

Final Report

April7, 2010

Emily Couric Clinical Cancer Center Charlottesville, VA

http://www.engr.psu.edu/ae/thesis/portfolios/2010/bnm5016/index.html

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University of Virginia

Architecture:

DESIGN: Consolidate existing

ROOM TYPES: Exam, 3 Linear

Accelerator, Offices,

services into one building

Radiation/Oncology, Café,

Access HUB, Phlebotomy

LOBBY: Large entry lobby 2 stories

EXPANSION: Entire fourth floor

Project Team:

Building Statistics:

Treatment Center

SIZE: 153,104 SF

COST: \$74 Million

STORIES: 6

FUNCTION: Out Patient Diagnostic and

CONSTRUCTION: Apr. 2008 – Dec. 2010

DELIVERY METHOD: Design-Bid-Build

Owner: University of Virginia CM: Gilbane Building Co. Architect: Zimmer-Gunsul-Frasca Architects, LLC MEP Engineers: AEI Surveying Engineers: Hurt & Profitt Structural Engineers: Robert Silman Associates, PLLC Consultants: Shirmer Testing Agency: Schnabel



Building Envelope: WALLS: Mostly Brick Veneer with a large Curtain Wall ROOF: Main roof, EPDM singleply roof membrane system with a white acrylic coating. Roof garden exists with similar materials



Structural:

FOUNDATION: Spread footings for support columns FRAMING: Structural Steel, Columns varying from W10x33 to W14x159 CONCRETE SLAB: 3" GA composite deck with 3.5" L.W. concrete and WWF 6x6 W2.9xW2.9

LIVE LOAD: Average is 100 PSF to include partitions

Lighting/Electrical:

480/277 Volts distributed throughout the building 23 Local transformers step from 480 to 208/120 V 83 panel boards located throughout the building 65 different light fixtures Lighting uses 277 Volts Recessed and suspended mounted fixtures with mostly fluorescent lights

Mechanical:

System: All-air with a local reheat unit in each room 4 MAIN AHUS: each supply 45,000 CFM, 529 MBH heating capacity, 2,390 MBH cooling capacity

located in the penthouse

288 Air Terminal Units: Varying from 70-1790 CFM, 1994-92108 Btuh Heating Coil Capacity

Brittany Muth

2010 Construction Option

<a>http://www.engr.psu.edu/ae/thesis/portfolios/2010/bnm5016/index.html>

EXECUTIVE SUMMARY

The Emily Couric Clinical Cancer Center in Charlottesville, VA is a 154,000 SF building owned by the University of Virginia. It is being constructed to combine existing cancer services into one building. It is scheduled for 2 years and to end within the budget of \$74 million. There were a few topics that were of interest to be studied and analyzed in this thesis.

The first analysis will be of the topic of using BIM technologies for façade construction. BIM was not implemented on this project at all. Not many people have been using BIM for the façade and it would be interesting to see how BIM can be used for façade construction. If people are using it for façade construction, in what ways is it being used and how do people wish it could be used?

The second analysis is of incorporating solar panels into the façade. Typically, solar panels are put on the roof and out of sight or they are put in fields away from the building. What kind of solar panels exist that can be designed into the façade? The Emily Couric Clinical Cancer Center has a large curtain wall on the South side of the building and it would be interesting if solar panels could be incorporated into the curtain wall without blocking the view. If there are technologies that can be incorporated into the curtain wall, are they economical? What would the payback period be and is it actually beneficial to be incorporated into the façade? All of these questions will be answered and discussed in great detail later in this paper.

The final analysis will be analyzed in the most detail. It is an analysis of the option of prefabricating the brick façade on the cancer center. It seems like a logical analysis because the majority of the façade is either brick or curtain wall so why not look into the possibilities? The prefabrication of the brick façade is not only a construction management depth but also a mechanical breadth. The impact on the budget, schedule, site logistic, and mechanical system will be analyzed. Also being discussed is the decision as to whether or not the prefabricated façade is actually beneficial or just a waste of money to decrease the schedule.

All of these analyses are discussed in more detail with a conclusion as to whether the results are worth implementing on the project or if it was a good idea not to implement them. Some of the are beneficial and others are not as beneficial. Nonetheless, all of the analysis were beneficial to my education and have taught me a lot about these topics that I can use in the industry.

CREDITS AND ACKNOWLEDGMENTS

University of Virginia: Fred Dunn Jeff Moore Dee Eadie

Gilbane Building Company Mike Poulin, Project Executive

ISEC, Inc.:

Matt Heistand Paul Harsch Jim McAllister

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Clark Nexson Jonathan Walker

Davis Construction

Balfour Beatty

Jacobs Engineering

United States Army Corps Engineers:

The Pennsylvania State University: Faculty

Friends and family

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INTRODUCTION

The Emily Couric Clinical Cancer Center is being constructed on the University of Virginia to consolidate their cancer services into one building. The University of Virginia (UVA) is located in Charlottesville, Virginia and it was founded by Thomas Jefferson in 1819. UVA currently has over 20,000 students attending the university. They have many degree programs in ten different schools including engineering, law, and medicine.

