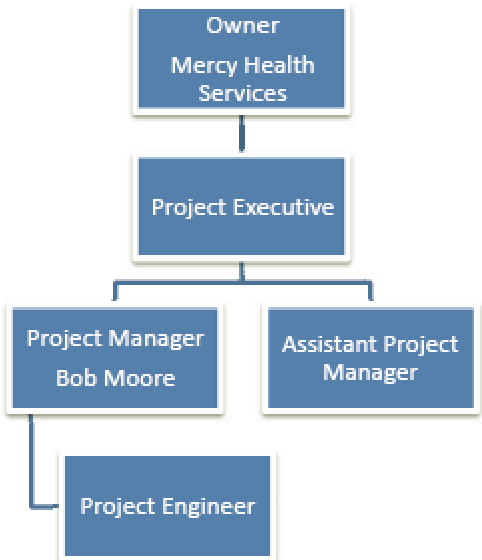
Project Delivery System

The project delivery will be guaranteed maximum price with a cost plus fee. The GMP is applied towards the contractors, Whiting-Turner Contracting Company and the cost plus fee is applied to Ellerbe Becket Incorporated along with the consultant companies. The GMP/Cost plus fee method was used due to the circumstances under which the project was awarded. The selection of the firm was through an extensive design competition, numerous site visits and a final proposal phase. This entire process spanned several months before the project was awarded. GMP/Cost plus fee contracts are used on projects where the contract is drawn up before the design development phase had begun; this was the case for this project. Each potential candidate had their own design scheme for the project, so the contract had to be standard for all candidates. This method is for to the owner's benefit, it ensures that the price is set. If money is saved on the project the owner will keep the savings, if money is lost the owner pays nothing extra, and the contractor takes on the additional costs. Lump sum contracts will be used for all relations between the contractor and the subcontractors. The subcontractors will be paid according to the the payment schedule.

Organizational Chart



Staffing Plan



Demolition

All existing structures are to be removed along with paving, surfacing, and hardscape elements. The existing structures included are the Calvert parking garage, which is to be replaced, and a remaining townhouse on Calvert Street. Areas in the existing hospital will require demolition. Levels G and 1 that will connect the proposed tunnel to the existing structure, will require demolition. Demolition will also be required at level 3(L)- bridge connections. All debris will be disposed of off-site. Excavation will require careful consideration due to the fact that, there is a difference in elevation. The difference in elevation is approximately 30’ from St. Paul Street to Calvert Street. St. Paul Street will need 3 levels of excavation below grade, while Calvert Street will need excavation for 1 level below grade.

Cast-in-Place Concrete

Building will be a cast-in-place system with reinforced concrete, with interior columns 30” square and exterior columns at 24” square. Concrete weight for floor construction, walls and slab on grade will be 6000 psi. For columns the weight will be 8000 psi, and for lower levels it will be 10000 psi. The reinforced steel will be ASTM A615 Grade 60, with some requiring Grade 75.

Mechanical System

Proper ventilation within a medical facility is very critical. The various services require that certain areas of the medical center need more ventilation than others. The main concern with ventilation is the prevention of cross contamination between rooms, and the prevention of air-borne infection spreading.The systems installed must be efficient and possess a long life span, to keep maintenance minimal. The medical center will employ the use of a chilled water system as well as a steam system. The chilled water will be purchased from Comfort Link, who will be responsible for the transport of the water as well as the chilled water piping and the heat exchangers. The contract with Comfort link is still under negotiation. The steam water will be purchased from Trigen, who will be responsible for transport to the building. Cooling devices will be installed to keep the temperature of the water below 140 degrees F, to decrease the amount of condensation before entering the building drainage system. The mechanical rooms are located on the 7th floor of the tower as well as the mechanical penthouse of the tower. There are a total of 23 AHU's each with capacities ranging from 32,000 CFM to 60,000 CFM. All air handling units will be associated with a return fan, and will be equipped with an economizing control to provide free cooling during appropriate outdoor conditions. The duct work for the building will include medium pressure duct work from the AHU's to the ATU's. There will be low-pressure for downstream ductwork, which will distribute air to the various spaces in the hospital. Filtration criteria for various spaces in the hospital vary with their uses. All inpatient areas will require two filter beds, while all labs, administrative areas and food prep areas will require one filter bed.

Fire Suppression

The building will use both wet standpipe and automatic sprinkler systems. In all areas of the hospital a light hazard wet system will be installed, except for the electrical, mechanical and communication rooms. Sprinkler risers will be installed in the trash chutes and Linen chutes. All standpipe risers will have fire department valves included with them. An electric fire pump will be installed along with dry pipe sprinklers at the loading dock and drop-off canopies. All elevator machine rooms and electrical rooms will have sprinkler protection. All sprinkler systems will be tied in with a new fire fighters control panel (FFCP).

Electrical System

The illumination levels within the hospital have an effect on the patients stay, and therefore require a detailed analysis, based on the area being occupied. Visual comfort, usage and task complexity are the main focus of the analysis. Areas such as labs, exam rooms and procedure rooms require illumination levels at higher levels, than a patient's room or a lobby. The emergency power requirements play an important role in the operation of the hospital. If the normal service of the building were ever interrupted

the emergency would be relied on to provide power for the time being. Emergency power will be divided into a Life Safety branch and a critical branch. The life safety will support Egress lighting, exit signs, the fire alarm system, medical gas alarms and the paging system. The critical system will support the illumination for the nurse call system, the telephone equipment and the mechanical equipment.
The materials used for the electrical wiring are as follows. Raceways will consist of electrical metallic tubing, with minimum sizing at ¾ inch. For below grade, non-metallic tubing will be used. 80 PVC for without encasement and 40 PVC for with encasement. The Busway will use aluminum or copper conductors over the entire length. They will be enclosed in non-ventilated prefabricated steel. The wires and cables will use #12 AWG, with THWN, THWN or XHHW insulation. Conductors will be color coded and labeled. The Utility Company, Baltimore Gas and Electric (BG&E) will provide the normal electrical service to the replacement tower. BG&E will be providing two 400amp 13.2Kv primary feeders to the medical center's primary switchboard. These are to be incased in concrete and routed internally. The configuration of the switchboard will be medium-tie-medium .The 15KV primary switchboard will have bussing at 1200amp, with 600amp medium voltage circuit interrupters for the feeders. Two double ended substations a north substation and south substation will be supplied. Each substation will have two 2000 KVA 13.2KV to 480/277V three phase 4 wire dry type transformers with 4000amp distribution. The electrical system will be a new 480/277V, 3 Phase, 4 Wire Switchgear. The system will mainly be used to feed the new center as well as major mechanical loads and building loads. The dry type transformers will provide 208/120volt power for smaller mechanical loads, building loads, as well as receptacles and lighting. Emergency service will include three 1000Kw natural gas generators. A 750Kw diesel generator will be provided for the life safety systems of the medical center. This portion of the electrical system is essential for a medical facility because, it ensures that in an emergency, operations within the building can continue. The general scheme of the emergency service is as follows:

1. Parallel switch gearing will be provided for the three generators.
2. Transfer switches for critical, life safety and equipment components will be located within the penthouse. All transfer switches are separate.
3. Feeders at 480V will be routed from the generator to the emergency distribution system in the electrical room.

Uninterruptable power systems will be provided for the Hospitals IT data server, and all telecommunication rooms. The UPS will be approximately 1500Kva with an input of 480V, and an output of 208/120V three phase.

Curtain Wall

The curtain wall is a custom pre-fabricated and pre-glazed unitized equalized curtain wall system.
A 2 ½" to 3" wide by 8" exposed mullion aluminum framing is to be provided. The curtain wall includes a combination of insulated vision glass and insulated spandrel glass panels. This curtain wall is to be located at all exterior windows. The glass types are as follows:

Glass Type 1: 1 inch clear low-E coated insulated glass units constructed of ¼ inch clear, heat strengthened exterior light with a high transmittance low-E coating applied to the Number 2 surface, ½ inch air space, and ¼ inch clear, interior light. Glass Type 2: 1 inch spandrel glass assembly constructed ¼ inch tinted exterior heat strengthened light and ¼" clear heat strengthened light with opacifier on number 3 surface.

Support for Excavation

The support of excavation will primarily consist of sheeting and shoring. All necessary precautions will be taken to prevent excess water of the site. Excavation requires careful attention due to the unlevel site, the building site slopes down 30' from St. Paul Street to Calvert Street.

Detailed Project Schedule

See Appendix A for detailed project schedule

Key Dates

Early Bid Documents-Demo, S&S, Excavation 06/08/07
File for Foundations/ Excavation Permit 06/18/07
Design Development Drawings 07/16/07
Garage Demolition Begins 9/28/07
Submit Early RFP Contractor Recommendations 10/08/07
Submit Early DD Estimate/ GMP based on DD documents 10/08/07
Verizon pull cables, splice, terminate 12/27/07
Electric pull cables, splice, terminate 12/28/07
S&S begins at location of old Pleasant street Garage 02/26/08
100% Construction Documents 3/03/08
Receive Building permit 04/28/08
Caissons Begin 05/13/08
Concrete Foundation Walls Begin 07/08/08
Fit-out/MEP on level 5 begins 04/21/09
Temporary Roofing on Level 9 completes 05/18/09
Concrete Roof Level Completes 08/31/09
Project Substantial Completion w/o weather contingency 08/31/10

<u>Schedule Outline</u>

Preconstruction

Duration: May 03, 2007-June 6, 2008

Key Activities
• Utility Relocation
• Garage Demolition
• Excavation
• Demolition of existing caissons

Construction

Duration: *May 13, 2008 - December 21, 2010* (with weather contingency)

Key Activities
Substructure
• Foundation Walls
• CMU backup Walls
Exterior
• Brick Veneer
• Curtain wall
Interior
• Fit-out/MEP
• MEP Penthouse
• Commissioning

Key Aspects of Schedule

The schedule of the project utilizes both a compressed schedule and a schedule with accelerated activities. This helps creates better efficiency on the project, and creates a buffer zone for any site issues such as weather conditions, unforeseen site conditions, and issues with material delivery. The curtain wall procurement could pose the most risk for the schedule. For the curtain wall construction to begin, the contractor needs to ensure that materials are available and will arrive on-time. The long time period for the curtain wall procurement can be attributed to the amount of curtain wall being procured.

Garage Demolition
The demolition began during late September. The garage was previously used for the Mercy Medical Center parking; the site will be the location of the replacement tower. The demolition takes a total of 110 days; the process involves the actual implosion of the garage as well as the clearing out of debris from the demolition.

Foundation Walls
Foundation wall construction begins on August 12, 2008 and ends on August 31, 2009. The size of the foundation walls decreases with the height if the building, so the duration for construction of each decreases as well. This also explains why the backup wall construction begins as the foundation walls decrease.

Potential Project Delays
The most likely project delays will pertain to weather and material delivery. A majority of the construction phase is done during the summer months of the year (i.e. June, July, and August).The initial construction of the foundation walls takes place during the months of January and February. This could

pose a threat to the curing process of the foundation walls. The cast-in-place system could have difficultly setting in cold temperatures, which could delay the entire construction process. Another possible delay could come from potential material delays, any delay of materials will cause the project to fall behind schedule. The detailed schedule is provided in Appendix A.

Site Plan

The site of the project gives way to multiple issues during construction. The replacement tower is located centrally in Baltimore city, which poses problems with material delivery, storage space, as well as pedestrian safety and access to adjacent buildings. This requires detailed planning for all phases of construction. The building envelope phase requires that adequate space is provided for cranes, storage and on site trailers. Fencing for the project needs to provide a safety barrier between pedestrians and hospital patients and the actual construction site. A new emergency entrance and ambulance drop –off will be established in order to keep the course of the existing hospital efficient. The downtown area of Baltimore, may slow down the delivery of various materials for the building envelope. Establishing an appropriate time for delivery, i. e. after the rush hour or before rush hour, will increase the efficiency of the project. Material storage will be located on the east side of the building, along with the trailers to allow for an easy drop-off for delivery trucks. Two cranes will be used to cover the entire building footprint. The key goal of the site plan is to create a flowing plan which minimally disturbs the flow the existing city. The site layout plan is provided in Appendix B, based on the building envelope phase.

Workforce: Development: Women in Construction

Introduction

The construction industry is one of the largest workforces in the Nation. Approximately 240,000 construction positions are filled each year. The field of construction over the past years has had an increase in the number of women in the industry. Although the numbers are increasing, there is still a shortage of women in the industry. This could be due to the lack of appeal of the construction industry, the fact that it is a male dominated industry, or that the construction industry isn't typically seen as an area where females flourish. As the issue of labor shortages continues to affect the industry more and more companies are looking to hire females.

Problem Identification

What are ways more women be recruited for the construction industry? How can women be retained in the construction industry? Why is the construction industry seen as unappealing to women?

Proposed Solution

Educating women about the industry and the opportunities available can foster new ideas about the construction industry. Doing so can increase the number of women interested. Providing peer-to-peer support through mentoring opportunities, will establish a relationship between those already within the industry and those considering entering the industry. Creating programs for entry-level female engineers, such as apprenticeships will give them a more stable environment when starting out. Each engineer would have a female or male mentor, for a particular time frame. The mentor would serve as a liaison between them and the established industry members.

Research Steps

1. Analyzing the trend of women in the construction industry over the past 20 years.
2. Identifying possible reasons for the trend.
3. Consulting both women and industry members about ways to increase the number women the industry. Also asking then about the incentives that they use to attract female employees.
4. Interviewing women in the construction industry about their experience within the industry.
    a. What incentives were provided when first starting out in the work force?
    b. What incentives are provided to them now?

c. What is the biggest change witnessed in the construction industry since they entered?

Background

The 2000 U.S. census bureau reported that approximately more than 9 million people were involved in construction. About 10 percent of those - an estimated 913,000 - were women. While the number of women working within the industry has increased, the overall percentage of women in construction has held steady at about 10 percent. NAWIC believes “increasing that proportion will become more crucial in the future as the economy turns around and the construction industry struggles to fill jobs with a work force depleted by the retirement of white male workers who dominated the field for years.” As the number of employees within the construction industry continues to decline, it is essential that the industry begins to look outside of the normal demographic, and begins recruitment at an earlier stage. The demographic that the construction industry can benefit from is women.

Construction Employment 2006-2007

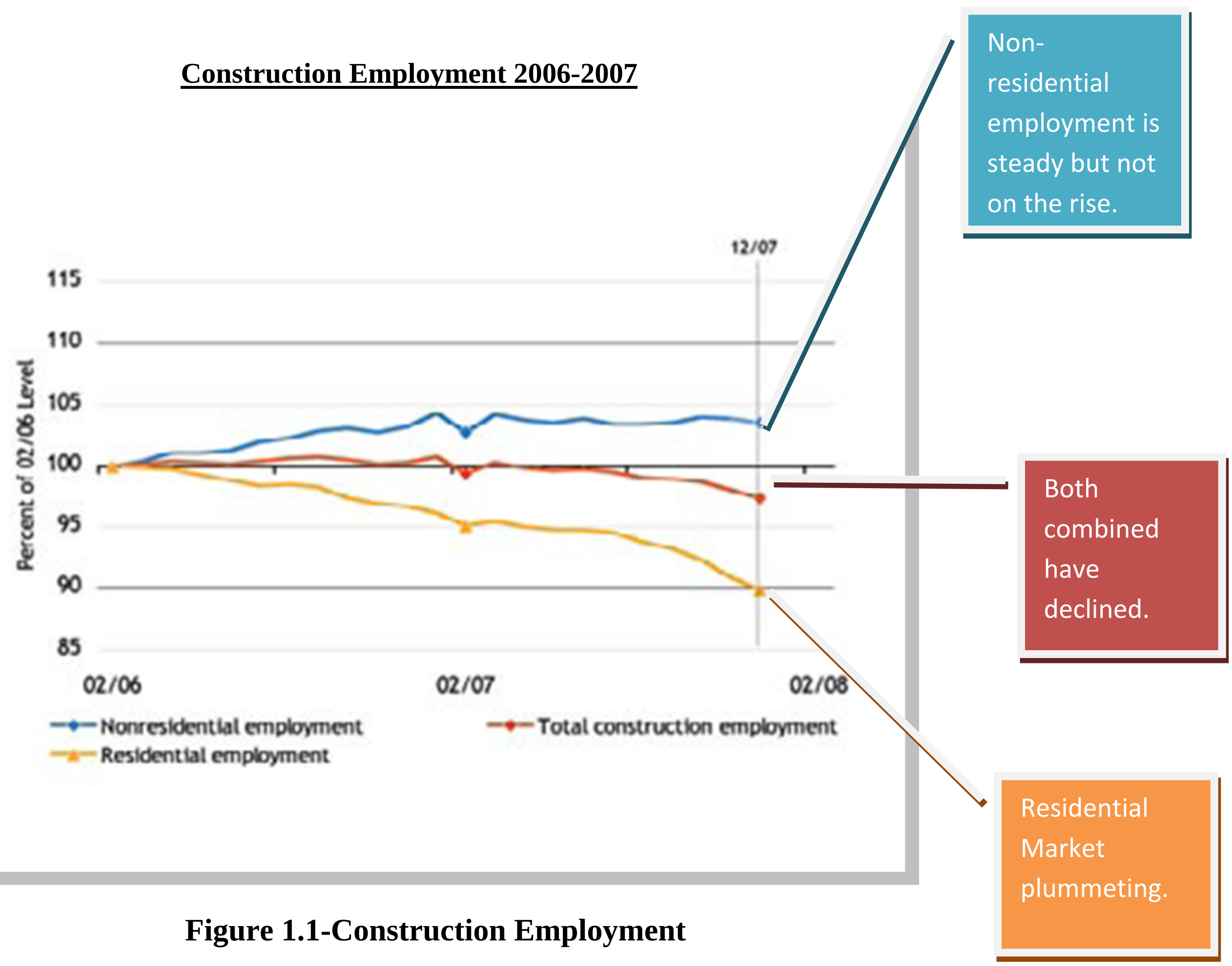


Figure 1.1-Construction Employment

Since the year 2002 the number of women in the construction industry has been increasing at a steady rate of 4.72 %. As of December 31, 2006, there was an average of 1,131,000 women employed within the construction industry. Women make up 9 percent of the entire construction industry employees. Below is a breakdown of the various occupations in which women are employed:

OCCUPATION SECTOR	NUMBER OF WOMEN	PERCENTAGE
Sales and Office	575,000	51%
Professional & Management	291,000	26%
Natural Resources,	237,000	21%
Service Occupations	15,000	1%
Transportation & Material Moving	13,000	1%

*The graph below shows the trend of women employment within the industry

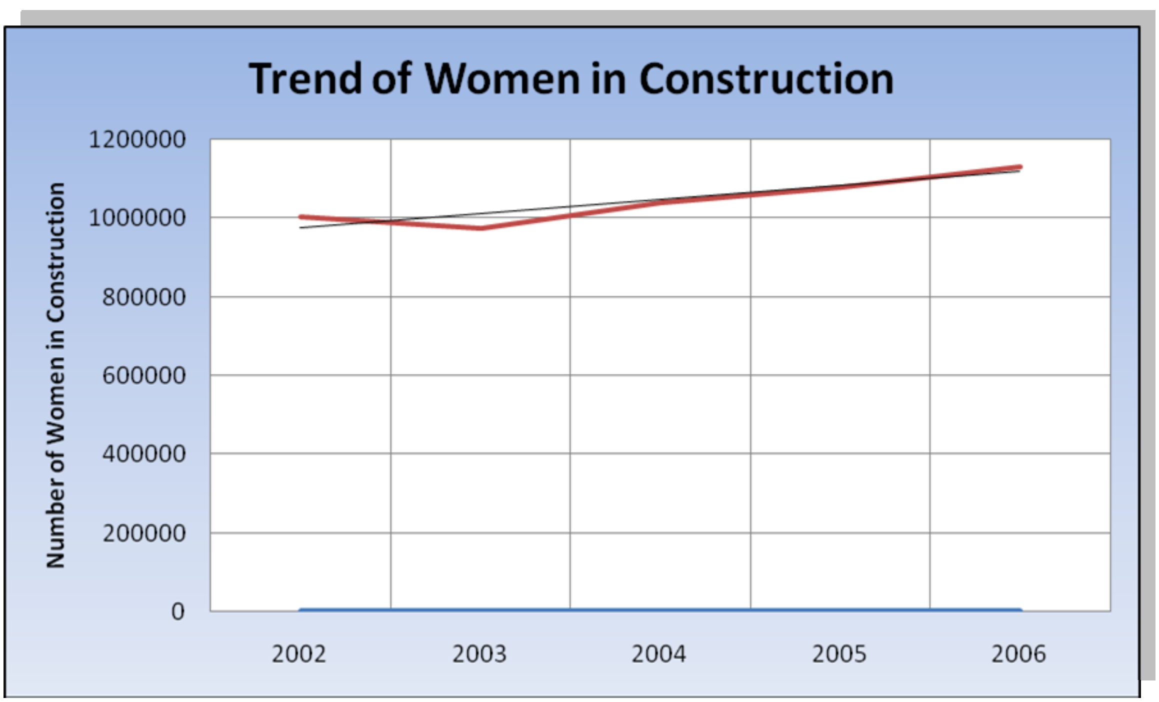


Figure 1.2-Trend of Women in Construction

This growing trend can help to supplement the decline of employment within the construction industry. Overall with the construction industry there has been a leveling off of the number of workers employed. This is becoming a concern when looking at the both residential and non-residential construction. Non-residential construction had a strong growth period from the early 2000's up until a couple of years ago. This Leveling of employment can be attributed to multiple aspects:

1. The rising cost of materials
2. A decline in wages

*The graph below shows the breakdown in the proportion of men to women.