The cancer center has been in the planning stages since 2005 and under a budget of **\$74 million**. The building is a design-bid-build project with the construction managers being Gilbane Building Company. The building is a 6 story building containing **153,104 SF**. The UVA broke ground on April 12, 2008 and is expecting the project to be completed December 29, 2010 to allow 3 months to move in furniture and prepare for opening day.

UVA chose to build this building because they have a lot of services for cancer patients already but they are spread out in different buildings throughout campus. They thought it would be a good idea to consolidate the services into one building making it easier on the patients. Dee Eadie explained it as a "one stop shopping experience in a holistic healing environment that provides hope, solace, and cutting edge cancer treatment."There are two reasons why the building was chosen to be constructed. One of the reasons was the death of the Virginia State Senator Emily Couric that was related to cancer. The other reason was there is an expected growth in cancer patients in the next fifteen years due to the aging baby boomers. The project is on its way to becoming a LEED Silver project with the newest technologies.

PROJECT BACKGROUND PROJECT DELIVERY SYSTEM

The Emily Couric Clinical Cancer Center is being delivered as a design-bid-build project. There was not a big push to get it done as fast as possible therefore the design-bid-build process seemed to be logical to use. The contractors are responsible to obtain and maintain "all-risk" builder's risk insurance in both the owner's and contractor's name. The contractor is required to have worker's compensation, employer's liability insurance, commercial general liability insurance, automobile liability insurance and occurrence-based liability insurance throughout the entire duration of the project. The contractor is required to provide a standard performance bond and a standard labor and material payment bond. Each of the subcontractors were chosen by first being pre-qualified and then by competitive bid. Having the contractor who will provide the quality for the best price by making it a competitive bid.

The owner holds all of the contracts of the trades and the CM helps to monitor the work and assure the work is being completed and to the owner's expectations. The contractors have agreed to report to both the owner and the CM with any questions or concerns. This was chosen because it allows the owner to be involved more because they have experience in construction. One issue could arise because the CM has no contractual agreement with the subcontractors and could have little influence on them if they are falling behind. Below, in **Figure 1**, is an organizational chart representing communication lines and contractual lines.



Figure 1: Project Level Organizational Chart

CONSTRUCTION MANAGER ORGANIZATIONAL CHART

Gilbane Building Company put together a staffing plan for their company as shown in **Figure 2** below. It includes a district manager, project executive, office manager, senior project engineer, office engineer, superintendent and a general superintendent. The lines on the figure show the relationship and who reports to whom. The office manager takes care of the administrative items. The senior project engineer is in charge of the typical engineering functions and the office engineer is in charge of RFI's and submittals. The superintendents are responsible for different field duties.



Figure 2: Construction Manager (Gilbane Building Co.) Organizational Chart

SITE CONDITIONS

The existing site conditions consisted of a parking garage that the University of Virginia has decided to demolish. The site does not contain a lot of extra space for trailers, storage of materials, and easy mobilization around the site. Therefore, the office trailers will be located near the site but not on the site. Existing utilities are also located on the site and need to be taken into consideration during construction.

The parking is very limited near the site and the employees have to try and find public parking if they drive to work. Most of the construction workers park in the nearby parking garage and the rest try to find other parking downtown as close to the site as possible. There will be temporary lighting located throughout the building after the floors start to be constructed. The working hours will be during daylight and it will not be necessary to light the sight during the night hours. Therefore, I did not locate any temporary lighting. The site outline is also the symbol for the fence surrounding the site during construction.

DEMOLITION

Since the parking garage was on the existing site, it needed to be demolished before construction could begin on the cancer center. Existing sidewalks and underground utilities also needed to be

demolished before the construction could begin. The types of materials that were demolished were concrete, asphalt and other yard structures on the site. The method of demolition used for the parking garage was to take it down little by little from top to bottom. Each piece of the structure had to be carefully removed from the site. The use of explosives was not permitted because of the surrounding buildings and other issues caused by explosives. Not using explosives helps to reduce the dust irritation that would be created with explosives. A picture of the demolition stage, provided by the UVA, is shown in **Figure 3**.

Figure 3: Demolition of the existing parking garage.