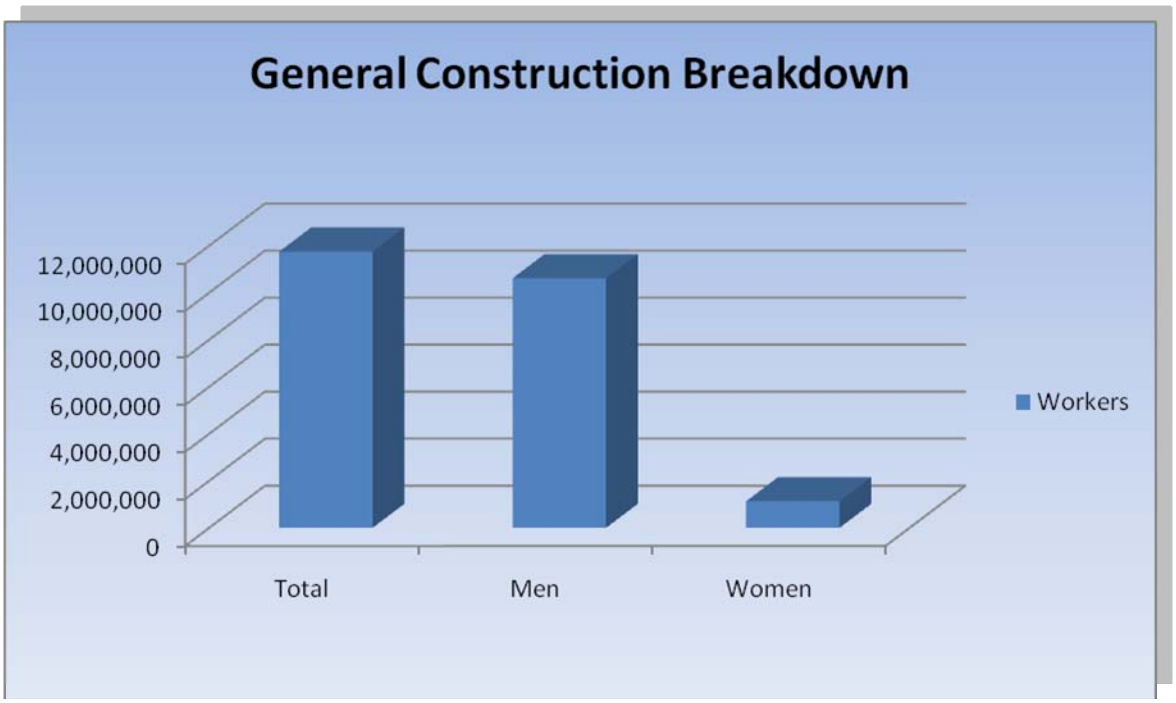
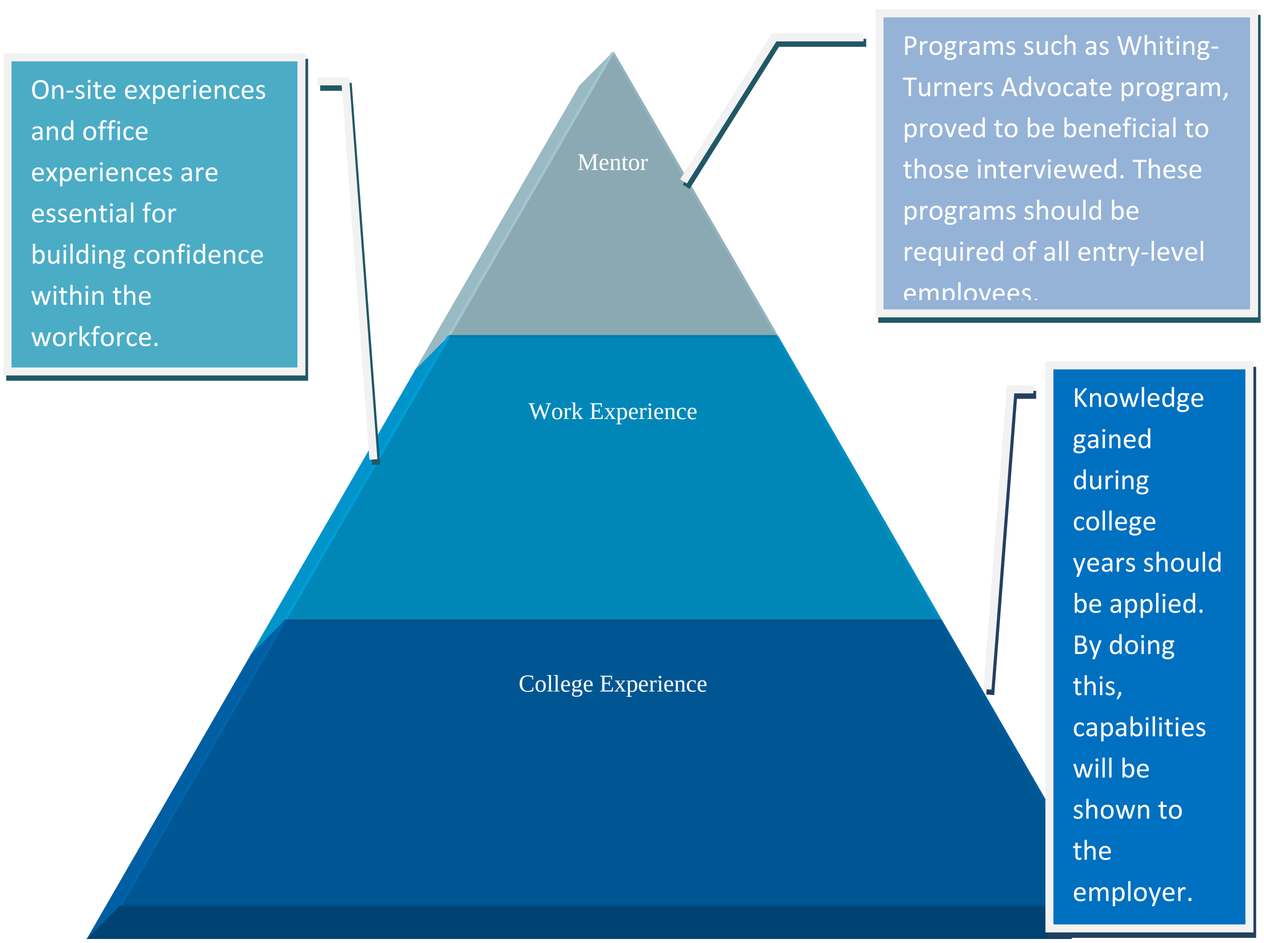


Figure 1.2-Construction Industry Breakdown

Additional Reasons:

Other reasons for this decline and shortage in the construction industry is the lack of enthusiasm exhibited. The construction industry is known as one of the most dangerous industries of the workforce. This causes hesitation from potential candidates in the workforce. Parents of children do not portray the construction industry as a safe or proper occupation. The task is to create a better outlook on the construction industry to allow for more young individuals to join the construction industry. Establishing a positive perspective of the construction industry will not only draw in more workers but will also keep current workers.

`The potential benefit of increasing the number of women in the construction industry is great. The increase in women can make up for the decrease in the number of construction industry members. The only issue would be obtaining more women for the construction industry. Construction is a male-dominated industry, with very few female role models to follow. This poses the issue of obtaining and retaining women in the construction industry. Observing the trends of women who enter the engineering field as college students, it is seen that those who have a foundation organization such as WISE or SWE have a better success rate than those who do not. Another trend observed showed that individual's who are involved in programs where apprenticeships and mentors are required, have a better foundation when entering the construction industry. The major factors of retaining women in construction are through mentorship, college experiences and work experience.



Questionnaire Results

A questionnaire was constructed to obtain a better understanding of women's perspective of the construction industry. Responses are from various members in the construction industry. The majority of the questionnaire participants are companies within Maryland, Virginia, and Washington D.C. Job titles of questionnaire participants include: Project managers, project engineers. The range of experience varies from 3 months to 17 years.

1. What difficulties did you face as a female, when first starting out in the industry?
2. How did your college experience (i.e. involvement) shape your transition into the work force?
3. Were you involved in any mentorship programs upon hiring? If so did they help you?
4. What advice do you have for women considering entering the construction industry?
5. How has the industry changed since you first started out?
6. Do you have any suggestions on ways of improving the industry for women?

Responses:

1. The general responses for women were issues dealing with respect, and equality. It was emphasized that women often have to prove themselves. This was especially true for young females working with older male engineers.
2. Most women cited that being involved in programs such as SWE helped them gain confidence entering the workforce.
3. The majority of the women were involved in mentorship programs initially. Having mentors helped to develop them into who they are today.
4. Having good confidence and being eager to learn were the major suggestions.
5. Many stated that the number of women within the industry increased.
6. Most suggested that continuing mentorship programs will increase the number of women in the industry.

Solution

Based on the responses obtained, in order to increase the number of women in construction, it is necessary to educate them about the opportunities available at an earlier stage. Creating a Women in Construction Workshop- For Penn State Construction management students and graduates (Similar to the PACE workshop), would be a viable solution in facilitating interest. The forum will consist of changes within the industry as well as new opportunities, and advice. The workshop will consist of various industry members at various levels in their careers such as CEOS, entry level, etc. The workshop will mainly serve as a liaison between high school students, college students and industry members.

The outline for the workshop can be found in Appendix C.

The workshop would focus on the following three goals:

1. **ESTABLISHING INTEREST**
    a. Through establishing interest there is a more likely chance that more females will enter into a construction related field.
2. **CREATING THE OPPORTUNITY**
    a. The workshops main purpose is to create and show the opportunities available within the construction industry.
3. **FOLLOW-THROUGH FROM BOTH PARTIES**
    a. Keeping in contact with the high school students is critical in their future decisions. By guiding them through the remainder of their high school careers, it will allow for a better transition from high school to college.
    b. The communication line can also create opportunities for mentorship and internship opportunities during their upcoming college careers.

After speaking to counselors within the centre county area the proposed workshop was seen as beneficial to high school as well as middle school students. Reaching out during the earlier stages of the individual's educational career, can determine that persons path later in life. In addition to the workshop visits to middle schools and high schools should be included. These visits would be used to teach young students not only about construction management, Architectural Engineering as a whole. The intention of this to create interest in the field, and show the many aspects and opportunities available. Located in Appendix D is a sample presentation geared towards middle school students, which can be used during visits.

Conclusion:

The decline in employment within the construction industry can be attributed to multiple factors. The focus shouldn't be placed on stopping through old techniques. The focus should be placed on using new techniques and targeting new audiences. Women can benefit from the construction industry opportunities. The construction would also benefit as well, with an increase in the number of employees. The plan for increasing more women is first by obtaining interest and then by retaining through the use of mentorships and workshops.

Effective Air circulation within a Hospital Environment

Introduction

Due to the fact that hospital already has operating facilities surrounding the proposed site, it is very important to maintain a level of active circulation in and around the site area for patients and pedestrians. Cross contamination from outside air and debris can cause the mechanical systems of the existing buildings to be less effective in filtering.

Problem Identification

How can cross contamination be reduced or eliminated? What are the major causes of cross contamination? What codes or laws are in place concerning construction and debris from the site? Do all parties of the construction process examine the possibility of cross contamination? In what ways can the construction process be affected by potential cross-contamination?

Proposed Solution

Onsite temporary ventilation systems could be provided to reduce the level of dangerous particles being circulated in the hospital setting. The system would allow for pedestrians and patients to freely enter adjacent buildings as well as provide onsite workers better air quality. The site should also be re-analyzed for evasive ways to reduce cross-contamination.

Research Steps

1. Using the ICRA matrix, the type of construction project will be identified.
2. Using table 2.b, the patient risk will be identified as low risk, medium risk, high risk or highest risk.
3. Using the matrix table 2.c, the medical center will be matched accordingly with a particular group.
4. Using table 2.d the steps necessary to reduce the infection risk will be identified.
5. After the steps are identified, a comprehensive list of feasible solutions will be constructed.

All tables mentioned are located in Appendix E.

Results

Based on the ICRA tables provided in the Appendix A, Mercy Replacement tower was classified in the following ways:

I. The Replacement tower falls into the category of Type D, it is a new construction project.

II. The risk determined for the tower is the Highest risk, all equipment will be in use in the existing tower and in the new tower. The existing tower includes centers for

Neurosurgery, Plastic and reconstructive surgery, a cancer institute and more. These areas require extreme care and consideration during the construction process.

III. The replacement tower can be classified in the group IV, for the class of precautions.

Based on all these assumptions the Replacement tower is at the highest risk for possible infection. This means all precautions need to be taken into consideration during and after the construction phases. In addition to the replacement tower, all adjacent facilities have been analyzed using the same ICRA table.

The facilities surrounding the proposed replacement tower include the following:

- Parking Garages
- Restaurants
- Offices
- Florists
- Storage Space
- Apartments
- The existing Medical Center- The existing medical center includes the following:
    - Gynecology Center
    - Breast Center
    - Plastic and Reconstructive Surgery
    - Women's Imaging
    - Bone Health Center
    - Prevention and Research Center
    - Medical Oncology & Hematology
    - Outpatient Chemotherapy
    - Surgical Oncology
    - Outpatient Surgery

The risk factor of the existing medical center shows the highest risk potential. The construction process needs to be carefully monitored and all precautions. In order to ensure this the contracting company should utilize the additional steps in the Infection Control Risk Assessment.

<u>Additional Research Steps</u>

1. Identify the areas surrounding the project area, to assess the potential impact.
2. Identify the specific site of the construction activity, i.e patient rooms, medication rooms, etc.
3. Identify issues related to: ventilation, plumbing, electrical.
4. Identify containment measures, using the prior assessment.
5. Consider the potential risk of water damage. Is there a risk due to compromising structural integrity?

6. Work hours: Can or will the work be done during non-patient care hours?

7. Do the plans allows for adequate number of isolation/negative airflow rooms?

8.Do the plans allow for the required number and type of hand washing sinks?

9. Does the infection control staff agree with the minimum number of sinks for this project?

10. Does the infection control staff agree with the plans relative to clean and soiled utility rooms?

11. Plan to discuss the following containment issues with the project team.

*Questions 4-11 were sent to the project manager on the Mercy Medical Center Project, for further analysis

1. The various risks have been identified on the ICRA site plan in Appendix B. The site plan only identifies buildings which lie closest to the construction site. The potential impact for each of these areas ranges from particle dispersion on areas such low risk areas such as restaurants and shops, or in an extreme case, the spread of harmful spores from the site entering the hospital setting.

2. The area the construction will be taking place is adjacent to the existing mercy medical center. The construction activities will include all necessary facilities a hospital needs to run effectively,

3. Ventilation is one of the largest concerns during the project. The existing hospital contains surgical rooms, oncology, which require extreme sterile conditions. The existing ventilation system must be effective in reducing the amount of harmful bacteria which enters the system. Also the construction site should make use of an effective ventilation system to further reduce the amount of bacteria which enters the hospital. An analysis comparing various mechanical and ventilation systems will be used to determine the most effective means of reducing bacteria.

4. The containment measured taken on the site are as follows:

   HEPA filter is required on site 24 hours a day. The HEPA filter will also include a sign which directed to not touch or relocate.

5. The risk for water damage is low on this project, due to the fact it is not a renovation project.

6. Work is not permitted during non-patient hours. Work must be done during daytime hours to ensure that the patients comfort levels are kept high.

7. Plans in the future will determine the use of negative air flow facilities within the existing hospital.
8. Plans in the future will determine the number of sinks required on site
9. To be determined in the future.
10. To be determined in the future

Background

The Center For Disease Control reports that every year over 2 million patients obtain infections in the hospital setting, while undergoing treatment for other issues. Of these reported cases, approximately 5,000 are construction related. This is due to the lack of attention being paid to keeping patients away from harmful fumes emitted onsite. Healthcare construction makes up for a large portion of construction projects every year, approximately $10 billion. If this trend of infection continues it will result in an increasing number of deaths as well as potential lawsuits. The need for more stringent procedures on the construction site is necessary for any changes to occur. Here is a table taken from an ASHE presentation by Bob Dooley, ICRA researcher

Here's Our Problem!

	Annual Passenger Departures Annual Hospital Admissions	Deaths per year/ Nosocomial Deaths per year	Deaths per Scheduled Activity
Airline Industry	**1,009,971,000**	**525**	**1death/ 1,923,750 passenger departures**
Hospital Industry	**34,890,768**	**88,000 (all nosocomial)**	**1 death/396 admissions**
Hospital Industry	**34,890,768**	**4,400 (airborne)**	**1 death/7,930 admissions**

ASHE

ASHE 2002 Annual

Figure 2.1-Table of Figures

Sources of Risk

Although the level information related to airborne contaminants in construction is limited, it is known that the materials chosen are the source. By eliminated certain materials that are known to cause contaminants, a reduction in the amount will be seen.