ARCHITECTURE

The general architecture of the cancer center includes a number of different spaces because the purpose was to bring together different services into one building. A few examples include 3 linear accelerator rooms, offices, radiation and oncology, a café, phlebotomy and an access hub. One of the grander spaces is the two story entry lobby which is encased with a curtain wall system to allow for optimal day lighting and bright space. The University of Virginia has decided to build a building that is larger than their needs to allow for expansion on the fourth

Figure 4: Rendering of entrance lobby.

floor. A rendering, provided by the UVA, of the entrance lobby is shown to the right in **Figure 4**. Below in **Figure 5**, is an image provided by the UVA of what the building will look like when it is completed.

Figure 5: Rendering of the facade of the cancer center.

BUILDING ENVELOPE

The building envelope includes many different materials and can be seen in the previous **Figure 5**, provided by the UVA. The main façade consists of a curtain wall system, brick veneer and stone. The building includes a large amount of masonry. The masonry on this project consists of eight inch concrete masonry units (CMU) as the exterior load bearing wall covered with brick veneer. The brick veneer is connected to the CMU block wall by galvanized bent steel plates. There was scaffolding placed around the building as they moved up the building to place the brick. At the floor levels the brick veneer changes and puts two rows of soldier bricks. The CMU blocks are covered with a transition membrane and insulation. There is a row of continuous stainless steel flashing around the building is used to direct water away from the building. Recycled content was used for this part of the building to help achieve LEED points for the project.

The curtain wall system is an aluminum frame system by Kawneer that is a sustainable product also attributing to the LEED credits. This all contributes to two different LEED credits including optimizing energy performance and on-site renewable energy. Together, these credits can total up to twenty six points which is a significant piece of the LEED Silver rating the University of Virginia is trying to obtain.

The LEED Silver rating, trying to be obtained, has affected the construction of the building envelope in a couple ways. They have designed a roof garden into their building to assist with the LEED points and it also creates a pleasant environment for the patients and employees to

spend time at. The roofing materials they have chosen is an EPDM (ethylene propylene dieneterpolymer) single-ply roof membrane system with a white acrylic coating. This gives the building a white roof which helps to reduce the heat island effect and the cooling load of the building by reflecting the heat from the sun away from the building. In **Figure 6**, the components that make up an EPDM roofing system are shown (found atwww.roofwise-se.com).

Figure 6: Example of EPDM Roofing components.

STRUCTURAL SYSTEM

The average live load calculated for the building is a 100 psf including partition. Using the loads the following system was designed and used for the Emily Couric Clinical Cancer Center. The foundation of the building consists of seventy seven caissons to support columns of the building. A picture of this part is shown in **Figure 7**, which was provided by the UVA. The main structural support in the building is a steel frame with metal deck and concrete slabs. The steel columns include a wide variety of sizes from W10x33 to

Figure 7: Drilling and placing caissons.

W14x159. Temporary bracing was be used to provide for the loads subjected to the structure while being constructed. A crane was used to construct this system and also used for the cast in place concrete slab that was constructed on top of the steel frame. The concrete slab is a three inch galvanized composite deck with three and a half inches of lightweight concrete. It is reinforced with a welded wire fabric size of 6x6 W 2.9xW 2.9. The picture below, in **Figure 8**, is of the steel frame system and was provided by the UVA.

Figure 8: Structural system.

MECHANICAL SYSTEM

The designed mechanical system for the building is an all-air system with a local reheat unit in each room. There are four main air handling units (AHU), each supplying the building with 45,000 CFM of air. Each of the AHU's have a 2,390 MBH cooling capacity and a 529 MBH heating capacity. All of these units are located in the penthouse. The system also includes 288 air terminal units supplying varying amounts of air from 70-1790 CFM. These units have anywhere from 1,994 to 92,108 Btuh heating coil capacity. The necessary fire dampers and fire-stopping procedures will be installed on this project complying with ASTM E-814. There is also a wet-pipe fire-suppression sprinkler system going to be installed to protect the occupants in the case of a fire.

LIGHTING AND ELECTRICAL SYSTEMS

The electrical system is a 480/277 volt system distributed throughout the building. Twenty three local transformers are used to step the 480 to 208/120 volt system, which is what is used to power our buildings equipment and lights. There are eighty three panel boards located throughout the building to locally distribute the electric to the building.

The lighting system in the building is powered with 277 volts of electricity. There are sixty five different types of fixtures being installed in the building. The majority of the fixtures are recessed and suspended mounted fixtures. The typical bulbs used in the building are fluorescent lights, which typically use less energy to create the same amount of light as an incandescent bulb.

EXISTING CONDITIONS LOCAL CONDITIONS

Typically in the Charlottesville, Virginia area, buildings are constructed using steel framing with composite metal decking for the structure of the project. Downtown Charlottesville is a little crowded and hard to store materials and move around the buildings being constructed. The construction workers have a difficult time finding parking near the site because they have to park in public parking areas. There is a garage near the site but it gets full quickly and they have to find other parking spots downtown. The University of Virginia owns most of the property in Charlottesville and is constructing a few projects in the area. They are very interested in becoming more sustainable and achieving LEED certification.

Along with the LEED certification, recycling is available and is being used on this project. They recycle over 90 percent of their waste materials and it is very common in the area. The tipping fees are not known for this project and are being researched.

The soils on the site in Charlottesville, VA consist of dense sand and hard consistency silts and hard consistency disintegrated rock. Due to there already being a structure on the site there was existing fill detected in their analysis that is above the natural materials. The soil is suitable for new compacted structural fill except it is not recommended for direct support for slaps and pavements due to its high swell values.

The water levels were observed between 29 and 40 feet in a few borings and the others remained dry up to 26.5 feet. A water observation well was drilled and measured at 4 days and 38 days. The depths of the water level were measured to be 35.5 and 31.5 feet in the water observation well.

One thing that needs to be identified under local conditions is the zoning regulations for the location of the building. The Emily Couric Clinical Cancer Center is located in the B-3 Commercial zoning section of Charlottesville, VA according to the Code of Ordinances of Charlottesville, VA. Under chapter 34, Article IV, Division 2, the height of a building is limited to 70 feet. Hospitals and health clinics in the B-3 zoning areas are required to have a by-right use permit. The green box on the map below, in Figure, shows the location and zoning area of the Emily Couric Clinical Cancer Center. (www.charlottesville.org, Zoning Map, 2009)

Figure 9:Zoning Map 2009 (0H<u>www.charlottesville.org</u>, Zoning Map, 2009)

PROJECT SCHEDULE

A detailed project schedule, derived from a much more detailed schedule last updated in February 2009, can be found in **Appendix A**. This schedule expands upon the project schedule summary in the previous technical assignment. This project has been in the planning stages since 2005 and finally broke ground on April 12, 2008. They mobilized the site in June of 2008 as the garage demolition was finishing. They had to demolish an existing parking garage before they could start building the cancer center. The building is separated into three different sections by column lines F-K, C-F, and Z-C for the construction of the exterior walls. The steel is split into 17 sequences and will top out on May 28, 2009. It is being constructed from the east to the west, floor by floor and will be substantially complete on December 29, 2010.

ANALYSIS 1: FAÇADE CONSTRUCTABILITY ANALYZED WITH BIM BACKGROUND

The first analysis will deal with the use of Building Information Modeling (BIM) for at least the façade of the Emily Couric Clinical Cancer Center. BIM is becoming more and more popular in the construction industry and the technology is becoming more advanced and user friendly to make this tool more useful in actual construction. BIM is very helpful in coordination and clash detection on construction projects. There are many benefits to using BIM on a construction project; one of the main reasons is that building the building in a virtual environment helps to reduce the number of construction conflicts in the field. This analysis will provide an area for critical industry research and constructability analysis.

PROBLEM/OPPORTUNITY STATEMENT

The University of Virginia chose not to implement the use of Building Information Modeling on the Emily Couric Clinical Cancer Center. After discussing some of the time consuming issues on the project with the project team, it was determined that the façade of the building consumed a large amount of time on coordination on this project. Because the façade includes many different materials, the connections of these materials needed to be intensely coordinated. Because the use of BIM was not implemented on this project all of the analysis will be based on previous projects and what is expected of proper use of BIM technologies.

RESEARCH STEPS

- 1. Create survey questions to be sent to numerous industry members.
- 2. Create and easy to use, short survey in <u>www.surveymonkey.com</u>
- 3. Make contacts to send survey to and allow time for responses.
- 4. Send survey to the numerous contacts.
- 5. Collect data.
- 6. Review and analyze data.
- 7. Apply results to the Emily Couric Clinical Cancer Center.

INTERVIEW AND SURVEY QUESTIONS

The responses to these questions are provided in Appendix B.

- 1. Have you worked on projects that both used traditional detailing/coordination of the façade and projects that have used BIM technologies for the façade construction?
- 2. Rate your experience with using BIM for the façade construction.
 - a. No experience
 - b. Little experience
 - c. Some experience
 - d. Moderate Experience
 - e. Expert
 - f. Please list size of project and other comments.
- 3. Using BIM has increased the constructability of a complex façade.
 - a. Strongly disagree
 - b. Disagree
 - c. Neutral
 - d. Agree
 - e. Strongly agree
 - f. Please explain in what ways.
- 4. Using BIM has increased the productivity of façade construction.
 - a. Strongly disagree
 - b. Disagree
 - c. Neutral
 - d. Agree
 - e. Strongly agree
 - f. Please explain in what ways.
- 5. BIM is beneficial for façade analysis and coordination.
 - a. Strongly disagree
 - b. Disagree
 - c. Neutral
 - d. Agree
 - e. Strongly agree
 - f. Please explain in what ways.
- 6. The learning curve negatively affected the productivity of the use of BIM for the facade.
 - a. Strongly disagree
 - b. Disagree
 - c. Neutral
 - d. Agree
 - e. Strongly agree
 - f. Please explain in what ways.