Risks of Patients

Individuals within the healthcare facility already have a lowered immune system, to it is imperative to create an atmosphere with the cleanest air possible. Also because the existing Mercy Medical hospital was built during the 1970's the likelihood that the mechanical systems are not at the same level, than when they were first installed is high. The ventilation systems should be maintained and re-installed as needed after a given amount of time.

Aspergillus Growth

Airborne spores are a common bacteria spread on construction sites. The spore Aspergillus can originate from water damaged building materials. The spores attach themselves to materials such as gypsum board and ceiling tiles, which are found in most hospitals. This occurs when these materials are wet for more than 72 hours. Because these spores have a low travel velocity they stay within the air for long periods of time. Aspergillosis is a disease contacted through the inhalation of dust particles which carry spores.. This can lead to pneumonia and the fungus disperses through the blood stream to various organs.

The following is a report of mortality rates :

95% in bone marrow transplant patients

13-80% in Leukemia patients

8-30% in kidney transplant patients

Figure 2.2 X-ray One Month Apart – Spore Infection

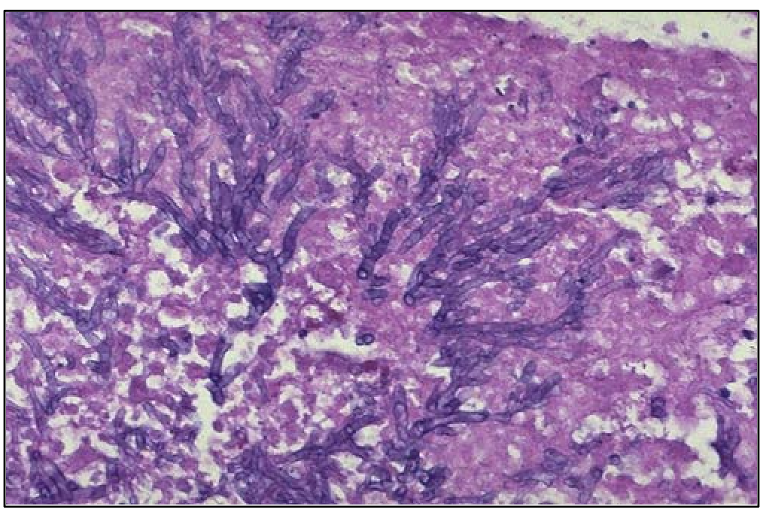


Figure 2.2 Aspergillus in the Lungs

Risk Management

During the earliest stages of construction, infection prevention and control measures must be employed. Successful risk management will require a lot attention and commitment. All personnel involved must have an active role in risk management. Patients with infections which are easily spread are usually contained in rooms with negative air pressure, this keeps the air within that particular room from leaving. Rooms with patients who are at a high-risk are kept on rooms where there is positive pressure, which allows for fresh air to flow into the room. The positive pressure blocked contaminants from entering the space. These rooms are labeled as protective isolation, because they are used to protect the patient.

The most important factor in risk management is ensuring that the construction site remain under negative pressure. The construction area should remain under negative pressure to keep contaminants from escaping into other areas. The various responsibilities allotted during the ICRA assessment, should be distributed in order to make the area as safe as possible. The responsibilities of sizing equipment, maintaining negative pressure and the monitoring of the construction site fall under the contractor. The risk management must involve both the engineering and contracting team in order to efficiently reduce and maintain a low risk level. There should clear lines of communication through all parties involved, to ensure that all preventative measures have been taken. Before the project commences A plan of action must be put in place which contains all responsibilities and communication plans for the duration of the project.

The assembly of a team prior to beginning construction can help alleviate problems dealing with infection spread. The ICRA team is the best way to do this. According to the AIA

> "*"…The ICRA shall be conducted by a panel with expertise in infection control, risk management, facility design, construction, ventilation, safety, and epidemiology. …"*

According to the CDC this panel should include the following:

- **Infection-control personnel, which includes hospital epidemiologists**
- **Laboratory personnel**
- **Facility administrators/ facility managers**
- **Director of engineering**
- **Risk-management personnel**
- **Directors of specialized programs (transplantation, oncology, and ICU's**

- **Employee safety personnel**
- **Environmental Services personnel**
- **Information systems personnel**
- **Construction administrators**
- **Architects, design engineers, project managers, and contractors**

Functions and Responsibilities

- ✓ Coordinate members' input in developing comprehensive project management plan
- ✓ Conduct a risk assessment of the project to determine potential hazards to susceptible patients
- ✓ Prevent unnecessary exposures of patients, visitors and staff to infectious agents
- ✓ Oversee all infection-control aspects of construction activities
- ✓ Establish site-specific infection control protocols for specialized areas
- ✓ Provide education about the infection-control impact to construction to staff and construction workers.
- ✓ Ensure compliance with technical standards, contract provisions, and regulations
- ✓ Establish a mechanism to address and correct problems quickly
- ✓ Develop contingency plans for emergency response to power failures, water supply disruptions and fires.
- ✓ Provide a water-damage management plan (including drying protocols) for handling water intrusion from floods, leaks and condensation.
- ✓ Develop a plan for structural maintenance.

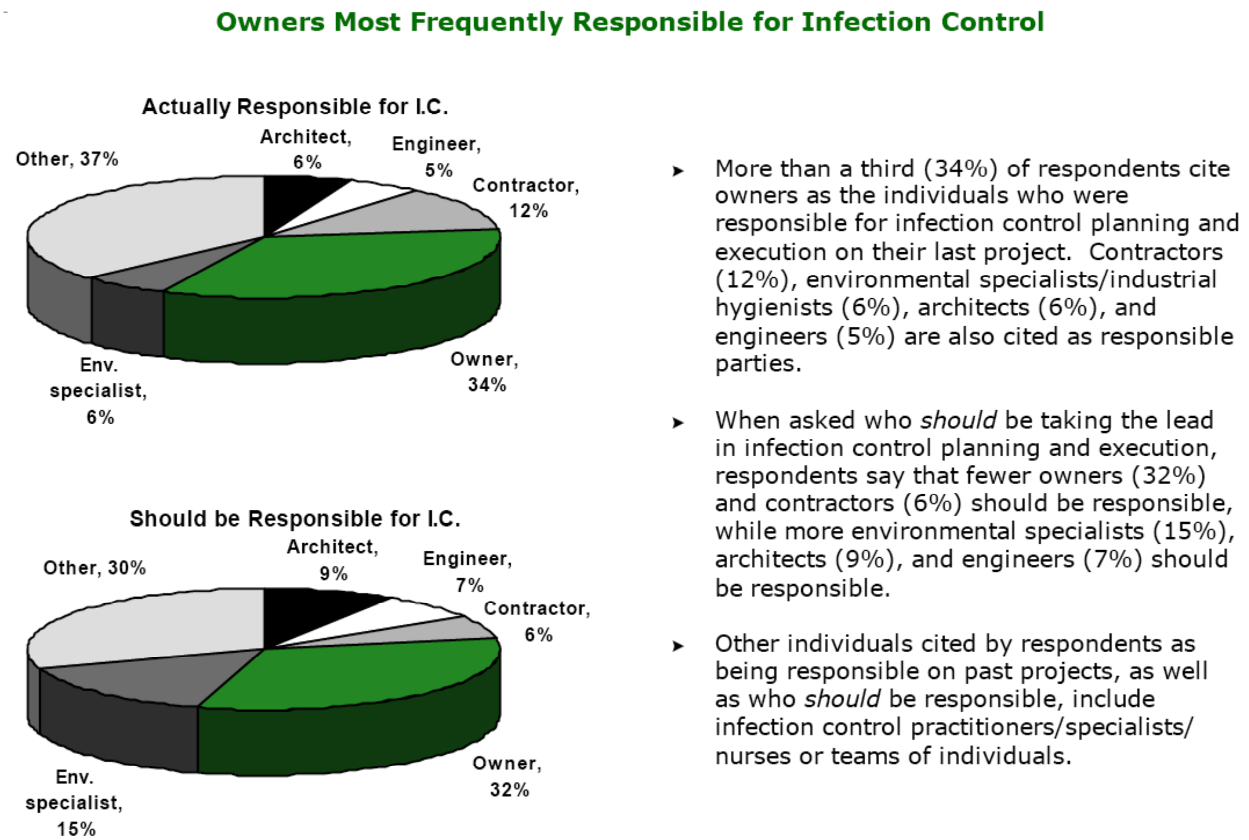


Figure 2.3-Responsibilty for Infection Control

The above charts show the distribution of the responsibilities during infection control. The results show that owners take the most responsibility during their projects with over 30 %. Contractor came in second, environmental specialists and architects came in third, with engineers following.

When looking at who should be responsible the distribution shifted, with less owners and contractors taking the responsibility, and more responsibility going to the environmental specialists, architects and engineers.

Analysis

Using the model created by Zaruhi Karapetyan, a graduate student from Pennsylvania State University. The purpose of this model is to determine the important factors in infection control, and during what phase of the project they should be applied. The actions and procedures taken during each of these phases are outlined in the chart below:

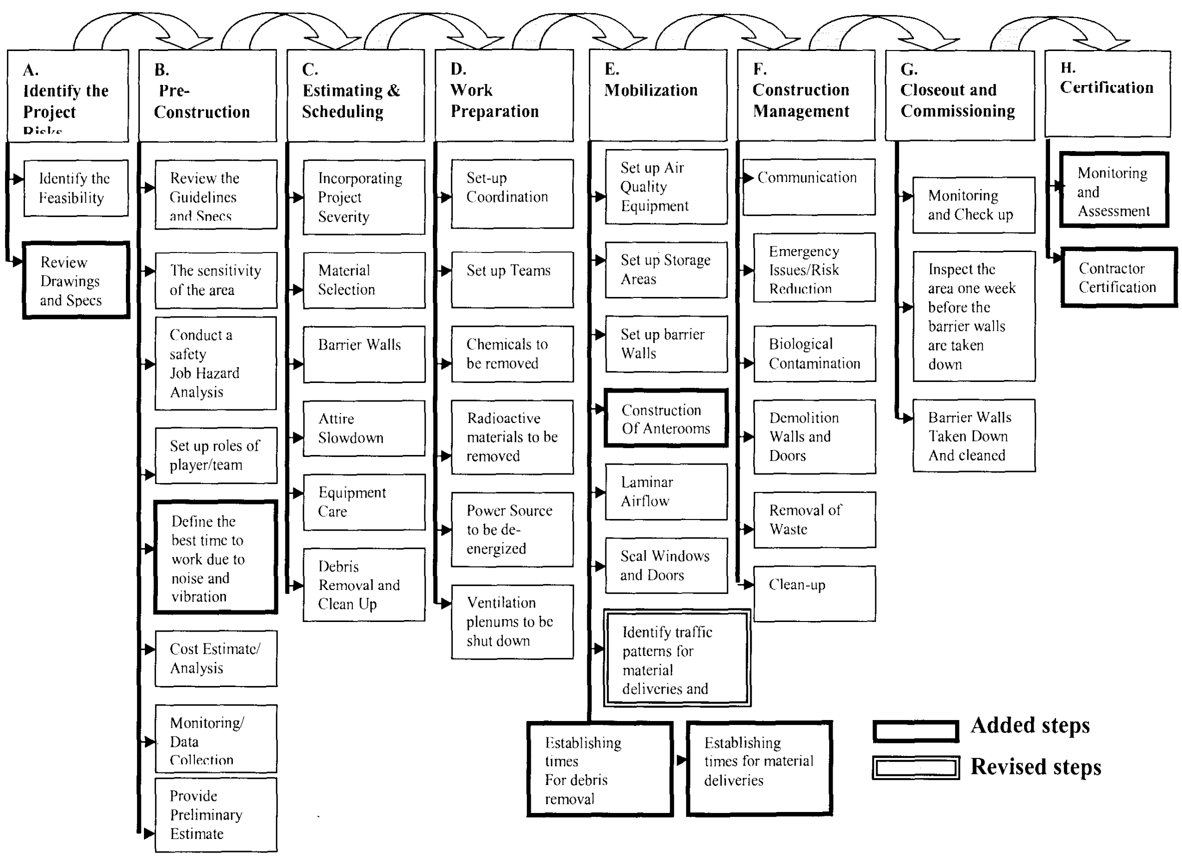


Figure #5.1: Revised Model for Infection Control during Hospital Construct

Figure 2.4-ICRA Model Chart

A. Identify Project Risks
B. Pre-construction
C. Estimating and Scheduling
D. Work Preparation
E. Mobilization
F. Construction Management
G. Closeout and Commissioning
H. Certification

TABLE 1 IDENTIFY PROJECT RISKS

A. The project risks were identified through the use of the ICRA chart. Based on conversations with Whiting-Turner Contracting Company, ICRA modifications will take place after the building is complete. The Contractor may intend on using the mechanical information from the proposed building to determine the need for future Infection Control measures for future construction.

B. Based on the owners concern for patients well-being and previous construction projects surrounding the existing hospital building, the contractor was selected according to the standards of performance required.

TABLE 2 PRECONSTRUCTION

2A. REVIEW THE GUIDELINES AND SPECIFICATIONS

The specifications provided insight into the site. The site should be maintained in a fashion where all potential risk is kept to a minimum. Whiting-Turner Contracting Company has employed the use of at least of HEPA filter. This filter will reduce the amount of site emissions, to the surrounding building areas.

2B. DEFINE PROJECT SEVERITY LEVEL

The risks of each adjacent facility have been identified through a schematic site plan. The site plan divides the areas into Low risk, medium risk, high risk and highest risk. The image below showcases this:

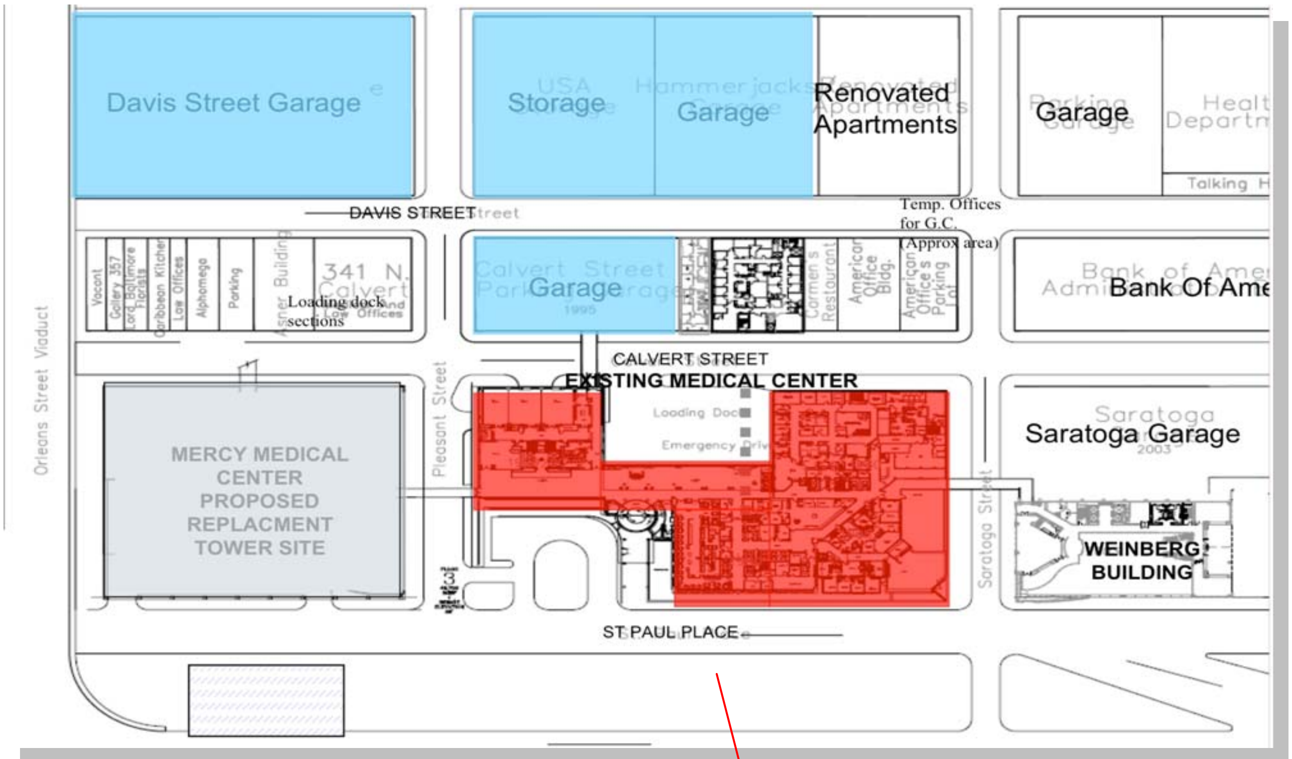


Figure 2.5 Risk Identification

RISK IDENTIFICATION

LOW RISK ZONE

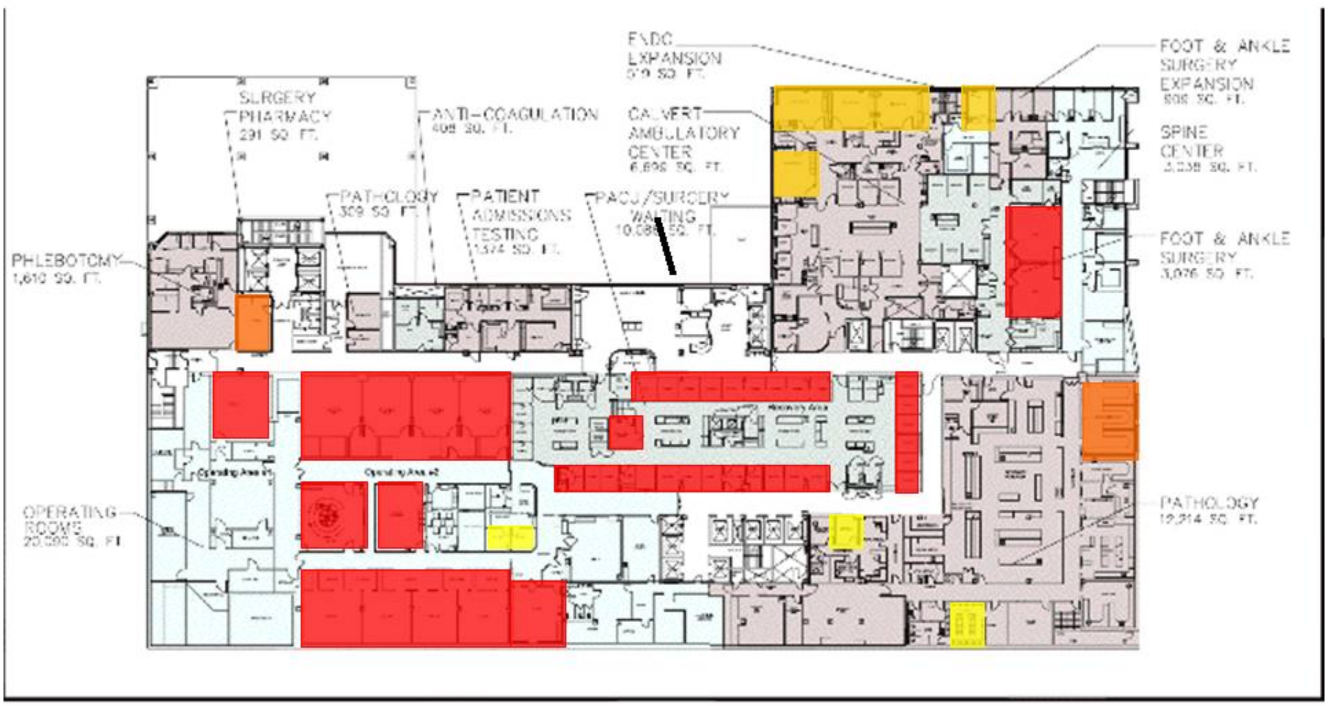
MEDIUM RISK ZONE

HIGH RISK ZONE

HIGHEST RISK ZONE

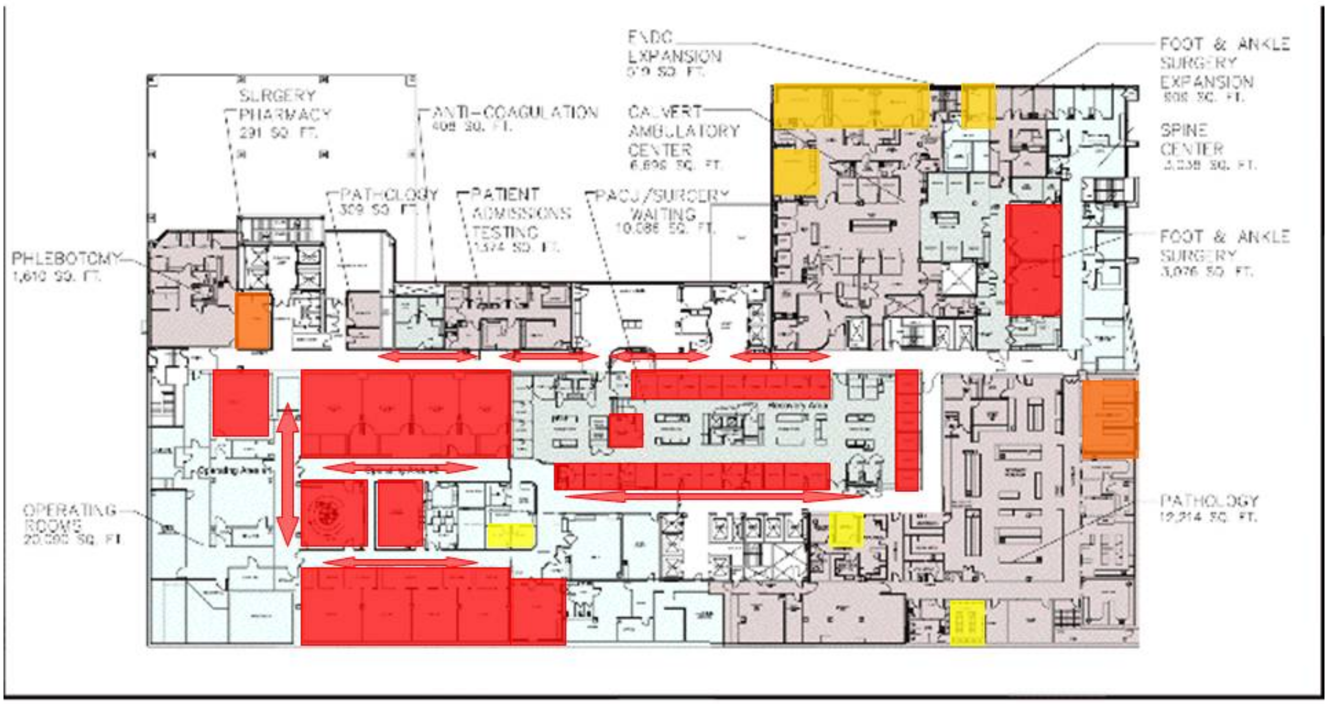
The existing hospital 2nd Floor was further analyzed

A further analysis of the existing hospital was completed. Identifying the floor with the highest risk areas, at risk patient areas were identified, pathways were identified and dust migration areas were identified. The 2nd floor was selected in the study.



At Risk Patient Areas

The image above shows the risk areas within the existinf hospital. The areas included on the second floor include; a surgery pharmacy,several operating rooms,radiology facilities, and offices. Red represnts the areas with the highest risk, followed by orange, orange-yellow and yellow. This schematic should be completed for all floors of the facility, to ensure that an accurate level of risk is determined.



At Risk Traffic Patterns

Next the traffic patterns of the risk were identified. This determines the need for ventilation within the system. Regulating the circulation of air can eliminate the spread of infection.

Location of vertical openings-Dust migration

The green areas on the plan represent the vertical openings within the hospital. These openings have the ability to cause the travel of dust particles and possibly mold particles within the system. These areas should be carefully monitored to prevent the spread of infectious particles and diseases.

2C. WORKERS MEDICAL QUALIFICATIONS

The precautions taken during the construction process are as follows:

The Contractor shall assure that all workers present on the Site including the employees and agents of sub-contractors, sub-subcontractors and material suppliers at any tier abide by the Owner's minimum, worker health requirements.

1. Immune Levels: Each worker shall have immunization documentation for Rubella (German measles), Rubeola (red measles), Varicella (chicken pox), and Mumps.

2. Tuberculosis:

a. Each worker shall have had a PPD-Skin-Test within the previous 3-months; a two-step exam will be required if the worker has not had one within the past year.

b. Any worker, with a positive TB history, shall have CXR and complete the Positive-PPD questionnaire.

c. These exams can be completed at a public health office, the worker's physician's office or clinic or can be acquired through the Owner's facilities by appointment for a nominal fee per person.

2D. SET UP THE ROLES OF EACH PLAYER IN PROJECT

The responsibilities of individuals are as follows:

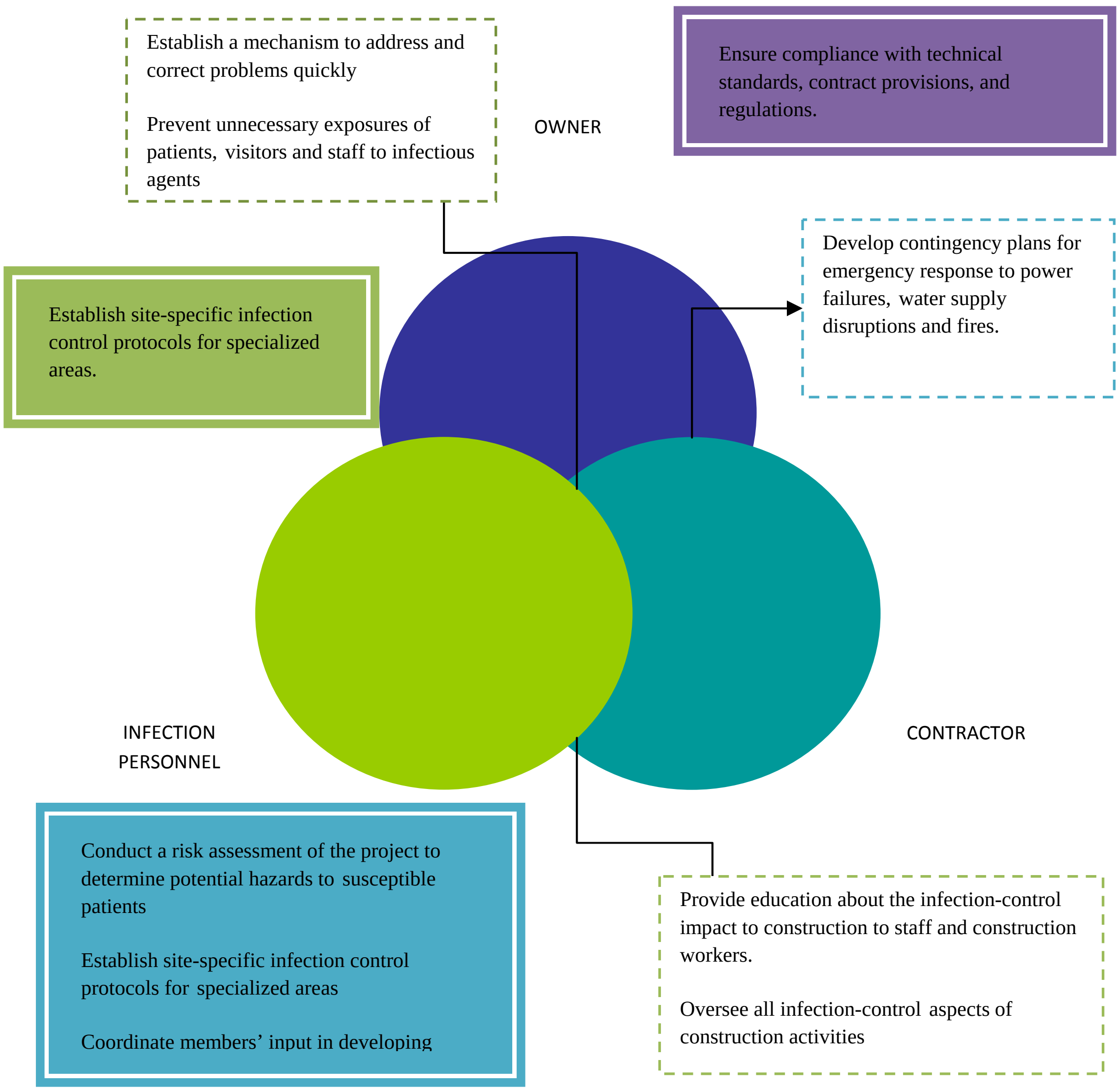


Figure 2.6 Distribution of Responsibility

2E. COST ESTIMATE AND ANALYSIS

The cost of the viable system versus the benefits are an important part of the analysis. Through the installation of a temporary ventilation system, benefits are seen:

- Increased safety of Patients
- More efficient construction site
- Increased productivity

2F. MONITORING AND DATA COLLECTION

TABLE 3 ESTIMATING AND SCHEDULING

Cost of implementation:

ICRA implementation costs are approximately .5-1.0% of the total construction costs. This totals to amount of

$158,381,990*.05=$7,919,099.5

3A. INCORPERATE PROJECT SEVERITY

Due to the fact the hospital is not a renovation, phasing will not be necessary during construction activities. Phasing of the project will only be applicable when medical equipment is being placed into the building.

3B.MATERIAL SELECTION

Critical materials selected during construction only pertain to barrier walls and materials which will be stored on site. Identifying the climate and planning is necessary to prevent any IAQ complaints. Certain materials have a tendency to react differently given different temperatures.

3C. BARRIER WALLS

Maintaining and scheduling the placement of barrier walls can be critical to the cost and schedule of the project. Depending on the barrier selected high cost of installation can be accrued.

3D. ATTIRE SHUTDOWN

Depending on the level of dust on a particular construction site, contractors may need to dress in proper attire, in order to not expose the existing hospital to infectious particles. This should not be an issue on this project, contact with the existing hospital should be minimal, and should only occur when necessary.

3E.EQUIPMENT CARE

Maintenance of the various infection control equipment used on site will be necessary during this project. There should be an initial schedule set up to determine the frequency of these maintenance checks. There should also be replacement costs and schedule compromises factored in when looking at possible set backs on site, due to equipment malfunction.

3F. DEBRIS REMOVAL AND CLEAN UP

The removal of debris especially during the demolition phase is crucial on site.

TABLE 4 WORK PREPARATION

4A.SET-UP COORDINATION

Coordination on-site will be based on conversations between the contractor and subcontractors. These conversations will mainly be used to discuss the material delivery schedules, storage areas, and access to site. Coordination with the adjacent facilities is necessary as well in determining access ways to buildings, convenient material delivery times, and the scheduling affects on the existing hospital.

4B.SET-UP TEAMS

For the Mercy Medical Center project a team was assembled which includes one ICRA practitioner. This individual will make weekly checks on site to determine is all ICRA requirements are being completed.

4C.CHEMICALS TO BE REMOVED

4D.RADIOACTIVE MATERIALS TO BE REMOVED

TABLE 5 MOBILIZATION

5A.SETUP AIR QUALITY EQUIPMENT

The equipment to be used during this phase of the project includes HEPA filtered vacuums, and barrier walls. The site makes the use of at least one HEPA vacuum during construction. The vacuum is to be used daily.

5B.SET-UP STORAGE AREAS

The ICRA team has not yet finalized the storage of the necessary equipment. This equipment will most likely be stored away from site materials, to avoid un-necessary damage to the equipment, and allow for longer time periods without serious maintenance issues.

5C.SET-UP BARRER WALLS

Plastic barriers will not be utilized on site for this project.

5D. AIRFLOW

5E.WINDOWS AND DOORS

5F.TRAFFIC PATTERNS

TABLE 6 CONSTRUCTION MANAGEMENT

6A.COMMUNICATION

The recommendations of AIA during construction are as follows:

- Clean to dirty airflow
- Construction of roof surfaces
- Well defined emergency procedures
- Criteria for interruption of protection
- Written Notification of Power
- Line of communication authority

Noise monitoring on site is crucial to the patients comfort levels. The contractor has not made special adjustments in the use noiseless equipment, but work is only scheduled during daytime hours.

6B.EMERGENCY ISSUES/RISK REDUCTION

Any major water damage to the existing hospital must be removed immediately and replace. Damage to gypsum wall will be covered to prevent the spread of Asperillgous.

6C. BIOLOGICAL CONTAMINATION

Maintaining good worker hygiene on site is an important way of minimizing contamination.

6D.ENTRY INTO VENTILATION SYSTEM

This will need to be discussed with the owner to determine appropriate access and the appropriate circumstances when this can occur.

6F.REMOVAL OF WASTE

The removal of waste should be coordinated on a weekly basis. Keeping contaminants on site to a minimum will maintain ICRA regulations, and will increase the amount of space on-site.

6G.CLEAN-UP

A HEPA vacuum is to be used daily to reduce dust on-site.

TABLE 7 CLOSEOUT AND COMMISSIONING

7A. MONITORING AND CHECK UP

Monitoring of the site will be necessary in determining whether ICRA regulations are being followed.

7B. INSPECTION OF THE AREA BEFORE BARRIER WALLS ARE REMOVED

After monitoring of the site has completed, and it has been determined that ICRA regulations have been followed, barriers will be removed.

TABLE 8 CERTIFICATION

8A CONTRACTOR CERTIFICATION

This final step will determine if all appropriate actions were taken during construction.

Solutions for contamination control:

Based on a conversation held on March 13, 2008 with Mike McLaughlin of Southland industries the most common method of risk reduction is the installation of temporary ventilation systems is the use of HEPA filters and vacuums.

Another way of reducing risk on hospital sites mentioned was through creating positive or negative pressure within certain hospital rooms and areas such as the waiting room and operating areas. Through doing this air travel is isolated and has the inability to spread any potential spores.

Based on talks with both the contracting team as well as the engineers on the project, the use of HEPA filters onsite will be the most applicable decision. Whiting-turner has not yet determined an effective plan for the site. A cost analysis will be completed at a later date, to determine impacts on cost as well as schedule.

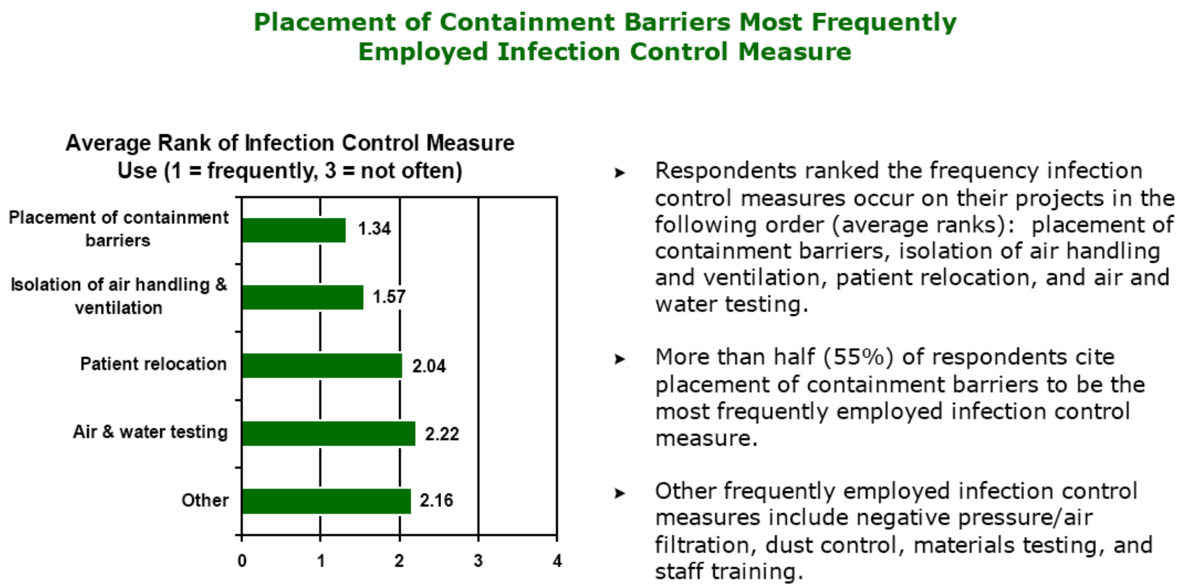


Figure 2.7-Frequently Employed Infection Control Measures

Safety Surveillor

The use of a monitoring which analyzes the number of patients infected during a particular time frame. The monitoring system also detect sudden outbreaks in the case of an emergency system was also considered for the site.

The benefits of this system are as follows:

- Arm infection control professionals with data and real-time tools needed to fight the battle against HAIs
- Rapidly detect clusters and outbreaks with automatic alerts
- Immediately notify infection control teams of potential problems, facilitating rapid intervention and investigation
- Automate house-wide surveillance, investigation efforts, National Health Safety Network (NHSN) benchmarking, and facilitate state and local public reporting needs
- Provide configurable routine and ad hoc reporting that includes: antibiograms, exposure management, rate reports, trend analyses, on demand queries and committee, executive team and board reports
- Offer a unique combination of functionality, ease of installation and low impact on scarce resources, initially and long-term
- Facilitate integration of the ICP into the clinical care team
- Redirect ICP efforts toward infection prevention and improve ICP team communications and decision-making.