- 7. Using BIM for the façade construction helps to reduce the cost of the façade significantly.
 - a. Strongly disagree
 - b. Disagree
 - c. Neutral
 - d. Agree
 - e. Strongly agree
 - f. Please explain in what ways.
- 8. Please explain what the most difficult part was about using BIM for facade construction.
- 9. Please explain what is most beneficial about using BIM for facade construction.

EXPECTED OUTCOME

The expected outcome of this analysis is to see how BIM could improve the process of the construction of the façade and hopefully add value to the project. The pros and cons to using BIM will be analyzed for the company and the project. A detailed cost analysis will not be conducted because the information from experienced companies is not public and it is difficult to calculate.

ANALYSIS

After receiving the results of the survey that was sent out to the industry members, it became apparent that using BIM (Building Information Modeling) for the façade construction is not a popular choice among project teams today. Only a few people responded to the survey and all of them had very similar answers to the questions. This leads me to believe that this is the most common thoughts in the industry.

The use of BIM for façade construction is not quite to the standards of items such as using it for mechanical, electrical, plumbing, etc. coordination and phasing. It is still very new and upcoming in the industry. Companies have looked at using BIM for mockups of the façade more than the entire façade construction. Companies are just now starting to implement BIM for the entire façade construction and find it more beneficial for facades that are very complex. It is more beneficial for the complex facades because, since there are multiple materials and scopes coming together, BIM helps to coordinate and organize the process.

BIM had definitely improved the coordination process and effectiveness of coordinating different trades and scopes on projects. One question in the survey was about increasing the constructability of the façade and if it was believed that BIM increased the constructability. The industry members feel that it is most beneficial for constructability by coordinating all the trades but sometimes the trades are not happy to model in three dimensions and continue to use two dimensions. BIM is also believed to reduce the schedule and assists in sequencing the trades properly. It does not necessarily make the project easier to construct but it helps to make the

contractors more efficient. The industry members say that building an entire project with a very detailed façade is not a good use of BIM yet, but they do think that it is very beneficial to build very detailed mockups of how building facades tie into each other. Another problem with using BIM for the façade construction is that not many façade contractors are modeling yet which does not allow three dimensional fabrication drawings. Overall, it seems to be making a breakthrough in the industry right now but it is mostly used for mockups of how the different façade materials meet and join together. These connections can be very detailed and confusing in the fields which can allow for delays on the project or even change orders if the façade is not constructed properly. If these connections are not constructed properly, many problems can occur and can cost the project team a large amount of money.

Does BIM increase the productivity of the façade construction? All of the industry members that responded to the survey agreed that it definitely increases the productivity of the façade construction. Even though not many projects have used BIM for complete façade construction it is definitely believed to impact productivity because of a few different reasons. The model can be sent to the contractor and subs in a means of coordination which will help reduce the schedule because it can provide the most efficient sequencing of the trades. This maximizes the productivity of the contractors and reduces the schedule of the entire project. The façade is normally on the critical path; therefore, if its schedule is reduced, the overall project schedule is reduced. The main reason it increases the productivity is that is helps to plan the execution of the project. If you have the most effective plan of execution, your project should be constructed in the most efficient way.

There are mixed feelings about whether or not BIM is beneficial for façade analysis and coordination. It was pointed out that there are certain areas that it is beneficial such as quantifying materials in façade energy analyses. The BIM model software providers do not currently have the capabilities to import information to understand subjects such as the possibilities of water infiltration or energy loss due to air gaps. However, the BIM model can be imported into a third party software if needed. Once the software providers can include this kind of information the façade analysis will be more beneficial than what it is now. It is genuinely agreed upon that coordination and sequencing is definitely a benefit of using BIM for the façade construction.

When asked if the industry felt that the learning curve negatively affected the productivity of the use of BIM for façade, the industry did not feel that it was an issue that could not be overcome. It was stated though that experienced modelers definitely are beneficial to the project and help improve the productivity. Overall, the industry members feel that the BIM model is definitely beneficial for productivity in the field because they have a "visual tool and a centralized database" that helps to understand the complexities of the façade. The consensus was to find a detail modeler that can use the proper tools to create a sufficient model for the team to use.

In response to the question about using BIM to help reduce the cost of the façade, the responses were mixed. A few agree and others disagree. One person, stated that there is no way that it should cost less because facades have a clearer picture and do not require a lot of rework and the material costs do not change, therefore the cost would not change. The rest of the responses were more towards agreeing that it would save money. It would save money because it avoids expensive errors and mistakes during construction but you would not know how much money you actually would be saving because the mistakes would not happen. Another reason for it to save money is that it would increase productivity which helps decrease the cost because time and labor is not being wasted. Using BIM would also create an opportunity to do more prefabrication which "allows for less field waste and a higher quality product which reduces the chances of rework."

The survey included a question asking them to explain the most difficult part about using BIM for façade construction and there were many different responses. The majority of the responses referred to including the correct amount of detail in a model. There are setbacks in using BIM for façade construction because the software does not provide the ability to add the correct amount of detail to make the model beneficial. Once the software providers can include the ability to apply more detail to the models, the models will be more beneficial for the façade construction. Another difficult part about using BIM is to know when to stop drawing in BIM. This makes a good point because you need to know when you get to the point where the model will stop adding quality and benefits to the project and project team.

It was also asked what the most beneficial part about using BIM for façade construction. The responses were more diverse. Some people simply like the idea of having the ability to send the model to sub-contractors to develop shop drawings from it. This just makes the process simpler and easier to do. Others like that after the model is completed you have a better understanding of the design. There are thoughts that the model helps with window and door scheduling and material identifications. Fewer mistakes are made by the contractor when the BIM model is used through the entire process including design and construction documents. The model also helps to increase the productivity in the field which is beneficial to the project in a few different ways such as schedule and cost of the project. It was also stated that the model helps to avoid tolerance conflicts in slab edge as-built conditions, curtain wall and precast shop drawings.

After reviewing all of the survey results and analyzing all of the data, I have come to the conclusion that using BIM technology on the project would have been very beneficial to the project. Most of the projects that have used BIM for façade construction have been over 150,000 SF which the Emily Couric Clinical Cancer Center falls into that category. The extent that BIM should have been used on the project may not be to the detailed level that MEP systems are

modeled in but it could be used in a less detailed model. Using BIM technologies for at least a mockup of the façade would be very beneficial because it would help to coordinate the more difficult connections of the façade materials.

The learning curve would not be a major problem because the detail would not be to the extent that you would need expert modelers. One thing that took a lot of time for the project team was to coordinate shop drawings for the many different façade material connections. Using BIM for mockups would help to create shop drawings and make the coordination process a quicker one, which could result in a possible schedule reduction. Reducing the schedule could also reduce the cost of the project because less time would be spent on coordination and reworking the mistakes.

It is agreed upon by the industry that using BIM helps to improve the constructability of the façade, reduces the schedule of the façade, and improves the coordination of the façade. All of these tasks are very important in façade construction and if they could all be improved by implementing the BIM process, then the project could be improved overall. Because Gilbane Building Company has used BIM on other projects, I believe that it should not be too difficult to train others or use an experienced modeler on the project.

ANALYSIS 2: INCORPORATING PHOTOVOLTAIC PANELS INTO THE FAÇADE (Electrical Breadth Study) BACKGROUND

The second analysis will deal with adding solar panels to the building. After looking into different façade materials, it was of interest to somehow incorporate photovoltaic panels into the façade. Photovoltaic panels are becoming more popular in the sustainable building market and they were not included in the design of the Emily Couric Clinical Cancer Center. Photovoltaic panels are beneficial for many different reasons including savings on the amount of energy purchased from the grid and also reducing the amount of fossil fuels being used to produce the energy. The analysis will be of installing photovoltaic panels into the curtain wall of the cancer center. Using photovoltaic panels could possibly contribute to the LEED points that the University of Virginia is trying to obtain for a LEED Silver rated building. This analysis will provide information in value engineering and also will be used for a mechanical breadth and electrical breadth.

PROBLEM/OPPORTUNITY STATEMENT

After looking into how the façade of the project could be changed to improve the value of the building, it was clear that photovoltaic panels could be incorporated into the project. One of the places the panels could be incorporated would be the curtain wall which is mainly closing in a lobby space. This change could definitely add value to the project and reduce the energy bills the cancer center will be receiving once the building is up and running. Initially the cost of the photovoltaic panels could be very expensive; therefore, a life cycle cost analysis will be calculated to determine the payback period to decide if the panels are actually beneficial to the project. Adding photovoltaic panels also would affect the electrical system by changing the size of feeders and transformers that would be needed. The new size of feeders and transformers will be calculated and compared to the existing feeders and transformers.