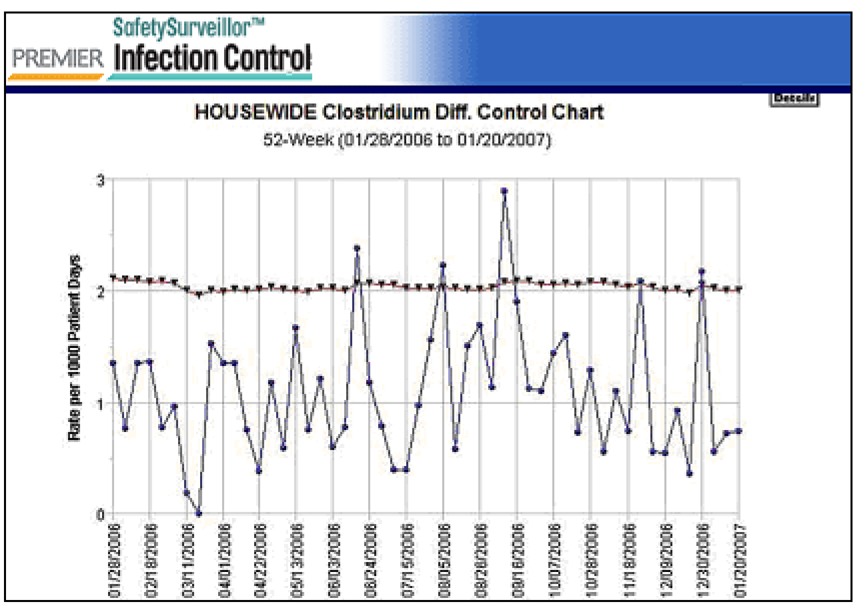


Figure 2.8-Sample Analysis

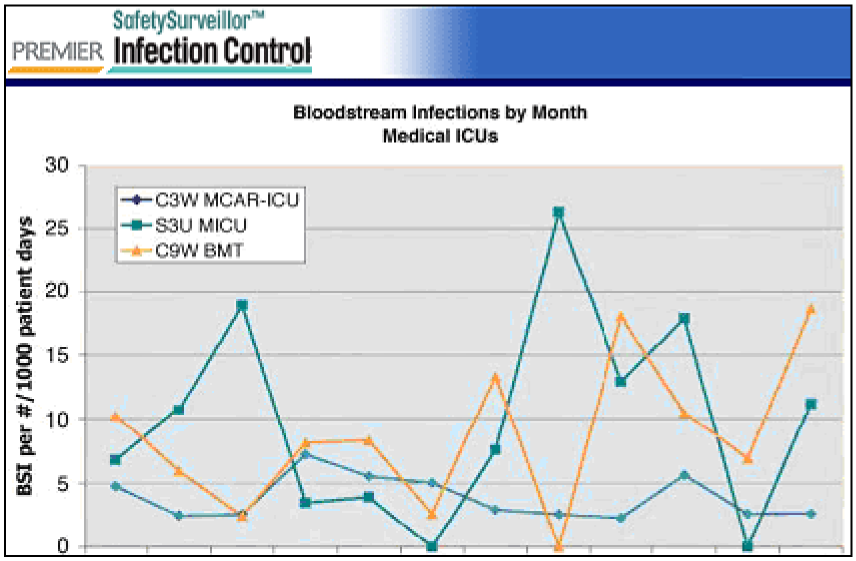


Figure 2.9-Sample Analysis

Conclusion

Whiting-turner contracting company has the intention of considering all these options when they apply ICRA to the construction site. Currently they have not taken significant steps in this process. The use of the ICRA model created By Zaruthi Karapetyan , should be applied earlier in the construction process, to effectively determine the cost, the time and the coordination necessary to assess the risk on site. When comparing the ICRA charts to The ICRA model, the model creates a better picture of what is to be determined onsite and the procedures taken. The final step of certification can be extremely beneficial to the construction team, in the final stages of the project. There is no certification process currently in use, but requiring one will create better risk assessment on sites and therefore lower the danger of infection on sites. The use of temporary on site ventilation systems is a practical application for the project. When comparing the proposed number of HEPA filters and vacuums to what I am proposing the cost is higher, but the level of safety on-site is improved. In addition to the HEPA filters and vacuums I have also proposed the use of a monitoring system, specifically made for infection control procedures. Although the cost is unavailable, the benefits show that the monitoring of the site will greatly benefit both the patients and the construction team.

Site Congestion

Congested Site Analysis

A critical issue in the construction industry is the efficient layout of the construction site. This is particularly on a congested site such as the mercy medical center located in Baltimore city, Maryland. The site poses many potential problems with the delivery of materials, as well as crane location. Another problem is parking spaces for the onsite workers as well as storage space onsite. Keeping the overall circulation of the downtown area is essential to have a smooth construction process as well as keeping adjacent buildings and customers content. The downtown Baltimore area provides multiple obstacles for the contractor. Establishing an efficient layout for all aspects of the building is a very challenging. The building is within existing conditions and is in the place of the demolished parking garage.

Problem Identification

How can site congestion be minimized without sacrificing the efficiency of surrounding buildings and transportation? In what ways can disputes between the contractor and the adjacent building owners be reduced? What ways can on site transportation be applied to create a union between the existing roadways and the new construction layout? In what ways the can pedestrian access be made safer, and more efficient? The construction site is one of the major components of the building process. Establishing a good site can reduce on site prices as well as make operation on site and adjacent to the site efficient. Researching the layouts of congested site plans as well as looking at the renovations of hospitals with respect to the transport of pedestrians and patients in the building and around the building.

Proposed solution

Providing guidelines for site congestion. Each level of congestion will have designated regulations. These regulations will be based on previous site plans.

Research Steps

1. Identifying similar site plans and areas and look at all problems and issues faced during those problems.

2. Analyze the various problems with the different levels of congestion

3. Creating different codes for each level of congestion and applying it to real life situations.

4. Creating ways to reduce the amount of danger on site, and the amount of congestion on site

5. Applying the techniques to the mercy medical center to create a better construction site

Outside Information Required

1. Information concerning adjacent buildings and how they are affected by the construction process.

2. Vehicle and pedestrian circulation through downtown Baltimore city, Maryland.

Expected Outcomes

The expected outcome will be a scaled chart with different levels of site congestion. The chart will show the conditions for each site condition and will have a breakdown of the steps that are needed to create a better site plan.

Actual Outcome

The site was analyzed using a series of questions to determine whether or not the site was effectively laid out. The results of the questions will show that although the site plan has made use of all possible solutions, more precautions can be taken when concerning the patients as well as pedestrians. The new site plan will try and utilize new spaces on-site to create better circulation on-site.

SITE LOGISTICS ANALYSIS

Purpose

The purpose of the Site Logistics Plan is to conduct an analysis of the proposed construction to determine the most rational ways to bring labor, equipment, materials, utilities, visitors and other people and services to the job site in an orderly, safe and productive manner.

Requirements

Conduct research and provide answers to the following questions:

Analysis

Once each of the above questions has been answered, locate this on a scaled site plan. Explain the information indicated on the Site Logistics Plan. In addition, provide a written description where a graphic indication would not suffice.

Analysis Results:

1. **Entrance and Access onto the Site:**

   a) What roads are there to access the site? Existing? Temporary?
      a. The main access to the site is through St. Paul Place and Pleasant road. These roads are existing roadways which are used for main travel. Theses roadways will serve as construction traffic route.

   b) How many entrances are there to the site? Will they change during the course of the work?
      a. There is one entrance and exit to the site. As construction progresses the exits and entrances will be adjusted if needed.

   c) Where are the permanent site access points?
      a. The permanent site access will be at the intersection of North Calvert Street and East Pleasant Street.

   d) Are there security measures necessary at the entrances?
      a. All entrances and exits have temporary fence panels, which prevents access to pedestrians and patients.

   e) Are these entrances just for deliveries or for employees and visitors?
      a. The construction route is only for deliveries. There is an additional route for pedestrians, which will also be used be patients and employees when accessing the existing hospital. Access routes for pedestrian will also be handicap accessible.

   f) Does the contract have signage requirements that accompany the site access?
      a. The site requires that signs be installed around the perimeter of the site.

   g) Are there erosion control measures associated with the access on and off the site? Do these criteria affect where the access might be?

   Where will the access points for sanitary facility service, garbage collection, debris disposal and recycling be?

Access points will be through the construction traffic entrance.

2. <u>Access Around the Site:</u>

a) What equipment will be around the site throughout the project?
   a. During the excavation phase equipment such as excavators, cranes and hoists will also be used.
b) If roads need to be constructed, what material will be used? Any special ramps or slope requirements for equipment?
   a. A new cross walk will be constructed to aid pedestrian access, when crossing St. Paul Place.
c) What kind of road maintenance is required?
   a. No additional road maintenance will be required.
d) Are there erosion control issues with the roads?
   a. There are no erosion control issues with the roads.
e) Will the roads be used for equipment only or for employees and visitors alike?
   a. The main entry roads will also be used for traffic access to other main roads.
f) Are provisions for mud and dust control around the site from equipment leaving the site?
   a. A minimum of one HEPA vacuum is required on site at all times.

3. <u>Office Location and Site Layout:</u>

a) What offices will be needed for all of the contractors involved? Where should they be located?
   a. Offices will be located at the south of East pleasant Street. These offices will be used primarily by the General Contractor. Temporary offices will also be located at Davis Street, north of the proposed building.
b) What storage facilities will be needed by all of the trades? Where will they be located?
   a. Storage will be located on the south side of the proposed building, adjacent to East Pleasant Street, as well as on the east perimeter of the building. This will allow for easy deliveries.
c) Where will materials and equipment be stored?
   a. Materials will be stored within the building footprint.
d) Will there be employee parking on the job site? If so, where? If offsite, where, and how will the employees get to the job site?
   a. Employee parking will not be provided on site. Employees will need to park in the new parking garage, adjacent to the proposed building site.

4. Miscellaneous Considerations

a) What kind of provisions will be provided for the safety of visitors such as architects, engineers, other consultants, owners, or others?
   a. Onsite hard hats and goggles will be provided.
b) What are the special provisions for minimizing lofted debris during wind storms?
   a. No special provisions have been made at this time.
c) Where will explosives, corrosives, gases, toxins and other volatile chemicals be stored and secured when not used?
   a. The use of these materials will only be on-site when there is a need for them. They will not be stored when not in use.
d) If the owner's requirements are for Sustainable Construction, or Green Construction, how will you meet these requirements?
   The owner has decided to employ the use of a green roof. They are not pursuing LEED accreditation.

SITE ANALYSIS:

The site plan shows that based on the level of congestion in the downtown area of Baltimore, adjustments are necessary to create an effective site plan. The pedestrian access roadway is effective in allowing a safe roadway which does not create conflict between the adjacent buildings. All adjacent buildings are accessible through the plan. The pedestrian roadway also makes accommodations for handicapped individuals through the use of two ramps at the ends of the new crosswalks, located at the north and south of St. Paul Place. The construction routes presented more challenges due to the large weights of materials and the loading required for the roadways to carry. Jersey barriers have been designed and placed at the perimeter of the 3-lane traffic roadway St. Paul Place.

COORDINATION ON SITE:

Due to the fact the site is located in a congested area, effective coordination on site is essential. Issues which affect the site productivity are as follows:

- Existing Hospital
  - The hospital needs to be protected from debris on site and patient comfort levels need to be monitored.
- Local facilities

  - Circulation within the downtown area can affect adjacent areas. Bad circulation can affect the amount of money that local businesses make.
- No on-site parking provided
  - On site parking for workers make it easier for work to be completed. Traveling to
- Storage on Site
  - Storage on site will become more of an issue as construction on the building continues.

ICRA:

The adjacent existing hospital is at risk for infection

- Patients comfort may be compromised due to noise, dust, and new access ways.
- Vacuuming is not permitted around materials due to the rise of dust can be elevated.

IMPROVING CONGESTION:

  - Designating a specific time frame and area for material drop delivery .Only allowing a specific amount of material on-site at a time.

- This would involve a high level of coordination between the subcontractors and the contractor. If effectively carried out it will decrease the level of congestion on site and improve the amount of work completed per day.

FOLLOWING ICRA REGULATIONS

Keeping materials which can induce the spread of dust particles should be confined until use. Installation of HEPA filters based on the amount of construction in a particular area of the site. Areas which are closest to the site will use more HEPA filters. As the site continues to evolve the number of HEPA filters and vacuums used will also adjust.

DELIVERIES:

Deliveries to site will become more and more difficult as the project progresses. Through limiting the amount of material on-site congestion can be lowered and the site can be kept in a more organized fashion.

COORDINATION MEETINGS:

Scheduling meetings during the week between subcontractors and the contractor will help in the timely delivery of materials as well as an improvement in the site layout and congestion levels.

Subcontractors should specify the amount of material being delivered and the time of the delivery. These meetings will increase in frequency as the number of subcontractors on site increases. During the early stages of construction meetings should take place once a week at the beginning of the week to determine what will be delivered, and the time frame it will be delivered in. During the stages after the construction of the foundation, the meetings should take place during the beginning of the week and the middle of the week, to ensure that deliveries are effectively executed.

TRAILER LOCATION:

The location of the trailers can remain in the same area. They are located on there opposite side of St. Paul Place.

Mat Slab Foundation Design

Introduction

The use of drilled shaft foundations is primarily used for buildings where a deep foundation is required, due to high axial loads. The idea of using a mat foundation instead of a drilled shaft foundation could provide savings in cost as well as the schedule. A mat foundation will require a large amount of reinforcing, but could provide multiple benefits in the process.

Problem Identification

Analyzing ways to reduce the schedule of the project, as well as provide some cost savings.

Proposed Solution

Applying the Mat foundation system to the Mercy Medical Center can effectively reduce the project schedule, and offer potential cost savings.

Research Steps

1. Identify the various pros and cons of using a mat foundation versus a drilled shaft foundation .
2. Create a proposed schedule using the mat foundation, and compare the new schedule to the previous schedule.
3. Design the mat foundation of the Mercy Medical Center.

Current Foundation System

The Mercy Medical Center is utilizing a Drilled shaft foundation system, for the hospital. This is a deep foundation system primarily used on buildings where there are large axial loads. The system is constructed through placing fluid concrete in a drilled hole. The system is also called caissons, drilled piers or bored piers.

Foundation Details:

- The existing grades slope downhill from St. Paul Street toward Calvert Street. The difference in elevation is on the order of 30'. At the St. Paul Street side, three levels will be below grade while at the Calvert Street side only the lowest level will be below grade. The site included three and four story townhomes along St. Paul Street (these have recently been demolished), and a ten level parking garage along Calvert Street.
- The geotechnical engineer at Schnabel Engineering recommended a Drilled Shaft foundation based on the site and the construction schedule.
- The drilled shaft foundation will consist of straight-sided drilled shafts supported on hard Gneiss rock.
- The foundation will be designed for an allowable end bearing capacity of 130 KSF.
- Total estimated Settlement.75 inch for drilled shafts up to 7.0 feet in diameter.

- The length of the drilled shaft will vary from 20 to 60 feet.

Boring Number	Proposed Floor Grade	Approximate Bedrock Elevation Suitable for 130 ksf Bearing Capacity	Estimated Drilled Shaft Length
B-1	6.5	Not encountered	---
B-2	6.5	Not encountered	---
B-3	6.5	EL -46	49.5-feet
B-4	6.5	Not encountered	---
B-5	6.5	Not encountered	---
B-6	6.5	EL -31	34.5-feet
B-7	6.5	EL -18.5	22-feet
B-8	6.5	EL -13	16.5-feet
B-9	6.5	EL -19	22.5-feet
B-101	6.5	EL -18.5	22-feet
B-102	6.5	Not Encountered	---

Figure 3.1Boring Sample

Drilled shafts are to be 50 feet below the water levels onsite.

- Temporary casing will be required to seal out water

- Normal weight Concrete with a minimum compressive strength of 6,000 PSI at 28 days will be used.
- Column sizes will be 24’X24’ and 36’X36’ at lower levels.

Slab on Grade:

- A typical slab will be 6” thick
- Over bentonite waterproofing ,over 2” thick mud slab

Foundation Wall Construction:

A retaining wall will be designed around the basement and below grade levels. On the St. Paul side of the street, this wall will be three stories tall. The wall will be designed as a basement retaining wall, supported by the basement slab and floor level slabs.

Excavation:

Building excavation will be up to 10-50 feet below grade and excavation support will be required. Wood-lagging and a temporary dewatering system will be employed to keep water levels below the bottom of excavation.

The following advantages are seen through the selection of a drilled shaft Foundation:

1. A single drilled shaft may be used instead of a group of piles and the pile cap.
2. Constructing drilled shafts in deposits of dense sand and gravel is easier than driving piles.
3. Drilled shafts may be constructed before grading operations are completed.
4. When piles are driven by a hammer, the ground vibration may cause damage to nearby structures. The use of drilled shafts avoids this problem.
5. Piles driven into clay soils may produce ground heaving and cause previously driven piles to move laterally. This does not occur during the construction of drilled shafts.
6. There is no hammer noise during the construction of drilled shafts.
7. Drilled shafts provide great resistance to uplifting loads.
8. The surface over which the base of the drilled shafts is constructed can be visually inspected.
9. The construction of drilled shafts generally utilizes mobile equipment, which may be more economical than methods of constructing pile foundations.
10. Drilled shafts have high resistance to lateral loads.

Disadvantages:

1. Concreting operation can be delayed by bad weather
2. Close supervision is necessary.
3. Deep excavations for drilled shafts may induce substantial ground loss and damage to nearby structures.

Original Schedule and Estimate

Deep Foundation cost: $ 3,804,477
Existing Foundation Removal: $ 119,809

Schedule:
<u>Drilled Shaft Foundation</u>

		Task Name	Duration	Start	Finish
1		Permitting	258 days	Thu 5/3/07	Mon 4/28/08
2		⊟ **Preconstruction**	**180 days?**	**Fri 9/28/07**	**Thu 6/5/08**
7		Exacavation	108 days	Tue 1/8/08	Thu 6/5/08
5		⊟ **Site Work**	**109 days?**	**Tue 4/8/08**	**Fri 9/5/08**
9		Demo Existing Caissons	44 days	Tue 4/8/08	Fri 6/6/08
12		Caissons	84 days	Tue 5/13/08	Fri 9/5/08
8		⊟ **Construction**	**837 days?**	**Mon 10/8/07**	**Tue 12/21/10**

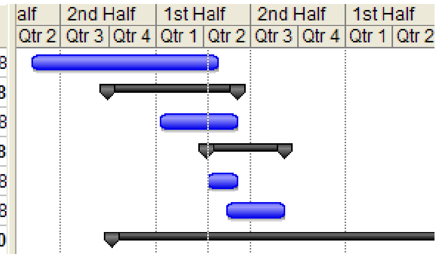


Figure 3.2 Schedule- Drilled Shaft Foundation

The schedule of the drilled shaft foundation shows that the construction of the caissons for the foundation will take 84 days. The concrete foundation will take 45 days to complete.