RESEARCH STEPS

- 1. Research different photovoltaic panels for curtain wall construction.
- 2. Choose a photovoltaic panel to incorporate into the façade.
- 3. Collect cost information of the photovoltaic panels.
- 4. Calculate impact on electrical system such as sizing transformers and feeders.
- 5. Compare the new size of the feeders and transformers to the existing ones.
- 6. Calculate impact on the heating and cooling loads of the lobby space the curtain wall surrounds.

7. Calculate the life cycle cost analysis and decide if the panels are beneficial to the project. **EXPECTED OUTCOME**

The expected outcome of this analysis is that the panels will be beneficial to the project in

multiple ways. The feeders and transformers should be less than what the building is currently designed for which could be cheaper and more efficient. It is expected that the panels will reduce the energy costs of the building and the payback period will be short enough to be more beneficial to the project. It is also expected to add LEED points to the project which would help to obtain the LEED Silver rating the University of Virginia is trying to obtain.

ANALYSIS

The first step of this analysis was to research the products and learn about the many different kinds of photovoltaic panels that are available. After using the internet to search the materials, it became apparent that putting solar panels into curtain walls is not a very common idea. There have been a few different technologies created that are transparent or semi-transparent solar panels. Not every manufacturing company makes these kinds of solar panels.

The transparent or semi-transparent can be of two different types. The most common type is to have the solar panels placed in glass and have space between small panels that is just clear so you can see through the window. This kind is represented below in **Figure 10**. The other type that exists is more of a window. It is just like looking through tinted glass, there are no panels blocking your view, it is simply just like a normal window. This type is shown in **Figure 11** below.

Figure 10: Solar Panel (www.diytrade.com)

Figure 11: Transparent Solar Panels. (Centennial Solar)

There is still another option that exists, which is to take a normal photovoltaic panel and just place it in the curtain wall. If this option is chosen, the structural integrity needs to be reevaluated for the curtain wall because the solar panels weigh more than the glass that the

curtain wall was designed to support. This option is the one I chose but due to time constraints, I will not be analyzing the structural aspects of the curtain wall.

The solar panels I chose to use are manufactured by Trina Solar. I chose these panels because after analyzing my curtain wall façade, I noticed that the majority of the façade is on the South side of the building which is the most beneficial location for the placement of solar panels because the South side is the side that receives the most sunlight throughout the day. The solar panels will only be replacing the 5' x 9' windows on the South side of the curtain wall. This gives a total of 1,710 SF of solar panels on the south façade. Each 5' x 9' window will be replaced with three 3' x 5' solar panels of the Trina Solar model TSM-DA05. The specification sheet is shown in **Appendix E** and looks like the solar panel to the right in **Figure 12**.

Figure 12: TSM-DA05 Solar Panel

(Trina Solar)

After talking with Jonathon Walker with Clark Nexson, also a Penn State Architectural Engineering alumnus, he introduced me to the program RETScreen. This program assists in calculating the energy savings of using solar panels and also the lifecycle costs of the solar panels. I originally thought it could be possible to select solar panels that would have a payback period between five to ten years. It was interesting to see the results of the actual calculations.

There was a lot of information to enter into the RETScreen program and all of the results are posted in Appendix F. I needed to research the electricity costs in Charlottesville, Virginia. I found on the internet that the average for Virginia is 8.1 cents per kilowatt hour. The program wanted the cost in megawatt hour so the cost used in the program was \$81.00. Because this was the average, I used the same value for every month of the year.

I assumed the inverter properties to be 96% efficient, a capacity of 100, and miscellaneous losses of 5%. After entering all of the values for the solar panels, the program calculated the total electricity exported to the grid would be 75.534 MWh. The next step was to calculate the cost and analyze it. I assumed approximately \$2,000.00 per panel because I could not reach a sales representative in time to get a more exact price. Using \$2,000.00 for each panel gives you a total of **\$228,000.00** because there will be 114 panels that would be installed. The green strips in **Figure 13** below represent where the solar panels will be located on the curtain wall. The engineering costs are also assumed to be \$20,000.00 for the whole system which may be conservative. The cost of the power system is approximately \$7.00 per Watt and \$7,000 per KW provided by Les Aseere and Randy Sansbury of Johns Manville Roofing. These two men specialize in integrating PV technology on roofs.

Figure 13: South Elevation (A3.01 elevation 1) provided by the Drawings by Zimmer Gunsul Frasca Architects.

After calculating all of that information, the inflation rates and incentives needed to be entered. I did not find a value for incentives for Virginia buildings to use solar power but there are incentive programs after researching online. I assumed a fuel cost escalation rate of 2% and inflation rate to be 3%. I used a project life of 50 years to see the payback period of the solar

panels. I used an electricity export escalation rate of 5% due to the cap coming off of electricity rates. After entering all of this information, the payback period was calculated to be **41 years**, shown in **Figure 14**. This is a very long time for a payback period and does not give a good reason to install solar panels. The money could be spent elsewhere. It is common for solar panels to have a payback period longer than the expected life of the solar panels.