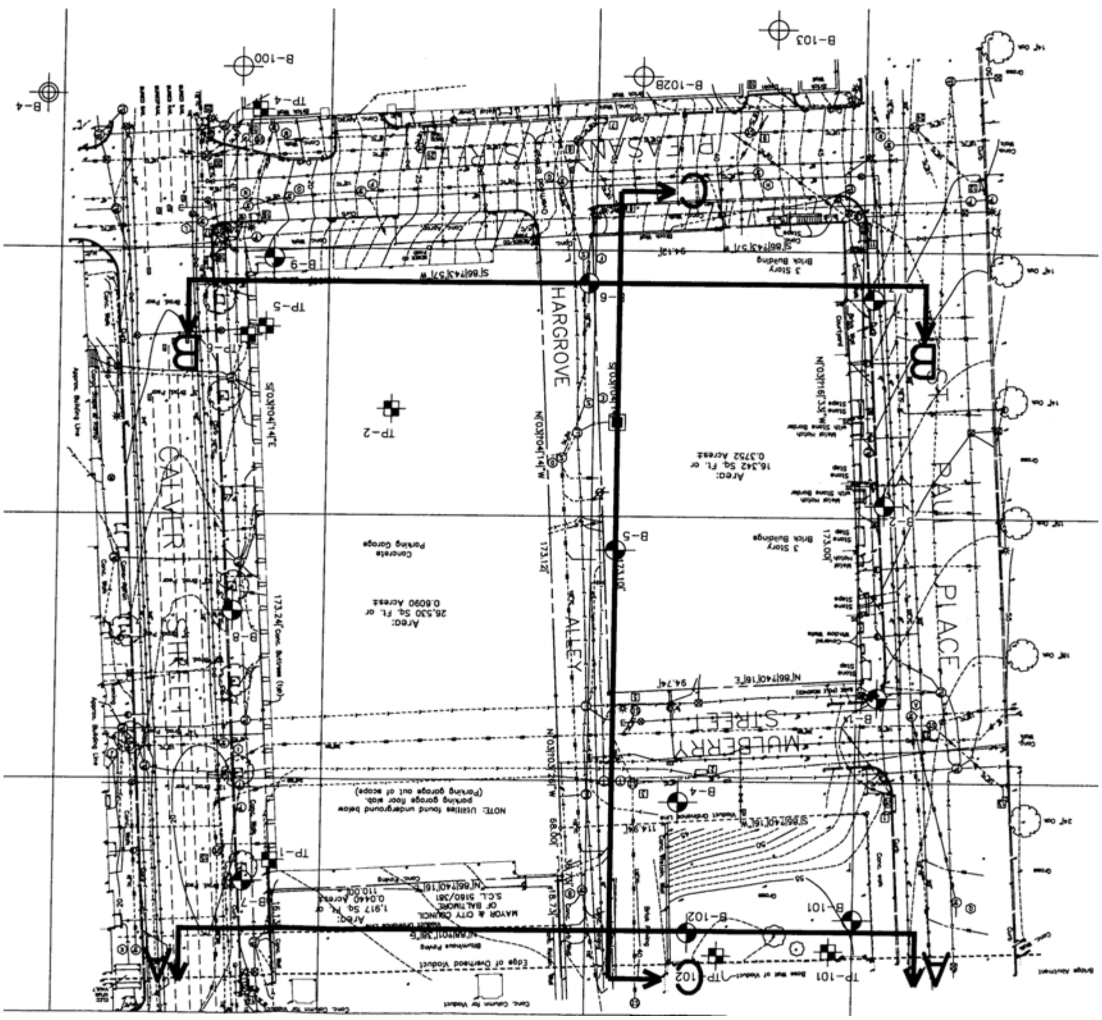


Figure 3.3 Boring Sample Layout

POSSIBLE ADDITIONAL COSTS

- **Rock coring**
- **Undercutting of unsuitable soils**
- **Drying fill soils**
- **Additional fill soils**
- **Importing fill soils**
- **Wasting unsuitable soils**
- **dewatering**

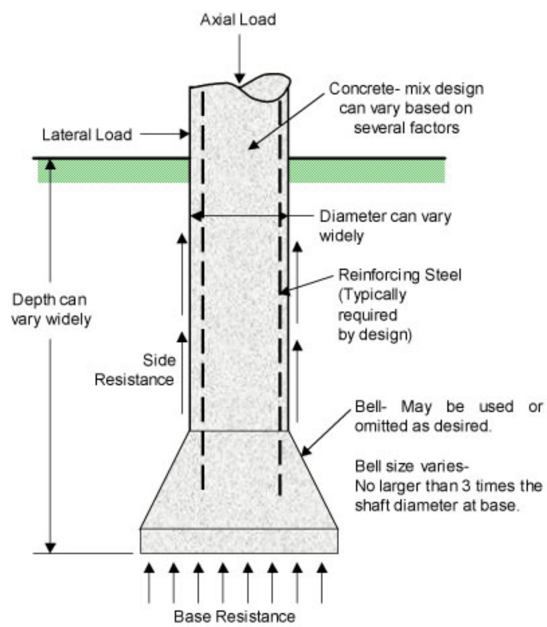


Figure 3.4 Drilled Shaft Foundation System

Cased Shaft

The casing method is often used either when shown on the plans or at sites when construction methods are inadequate to prevent hole caving or excessive deformation. In this method the casing may be either placed in a predrilled hole or advanced through the ground by twisting, driving or vibration before being cleaned out.

Casings are tubes that are relatively strong, usually made of steel, and joined, if necessary, by welding.

There are two types of casing used in Drilled Shaft Construction.

- Temporary (removed)
- Permanent (left in place)

Common situations where casing is used are:

- When there is a clean sand below the water table underlain by a layer of impermeable limestone or low permeability clay into which the drilled shaft will penetrate. In this case, since the overlying sand is water bearing, it is necessary to seal the bottom of the casing into the underlying rock/soil to prevent flow of water and caving of soils into the borehole.

Foundation Redesign

Mat-slab foundations are used to distribute heavy column and wall loads across the entire building area, to lower the contact pressure compared to conventional spread footings. Mat-slab foundations can be constructed near the ground surface, or at the bottom of basements. In high-rise buildings, mat-slab foundations can be several meters thick, with extensive reinforcing to ensure relatively uniform load transfer.

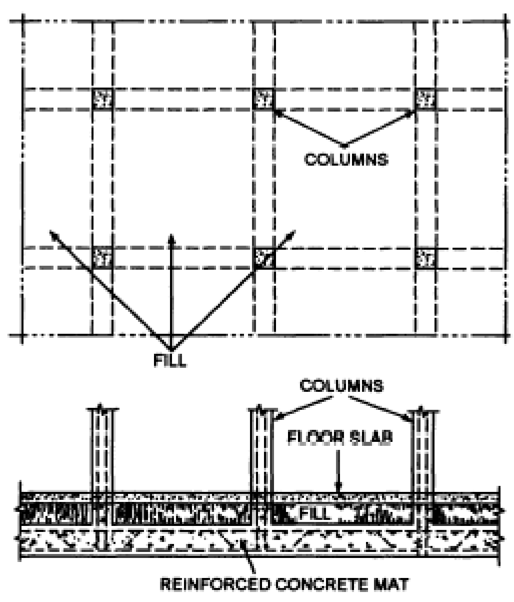


Figure 3.5 Mat Slab Foundation System

Advantages of Using a shallow foundation

- Cost (affordable)
- Construction Procedure (simple)
- Materials (mostly concrete)
- Labor (does not need expertise)

Disadvantages of Using a shallow foundation

- Settlement
- Limit Capacity * Soil * Structure
- Irregular ground surface (slope, retaining wall)
- Foundation subjected to pullout, torsion, moment.

Preliminary Mat Foundation Considerations:
Before beginning the redesign of the foundation, the site needed to be analyzed to determine if a mat foundation was an option. Looking at the geotechnical report, a mat foundation is best suited for would be on firm natural soils. Careful considerations should be taken during the excavation for the mat foundation system through minimizing the disturbance of sub-grade soils. Disturbed, frozen, wet or loose soils should be removed prior to the placement of the concrete for the foundation. The site will be graded to prevent surface water from entering the mat excavation. If the foundation system is installed during the winter and spring months more costs or delays may be expected. Soil class D will be selected for the mat foundation. This soil is found between the depths of 28.5 and 83.5 feet at all test boring locations. Residual soils will consist of green, orange, yellow, brown and gray; SAND, SILT, and CLAY. The soils have a high plasticity with liquid limits between 65 and 87, and plasticity indices of 37 to 59. The natural moisture content values varied from 23.3 to 31.5 percent.

A mat foundation system can be applied to this site due to the possibility that it could provide cost advantages. The bearing capacity of the soil is low, so a mat foundation is a good candidate.

Mat Foundation Design Steps

Mercy Medical Center Calculations:

- AREA CALCULATIONS: 41,520 SQ FT
- LIVE LOAD :101,761 kips
- DEAD LOAD :104,767 kips
- CRITICAL COLUMN LOAD:6,935 kips
- MAT SLAB THICKNESS: 74 INCHES

- REINFORCEMENT: No. 11 bars @ 6 ½ inches apart

Detailed calculations can be found in Appendix H.

Mat Foundation System Estimate:

Description	Quantity	Unit	Unit Price	Cost
Structural Concrete	9,959.5	CY	115.44	1,149,724.68
Concrete Placing	9,959.5	CY	6.11	5,862.5
Reinforcement	883	Tons	1,196.82	1,056,792.06
Backfill	120	CY	5.62	674.40
Hauling	11,000	CY	1.92	$21,120
			TOTAL	2,289,163.69

Figure 3.6 Mat Foundation Estimate

COST COMPARISON:

The original deep foundation had a cost of $ 3,804,477

The new cost of the mat foundation comes to a total of $2,289,163.69

Schedule Comparison

		Task Name	Duration	Start	Finish
1		Permitting	258 days	Thu 5/3/07	Mon 4/28/08
2		**Preconstruction**	**180 days?**	**Fri 9/28/07**	**Thu 6/5/08**
7		Exacavation	108 days	Tue 1/8/08	Thu 6/5/08
5		**Site Work**	**109 days?**	**Tue 4/8/08**	**Fri 9/5/08**
9		Demo Existing Caissons	44 days	Tue 4/8/08	Fri 6/6/08
12		Foundation	23 days	Tue 5/13/08	Thu 6/12/08

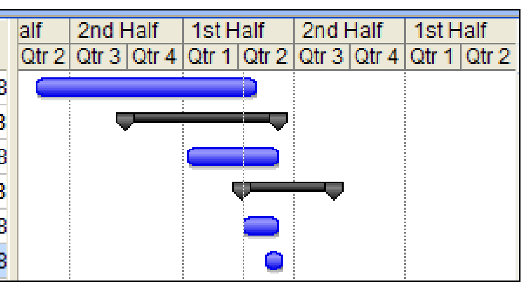


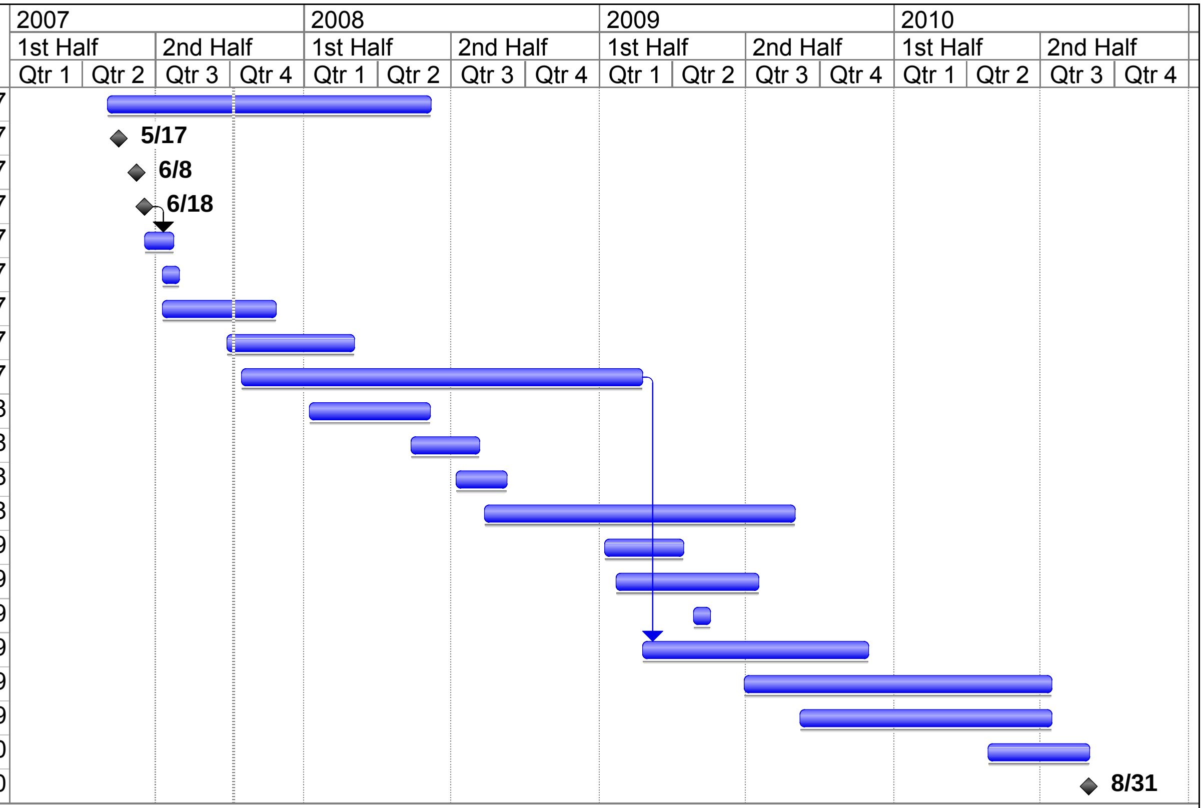
Figure 3.7 Mat Foundation Schedule

The schedule impacts of the mat foundation are positive. The mat foundation can be completed within 23 days, in comparison to the 45 days that the drilled shaft foundation can be completed. The site still requires that the existing caissons be removed, excavation will be less therefore it is necessary to have additional costs for hauling the material off-site. Back fill requirements will also increase the cost of the mat foundation.

Conclusion:
The installation of a mat foundation instead of a drilled shaft foundation provides both cost benefits and schedule benefits.

Appendix A

ID	Task Name	Duration	Start
1	Preconstruction	287 days	Thu 5/3/07
2	CON approval	0 days	Thu 5/17/07
3	Early Bid Documents	0 days	Fri 6/8/07
4	File for Foundations/Excavation	0 days	Mon 6/18/07
5	Permitting	26 days	Mon 6/18/07
6	Demolition of Existing Oxygen T	15 days	Tue 7/10/07
7	Utility Relocation	101 days	Tue 7/10/07
8	Garage Demolition	112 days	Fri 9/28/07
9	Curtain Wall Procurement	355 days	Tue 10/16/07
10	Excavation	108 days	Tue 1/8/08
11	Caissons	61 days	Tue 5/13/08
12	Foundation Walls	45 days	Tue 7/8/08
13	Foundations	275 days	Tue 8/12/08
14	CMU-Backup walls	70 days	Thu 1/8/09
15	Brick Veneer	127 days	Thu 1/22/09
16	Temporary Roofing Level 9	15 days	Tue 4/28/09
17	Curtain Wall installation	200 days	Tue 2/24/09
18	Fit out/MEP	273 days	Tue 6/30/09
19	MEP Penthouse	224 days	Mon 9/7/09
20	Commissioning	90 days	Wed 4/28/10
21	Project Substantial Completion	0 days	Tue 8/31/10

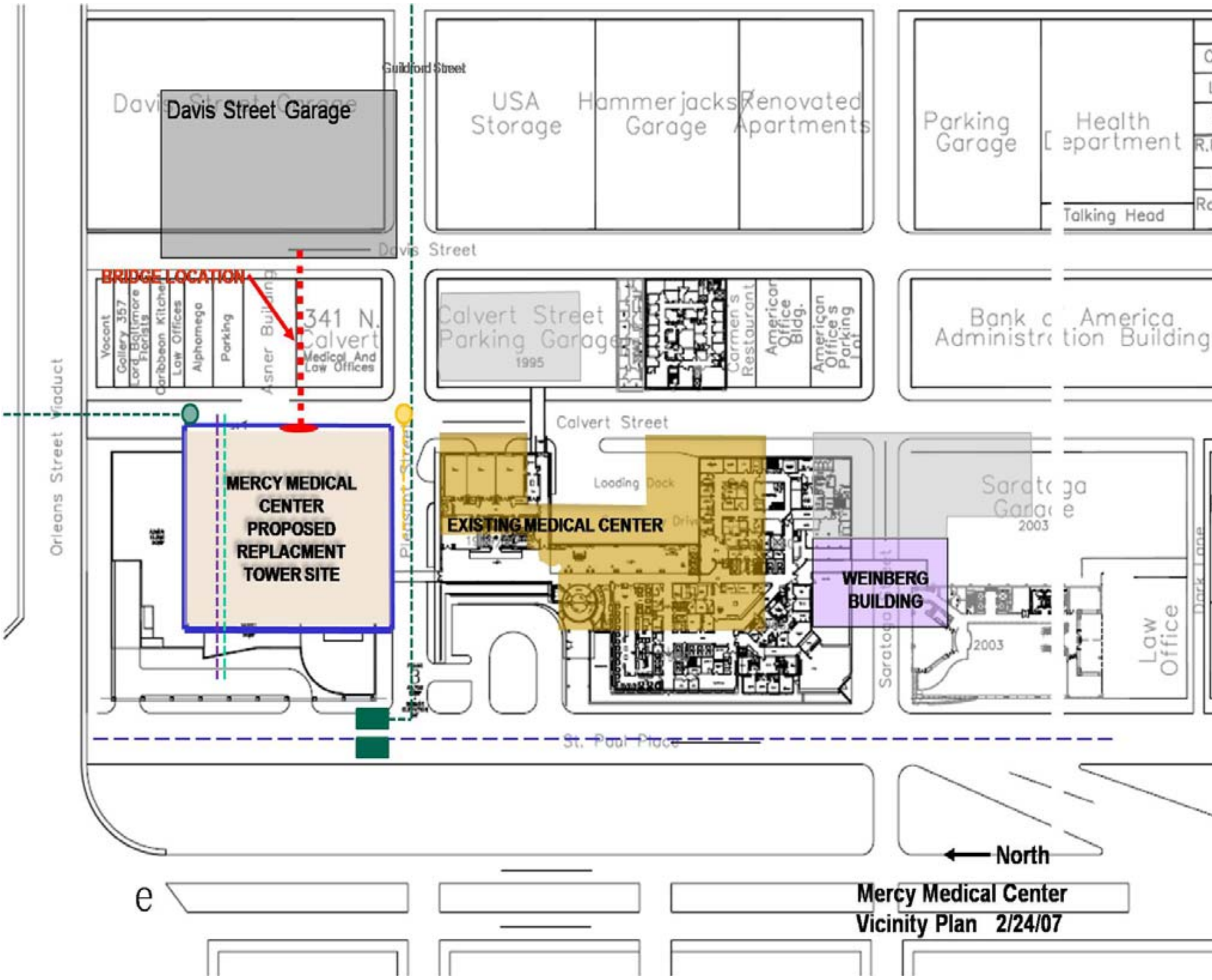


Project: Replacement Tower
Date: Fri 10/5/07

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

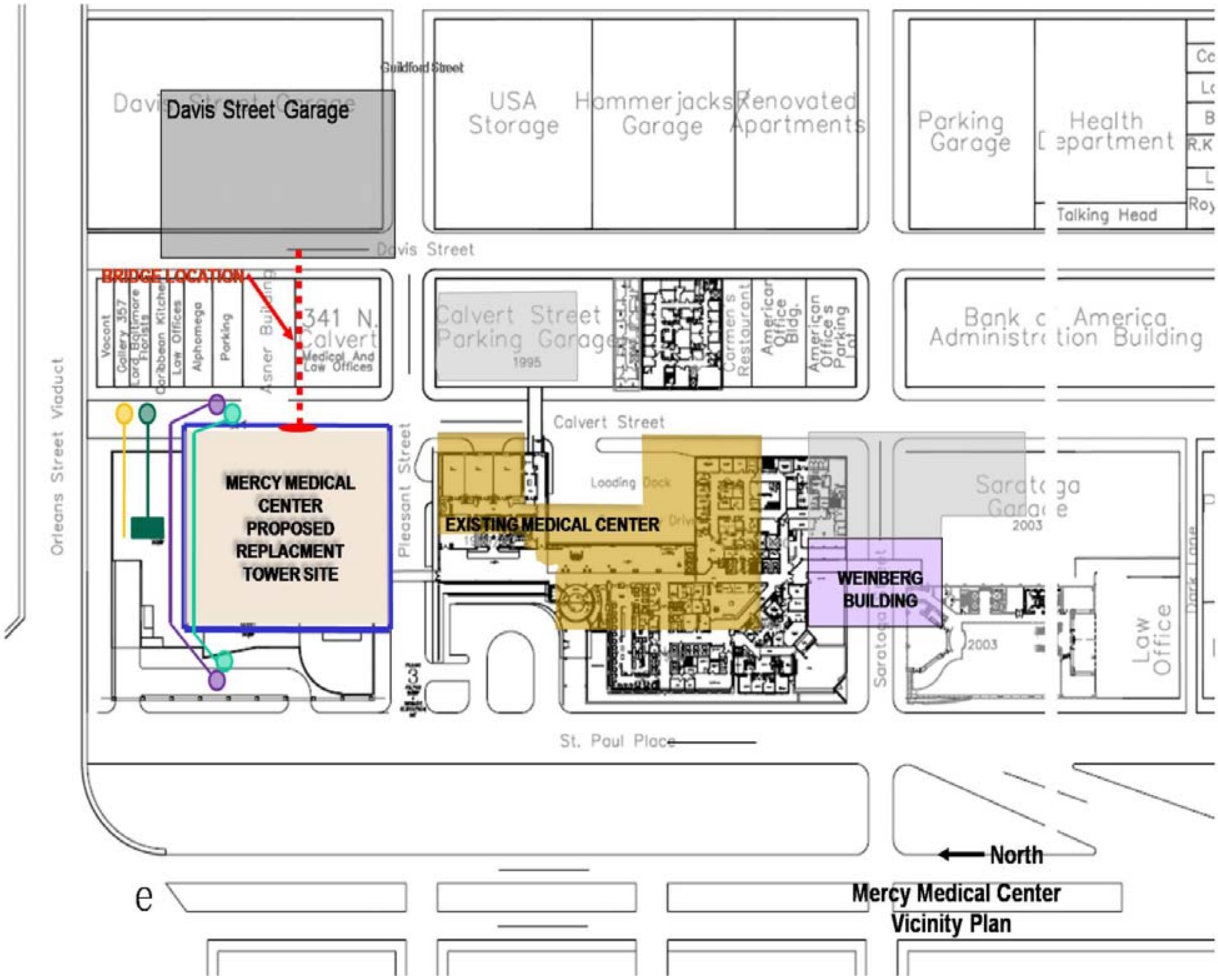
Appendix B

Existing to Remain Utilities



- Existing Verizon to remain -----
- Existing Electrical to remain -----
- Existing storm to remain -----
- Existing Sanitary to remain -----
- Existing water to remain _ _ _ _

Relocated Utilities



- Relocated Verizon
- Relocated Electrical
- Relocated Storm
- Relocated Sanitary

Appendix C

Women in Construction Worshop

"Empowering Women for the future"

Pennsylvania State University

The Purpose

- The purpose of the Workshop is to provide a medium between current industry members and soon-to-be graduates.
- As a female within the construction sector it is hard to find a network where industry members can actively communicate and share ideas.

The Format

- The workshop is to be modeled after the PACE workshop which takes place twice a year.
- Female industry members will be invited to converse about the various issues they face, as well as discuss the many opportunities available within the construction industry.
- Invitees will include high school female students interested in the construction sector, soon-to-be graduates, and recent graduates.
- The focus will be placed on students seeking a construction management degree, mainly those in architectural engineering, and civil engineering.

Topics Discussed

- To learn about common issues within the construction industry and share ideas and best practice in dealing with these.
- To network with like-minded people who share the same issues and to develop new business relationships

The Approach

The workshop will be a luncheon, to foster an informal atmosphere. This will allow for everyone to feel comfortable networking with industry members as well soon-to-be graduates.

Appendix D

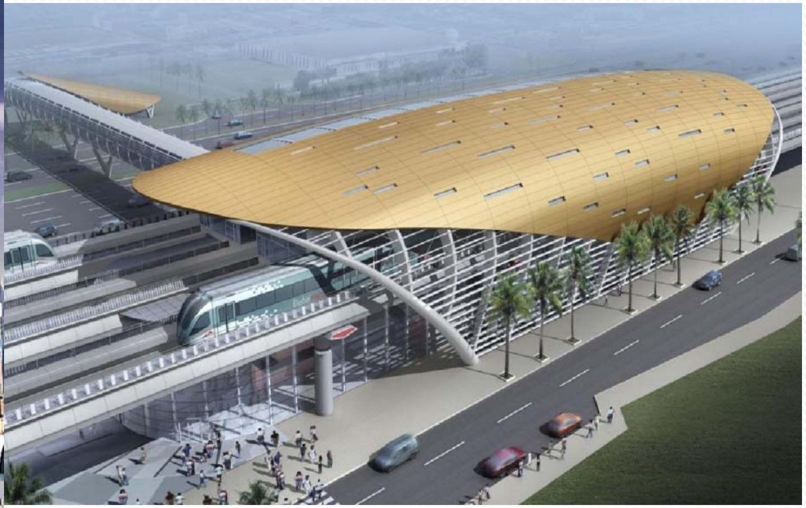
Architectural Engineering: Building the Future

What is Architectural Engineering?

- **Architectural Engineering** deals with all engineering aspects of building performance, integrated with the building's architectural requirements.

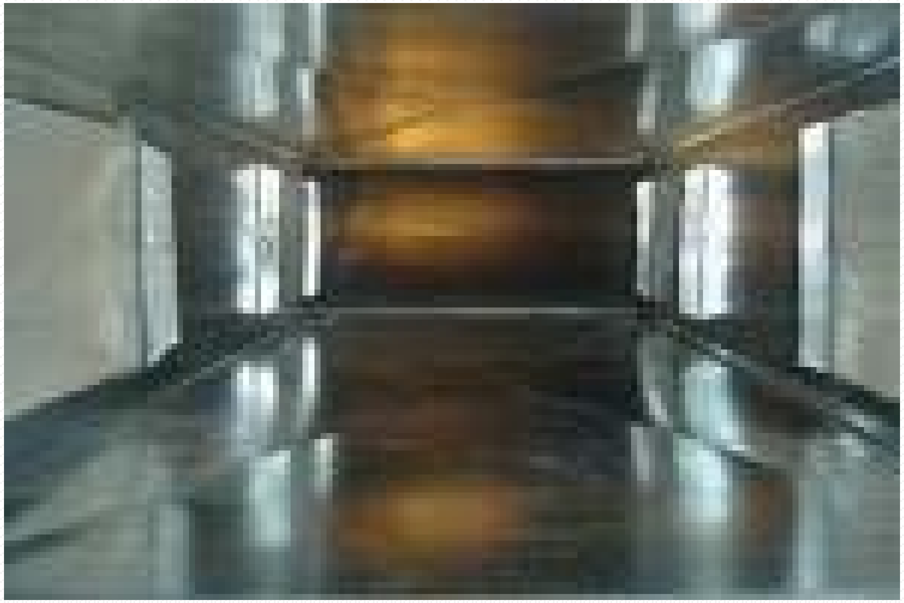
The broad world of Architectural Engineering

Construction management Combines the technical education of engineering with the financial, legal, and business skills of management. These include methods and materials for construction, cost estimating, and planning and scheduling of construction projects.



The broad world of Architectural Engineering

- **Mechanical** is concerned with the design of Air conditioning and HVAC systems. These systems improve the air we breath.They also regulate temperatures.



The broad world of Architectural Engineering

- • **Structural** deals with the design of structures that successfully integrate science, and architecture.



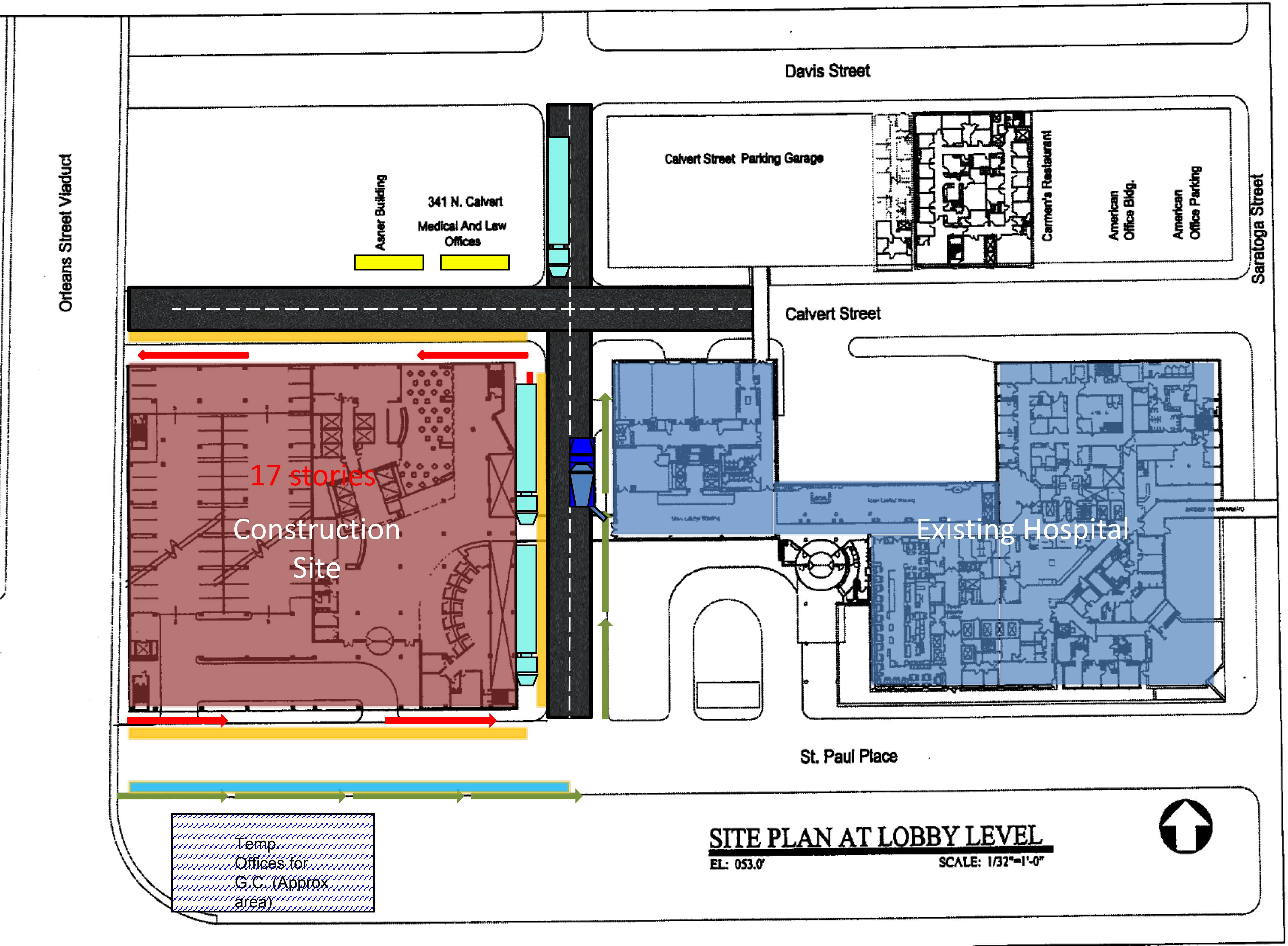
The broad world of Architectural Engineering

- **Lighting and Electrical involves the design of lighting systems seen in classrooms as well as restaurants.**

Where can you work?

- ANYWHERE YOU WANT!!!

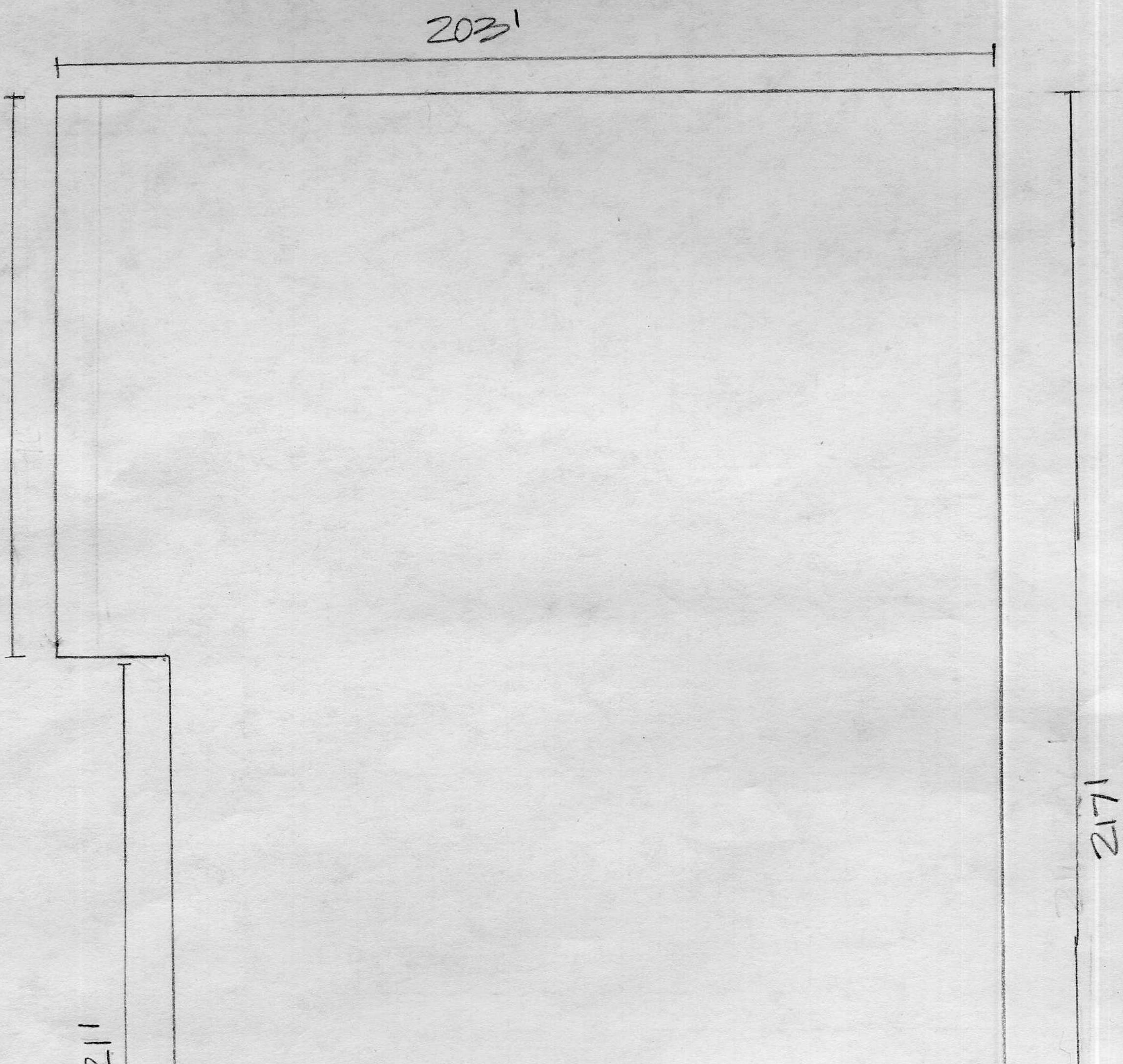
Appendix E



Davis Street
Calvert Street Parking Garage
Carmen's Restaurant
American Office Bldg.
American Office Parking
Saratoga Street
Orleans Street Viaduct
Asner Building
341 N. Calvert
Medical And Law Offices
Calvert Street
17 stories
Construction Site
Existing Hospital
St. Paul Place
Temp. Offices for G.C. (Approx area)
SITE PLAN AT LOBBY LEVEL
EL: 053.0'
SCALE: 1/32"=1'-0"

Appendix F

FOUNDATION RE-DESIGN



TOTAL SQUARE FEET:

FOUNDATION AREA = 217 × 203 = 44,051 SQ.FT

MINUS 121 × 20.916' = 2,530.836 ≈ 2531 SQ.FT

TOTAL FOUNDATION SQ.FT = 41,520.1 SQ.FT

BUILDING SQ.FT

LEVEL	GROSS AREA
GROUND	50,010 SF
LEVEL 1	40,420 SF
LEVEL 2	40,700 SF
LOBBY	40,000 SF
LEVEL 3	30,830 SF
LEVEL 4	47,960 SF
LEVEL 5	47,960 SF
LEVEL 6	47,960 SF
LEVEL 6.5	21,400 SF
LEVEL 7	37,085 SF
LEVEL 8	29,700 SF
LEVEL 9	30,540 SF
LEVEL 10	29,700 SF
LEVEL 11	29,700 SF
LEVEL 12	29,700 SF
LEVEL 14	29,700 SF
LEVEL 15	29,700 SF
LEVEL 16	29,700 SF
LEVEL 17	29,700 SF
TOTAL	672,465 GSF

LIVELOAD:

= (672,465 GSF)(150 PSF) + (30 PSF)(29,700 GSF)

LL = 100,869.75 KIPS + 891 KIPS

= 101,760.75 KIPS ≈ 101,761 KIPS

MISC FLOOR LOADS

30 PSF (672,465 SF) = 20,174 KIPS

ROOF LOADS

30 PSF (29,700) = 891,000 lb / 1000 = 891 Kps

CONCRETE

STRUCTURAL CONCRETE — 5,309 CY ?

ELEVATED SLABS — 9339.79 CY

SHEAR WALLS — 3215 CY ?

COLUMNS — 2106.2 CY

19,970 CY

$19{,}970\,CY \times 27\frac{CF}{CY} \times 150\,lb/CF = 80{,}878{,}500/1000 = 80{,}878.5\,KIPS$

REINFORCING: 1,125 TONS

$1{,}125\,TONS \times \frac{2000\,lbs}{TON} = 2{,}250{,}000\,lbs/1000 = 2{,}250\,KIPS$

POST-TENSIONING: 573 KIPS

WEIGHT STRUCTURE:

80,878.5 + 2,250 + 573 = 83,702 KIPS

TOTAL BUILDING DEADLOAD:

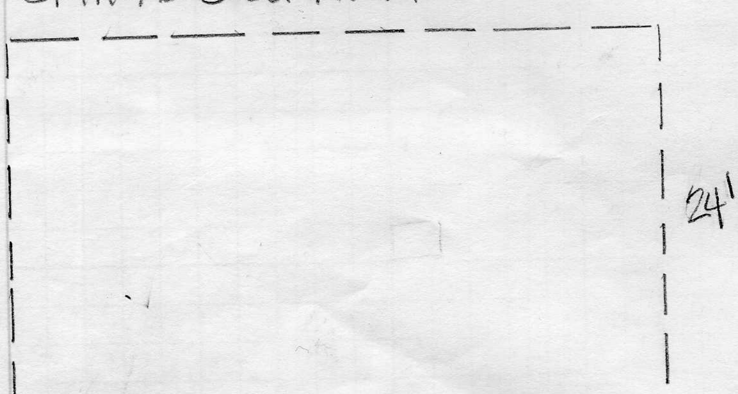
83,702 KIPS + 20,174 + 891 = 104,767 KIPS

FACTORED LOAD: ACI 318-95

(1.4)(104,767) + 1.7(101,761) =
146,673 + 172,993.7 = 319,666.7 KIPS

NON-FACTORED: 206,528 KIPS

CRITICAL COLUMN LOAD:



319,667 KIPS / (41,530) = 7.697 Kips/Ft

CRITICAL COLUMN LOAD

FACTORED LOAD ON COLUMN

(24X37) X 7.697 = 6,834.9 Kips

$b_0 = 4(24+d) = 96+4d$

$\frac{(.85)(4)(\sqrt{6000})}{1000} \geq 6,834$ Kips

$(96+4d)d \geq 25,948.9$ Kips

$96d+4d^2 > 25,948.9$ Kips

d = 69.4

d ≈ 70

3 inches OVER REINFORCE + 1 inch Reinforce

Mat slab thickness = 74 inches

REINFORCING (ACI 318.95)

$\frac{200}{Sy} = \frac{200}{60,000} = .00333$

As = (.00333)(12)(70) ⇒ As = 2.7972 in^2/ft

As = 2.8 in^2/ft

Use No. 11 bars at 6½ inches apart

MAT CONCRETE QUANTITY

(74/12)(41,530) = 256,101.66/27 = 9,485.24 CY x 1.05 = 9,959.5 CY

REINFORCE QUANTITY

(8)(41,530) = 332,240 ft

$(332,240 ft)(5.313 lb/ft) = \frac{1,764,766.08}{2000 lb/ton} = 882.38$

883 TONS

WEIGHT OF MAT SLAB:

9,959.5 CY x 27 $\frac{CF}{CY}$ x 150 lb/CF + 883 TONS x 2000 lb/TON =

40,335,975 + 1,766,000 = 42,101,975 lbs

= 42,101.9 KIPS

ALLOWABLE BEARING CAPACITY:

$$q_{net(ALL)} = .25N_{60}\left[1+.33\left(\frac{D_f}{B}\right)\right][S_e(in)] \leq .33N_{60}[S_e(in)]] =$$

$N_{60} = 10$ $S_e = .75$ inch

$B = 203'$

D_f = Depth of foundation measured from ground surface. → 12in

$$q_{net(ALL)} = .25(10)\left[1+.33\left(\frac{12}{203}\right)\right][.75in] \leq .33(10)(.75$$

$$2.5 + .048 = (2.548)(.75) = 1.911 \text{ kips/ft}$$

$$q = \frac{\text{BUILDING LOAD} + \text{MAT SLAB}}{\text{AREA OF FOUNDATION}} - \gamma D_f$$

$$\frac{104,707,000}{41,520} + 42,101,975 = 3,536.3 - 8(100)$$

$3,536.3 - 800 =$

$2,736.3$

2.736 KIPS/FT

ICRA Resources

Infection Control Risk Assessment
Matrix of Precautions for Construction & Renovation

Step One:

Using the following table, *identify* the Type of Construction Project Activity (Type A-D)

TYPE A	**Inspection and Non-Invasive Activities**. Includes, but is not limited to: ▪ removal of ceiling tiles for visual inspection limited to 1 tile per 50 square feet ▪ painting (but not sanding) ▪ wallcovering, electrical trim work, minor plumbing, and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
TYPE B	**Small scale, short duration activities which create minimal dust** Includes, but is not limited to: ▪ installation of telephone and computer cabling ▪ access to chase spaces ▪ cutting of walls or ceiling where dust migration can be controlled.
TYPE C	**Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies** Includes, but is not limited to: ▪ sanding of walls for painting or wall covering ▪ removal of floorcoverings, ceiling tiles and casework ▪ new wall construction ▪ minor duct work or electrical work above ceilings ▪ major cabling activities ▪ any activity which cannot be completed within a single workshift.
TYPE D	**Major demolition and construction projects** Includes, but is not limited to: ▪ activities which require consecutive work shifts ▪ requires heavy demolition or removal of a complete cabling system ▪ new construction.

STEP 1:____

Step Two:

Using the following table, ***identify* the Patient Risk Groups** that will be affected.
If more than one risk group will be affected, select the higher risk group:

Low Risk	Medium Risk	High Risk	Highest Risk
▪ Office areas	▪ Cardiology ▪ Echocardiography ▪ Endoscopy ▪ Nuclear Medicine ▪ Physical Therapy ▪ Radiology/MRI ▪ Respiratory Therapy	▪ CCU ▪ Emergency Room ▪ Labor & Delivery ▪ Laboratories (specimen) ▪ Newborn Nursery ▪ Outpatient Surgery ▪ Pediatrics ▪ Pharmacy ▪ Post Anesthesia Care Unit ▪ Surgical Units	▪ Any area caring for immunocompromised patients ▪ Burn Unit ▪ Cardiac Cath Lab ▪ Central Sterile Supply ▪ Intensive Care Units ▪ Medical Unit ▪ Negative pressure isolation rooms ▪ Oncology ▪ Operating rooms including C-section rooms

Step 2____

Step Three: ***Match* the**

Patient Risk Group (***Low, Medium, High, Highest***) with the planned **…**
Construction Project Type (***A, B, C, D***) on the following matrix, to find the **…**
Class of Precautions (***I, II, III or IV***) or level of infection control activities required.

Class I-IV or Color-Coded Precautions are delineated on the following page.

IC Matrix - Class of Precautions: Construction Project by Patient Risk

Patient Risk Group	Construction Project Type: TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	I	II	II	III/IV
MEDIUM Risk Group	I	II	III	IV
HIGH Risk Group	I	II	III/IV	IV
HIGHEST Risk Group	II	III/IV	III/IV	IV

Note: Infection Control approval will be required when the Construction Activity and Risk Level indicate that **Class III** or **Class IV** control procedures are necessary.

Step 3____

Description of Required Infection Control Precautions by Class

	During Construction Project	Upon Completion of Project
CLASS I	1. Execute work by methods to minimize raising dust from construction operations. 2. Immediately replace a ceiling tile displaced for visual inspection	
CLASS II	1. Provide active means to prevent airborne dust from dispersing into atmosphere. 2. Water mist work surfaces to control dust while cutting. 3. Seal unused doors with duct tape. 4. Block off and seal air vents. 5. Place dust mat at entrance and exit of work area 6. Remove or isolate HVAC system in areas where work is being performed.	1. Wipe work surfaces with disinfectant. 2. Contain construction waste before transport in tightly covered containers. 3. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area. 4. Remove isolation of HVAC system in areas where work is being performed.
CLASS III	1. Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. 3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 4. Contain construction waste before transport in tightly covered containers. 5. Cover transport receptacles or carts. Tape covering unless solid lid.	1. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department and Infection Control Department and thoroughly cleaned by the owner's Environmental Services Department. 2. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 3. Vacuum work area with HEPA filtered vacuums. 4. Wet mop area with disinfectant. 5. Remove isolation of HVAC system in areas where work is being performed.
CLASS IV	1. Isolate HVAC system in area where work is being done to prevent contamination of duct system. 2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. 3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 4. Seal holes, pipes, conduits, and punctures appropriately. 5. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave the work site. 6. All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area. 7. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department and Infection Control Department and thoroughly cleaned by the owner's Environmental Services Department.	1. Remove barrier material carefully to minimize spreading of dirt and debris associated with construction. 2. Contain construction waste before transport in tightly covered containers. 3. Cover transport receptacles or carts. Tape covering unless solid lid 4. Vacuum work area with HEPA filtered vacuums. 5. Wet mop area with disinfectant. 6. Remove isolation of HVAC system in areas where work is being performed.

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Steps 4-14 Adapted with permission Fairview University Medical Center, Minneapolis MN by ECSI Inc 2001
Forms modified and provided courtesy of J Bartley, ECSI Inc 2002

Step 4. **Identify the areas surrounding the project area, assessing potential impact**

Unit Below	Unit Above	Lateral	Lateral	Behind	Front
Risk Group	Risk Group	Risk Group	Risk Group	Risk Group	Risk Group

Step 5. **Identify specific site of activity eg, patient rooms, medication room, etc.**

____

Step 6. **Identify issues related to: ventilation, plumbing, electrical in terms of the occurrence of probable outages**.

____

Step 7. **Identify containment measures, using prior assessment. What types of barriers? (Eg, solids wall barriers); Will HEPA filtration be required?**

____

(Note: Renovation/construction area shall be isolated from the occupied areas during construction and shall be negative with respect to surrounding areas)

Step 8. **Consider potential risk of water damage. Is there a risk due to compromising structural integrity? (eg, wall, ceiling, roof)**

Step 9. **Work hours: Can or will the work be done during non-patient care hours?**

Sep 10. **Do plans allow for adequate number of isolation/negative airflow rooms?**

Step 11. **Do the plans allow for the required number & type of handwashing sinks?**

Step 12. **Does the infection control staff agree with the minimum number of sinks for this project?**
(Verify against AIA Guidelines for types and area)

Step 13. **Does the infection control staff agree with the plans relative to clean and soiled utility rooms?**

Step 14. **Plan to discuss the following containment issues with the project team. Eg, traffic flow, housekeeping, debris removal (how and when)**

____

____

Appendix: Identify and communicate the responsibility for project monitoring that includes infection control concerns and risks. The ICRA may be modified throughout the project. Revisions must be communicated to the Project Manager.

Steps 1-3 Adapted with permission V Kennedy, B Barnard, St Luke Episcopal Hospital, Houston TX ; C Fine, CA
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Infection Control Construction Permit

	Permit No:
Location of Construction:	Project Start Date:
Project Coordinator:	Estimated Duration:
Contractor Performing Work	Permit Expiration Date:
Supervisor:	Telephone:

YES	NO	CONSTRUCTION ACTIVITY	YES	NO	INFECTION CONTROL RISK GROUP
		TYPE A: Inspection, non-invasive activity			GROUP 1: Low Risk
		TYPE B: Small scale, short duration, moderate to high levels			GROUP 2: Medium Risk
		TYPE C: Activity generates moderate to high levels of dust, requires greater 1 work shift for completion			GROUP 3: Medium/High Risk
		TYPE D: Major duration and construction activities Requiring consecutive work shifts			GROUP 4: Highest Risk

CLASS I	1. Execute work by methods to minimize raising dust from construction operations. 2. Immediately replace any ceiling tile displaced for visual inspection.	3. Minor Demolition for Remodeling
CLASS II	1. Provides active means to prevent air-borne dust from dispersing into atmosphere 2. Water mist work surfaces to control dust while cutting. 3. Seal unused doors with duct tape. 4. Block off and seal air vents. 5. Wipe surfaces with disinfectant.	6. Contain construction waste before transport in tightly covered containers. 7. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area. 8. Place dust mat at entrance and exit of work area. 9. Remove or isolate HVAC system in areas where work is being performed.
CLASS III **Date** **Initial**	1. Obtain infection control permit before construction begins. 2. Isolate HVAC system in area where work is being done to prevent contamination of the duct system. 3. Complete all critical barriers or implement control cube method before construction begins. 4. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 5. Do not remove barriers from work area until complete project is thoroughly cleaned by Env. Services Dept.	6. Vacuum work with HEPA filtered vacuums. 7. Wet mop with disinfectant 8. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 9. Contain construction waste before transport in tightly covered containers. 10. Cover transport receptacles or carts. Tape covering. 11. Remove or isolate HVAC system in areas where work is being performed/
Class IV **Date** **Initial**	1. Obtain infection control permit before construction begins. 2. Isolate HVAC system in area where work is being done to prevent contamination of duct system. 3. Complete all critical barriers or implement control cube method before construction begins. 4. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units. 5. Seal holes, pipes, conduits, and punctures appropriately. 6. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave the work site.	7. All personnel entering work site are required to wear shoe covers 8. Do not remove barriers from work area until completed project is thoroughly cleaned by the Environmental Service Dept. 9. Vacuum work area with HEPA filtered vacuums. 10. Wet mop with disinfectant. 11. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. 12. Contain construction waste before transport in tightly covered containers. 13. Cover transport receptacles or carts. Tape covering. 14. Remove or isolate HVAC system in areas where is being done.

Additional Requirements:	
______ Date Initials	___Exceptions/Additions to this permit Date Initials are noted by attached memoranda
Permit Request By:	Permit Authorized By:
Date:	Date:

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Steps 4-14 Adapted with permission Fairview University Medical Center, Minneapolis MN
Forms modified and provided courtesy of J Bartley, ECSI Inc 2002

Phase **1:** Identify Project Risks

Processes for infection control	Description	**Importance of the processes in different risk areas**												**Cost of Implementation**			
		Low Risk			**Med Risk**			**High to Med Risk**			**High Risk**			**Low**		**High**	
				3	I	2	3	1	2	3	1	**2**	**.**	1	2	3	4
Identify the Feasibility	Reading through the project guidelines and applicable specifications will prepare the contractor for planning and proper feasibility analysis.																

Comments:

Phase 2: Preconstruction

Review the Guidelines and Specs	When team members refer to the infection control section of project specs, questions and concerns mush be addressed well before project starts.																
Identify The sensitivity of the area	The contractor needs to have the necessary tools to plan, estimate, and schedule in case they won't be told the level of risks until right before the construction.																
Conduct a safety Job Hazard Analysis																	
Set up roles of player/team	Everybody involved in construction process has to be aware of the tasks he/she is assigned to.																
Establish Cost Estimate/ Analysis	Budget monitoring is important to complete the project as planned and financed.																
Set up Monitoring/ Data Collection	The investigator must be cognizant of the many pitfalls associated with the interpretation of environmental data.																
Provide Preliminary Estimate	Infection control is factored into the estimate so concerns regarding the pricing or projected work should be discussed at this time																

Comments:

Phase **1:** IdentifyProject Risks

Processes for infection control	Description	**Importance of the processes in different risk areas**												**Cost of Implementation**			
		Low Risk			**Med Risk**			**High to Med Risk**			**High Risk**			**Low**			**High**
				3	I	2	3	1	2	3	1	**2**	**.**	1	2	3	4
Identify the Feasibility	Reading through the project guidelines and applicable specifications will prepare the contractor for planning and proper feasibility analysis.																
Comments:																	

Phase 2: Preconstruction

Review the Guidelines and Specs	When team members refer to the infection control section of project specs, questions and concerns mush be addressed well before project starts.																
Identify The sensitivity of the area	The contractor needs to have the necessary tools to plan, estimate, and schedule in case they won't be told the level of risks until right before the construction.																
Conduct a safety Job Hazard Analysis																	
Set up roles of player/team	Everybody involved in construction process has to be aware of the tasks he/she is assigned to.																
Establish Cost Estimate/ Analysis	Budget monitoring is important to complete the project as planned and financed.																
Set up Monitoring/ Data Collection	The investigator must be cognizant of the many pitfalls associated with the interpretation of environmental data.																
Provide Preliminary Estimate	Infection control is factored into the estimate so concerns regarding the pricing or projected work should be discussed at this time																
Comments:																	

Phase **3 - Estimating and Schedulin**

Processes for infection control	Description	Importance of the processes in different risk areas												Cost of Implementation			
		Low Risk			**Med Risk**			**High to Med Risk**			**High Risk**			**Low Cost**		**High Cost**	
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4
Incorporate Project Severity	Identify the sensitivity of the area will help greatly in determining infection engineering controls for equipment and productivity slowdowns.																
Select Materials	It is the contractor's responsibility to select the right materials. It plays an important role in infection control.																
Barrier Walls	If the contractor is responsible for constructing the barrier walls, this can have a big impact on scheduling and cost.																
Drywall Other Walls	In sensitive or long term projects, drywall partitions needs to be constructed.																
Attire Shutdown	Contractors have to be aware of the sensitive areas in order not to spread infection particles from dusty clothing.																
Equipment Care	The infection control equipments need to be supplied by contractor.																
Debris Removal and Clean Up	This step has to be done using tightly sealed containers.																
Comments:																	

Phase 4 - Pre-Work Preparation

Processes for infection control	Description	Importance of the processes in different risk areas												Cost of implementation			
		Low Risk			**Med** Risk			Hi to **Med** Risk			1-ti Risk			Low **Cost**			**High Cost**
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4
Set-up Coordination	There must be a clear communication and coordination between people working on project.																
Set up Teams	Each team and each member's accountability for their assigned role is critical																
Remove the Chemicals	Remove all chemicals from construction site.																
Remove all Radioactive	Proper decommissioning of work areas should eliminate the hazard.																
De-Energize Power Sources	All power sources has to be turned off																
Analyze Ventilation plenums	Any work on the HVAC system must be planned well advance and coordinated with the infection control committee.																

Comments:

Phase **5 - Mobilization**

Processes for infection control	Description	**Importance of the processes in different risk areas**												**Cost of Implementation**			
		Low Risk			**Med** Risk			Hi **to Med** Risk			Hi Risk			Low		**High**	
		1	2	3	1	2	3	1	2	3	1	2	**3**	1	2	3	4
Set up Air Quality Equipment	Before beginning the construction work, HEPA vacuum and a negative air machine need to be set up.																
Build Storage Areas	Clinical areas must maintain appropriate storage areas																
Build barrier Walls	The area to be barricaded should be isolated, as the project requires																
Establish Laminar Airflow	Proper airflow must be set up and tested before the construction activity begins																
Seal Windows and Doors	To minimize infiltration from activities such as debris removal, windows and doors need to be tightly sealed																
Establish Traffic Patterns	To reduce the amount of dust and dirt in the hospital and the risk of exposures to infection agents, patients, visitors, and staff may need to traverse the hospital by alternative routes.																

Comments:

Phase **6 - Construction Management**

Processes for infection control	Description	Importance of the processes in different risk areas												Cost of Implementation			
		Low Risk			Med Risk			Hi to Med Risk			Hi Risk			Low Cost			High Cost
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4
Set up clear and good Communication	During the construction process good communication needs to be set up.																
Emergency Issues/Risk Reduction	When there is an emergency an immediate action needs to be taken																
Biological Contamination	Decommissioning of the work area and proper work practices should minimize the risk of infection.																
Demolition Walls and Doors	The contractor must be aware of fungal infestation that may be exposed during demolition.																
Remove the Waste	If a wall system for depositing waste as accessing its removal is planned, then the construction materials and mechanisms would address infection control aspects of contaminant and confinement with risk reduction cleaning capabilities.																
Clean-up	Neighboring areas, especially the area just outside the door of the construction area, should be cleaned with a damp mop each day or more frequently when needed																

Comments:

Phase 7 - Closeout and Commissioning

Processes for infection control	Description	Importance of the processes in different risk areas												Cost of Implementation			
		Low **Risk**			**Med Risk**			**Hi to Med Risk**			**Hi Risk**			Low **Cost**			**High Cost**
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4
Monitoring and Check up	All parameters for ventilation and cleanliness are usually checked at this point and air count and particle data analyzed.																
Inspect the area one week before the barrier walls are taken down	Contractors cannot remove barrier walls until monitoring has been completed and results are satisfactory.																
Take Down Barrier Walls	The contractor cannot remove barrier walls until monitoring has been completed and results are satisfactory.																
Comments:																	