Figure 14: RETScreen graph of the payback period.

Overall, the system would not be a good choice for the value of the dollar. It takes too long to get the money back that was spent on the system. Even though it is good for the environment and adds to LEED points, it is not that beneficial to the building owners, the University of Virginia.

ANALYSIS 3: USING PREFABRICATION FOR THE FAÇADE

(CONSTRUCTION MANAGEMENT DEPTH) (Mechanical Breadth) BACKGROUND

The third analysis will deal with the use of prefabrication of the facade. The facade of the Emily Couric Clinical Cancer Center is so complex with so many different materials including a curtain wall, brick veneer, stone and others. Since there are so many different materials, it is very difficult to coordinate how these materials will connect to each other. Prefabrication allows for difficult connections to be constructed in a controlled environment and reduces the amount of coordination needed to construct this in the field. Prefabrication is beneficial for different reasons. It is capable of increasing the quality of the project because the items being prefabricated are constructed in a controlled environment and can be inspected more closely and in a timelier manner. Another reason to use prefabrication is to reduce the schedule of a project. Projects that are on very tight time schedules often prefabricate more items because they can be built ahead of time and be installed more quickly on site. Prefabrication is more often used in mechanical and electrical systems or systems that are highly repetitive. Sometimes the use of prefabrication can also reduce the cost of the project due to less labor used in the field and the higher level of quality reduces the chances of having to rebuild areas of the building. This analysis will allow for area of critical industry research, schedule reduction, and constructability to be analyzed.

PROBLEM/OPPORTUNITY STATEMENT

The Emily Couric Clinical Cancer Center includes a very complex façade and the façade is on the critical path of the project. This means that the façade needs to be completed on time and the coordination of the complex façade could result in a delayed start on the construction delaying the entire project. Therefore, the use of prefabrication will be analyzed to reduce the schedule of the façade and keep the project on time. Another aspect of changing to a prefabricated brick façade is that it changes the properties of the wall. Therefore, the R-values and heat losses need to be calculated to contribute to the analysis of whether or not the prefabricated façade is beneficial in that aspect.

RESEARCH STEPS

- 1. Contact a prefabrication company that is willing to aid in the understanding of the prefabrication process and provide detailed steps of analyzing the value of prefabricating.
- 2. Make list of all materials used in the façade of the building and find prices of materials to analyze the cost of the project.
- 3. Take off all materials in the façade.
- 4. Gather prices and labor hours for all façade materials.

5. Compare and analyze the results.

ANALYSIS

Prefabrication is not often a common suggestion for façade construction. The façade construction is on the critical path of almost every building and can take a very long time depending on how complex the façade is. Because the Emily Couric Clinical Cancer Center has a very complex façade with many different materials, it takes a very long time to construct. Prefabrication of the façade was chosen to analyze how much quicker the façade could be installed and if it would have been beneficial to the project by shortening the schedule.

The scheduled duration of the façade construction is from May 18, 2009 to January 6, 2010 for a total of 244 days. This is about six and a half months of façade construction. Originally, I thought that prefabrication would result in a cost reduction, schedule reduction and quality improvement. If this turned out to be the case, why do people not choose this option more often?

After making a few phone calls to prefabrication companies to get some contacts to assist me with my research and studies, I reached a man named Wayne Martin who works for Eastern Exterior Wall Systems Inc. He was already familiar with the thesis program at The University of Pennsylvania's Architectural Engineering program. He has actually judged the finalist competitions before and knew a lot about the program. Mr. Martin was very willing to help and allowed me to contact him with many questions about the process.

After talking with Mr. Martin, he pointed out that the prefabrication of the façade for the Emily Couric Clinical Cancer Center may actually be more expensive. He stressed the fact that prefabrication would definitely decrease the schedule and improve the quality of the project. Mr. Martin helped me to get on the right track by teaching me how the process works and how to get information.

First, a list of all materials would need to be made to estimate how many materials are needed. Once the materials are taken off, prices of the materials need to be gathered. There are a couple ways that these prices can be obtained which are to call local companies and get the actual local prices and the other is to use RS Means. RS Means is what I chose to use, due to time constraints, and it is recognized throughout the industry. After compiling the list of materials, we picked a prefab system that would be suitable for the Emily Couric Clinical Cancer Center's façade. The system we picked was a thin brick system.

There are a couple reasons to choose this system rather than just build the planned system. First, using this system allows the façade to weigh up to seventy five percent less than the designed system. (http://www.eews.com/solution.html) Another reason is that it eliminates the use of a

weep system. (http://www.eews.com/solution.html) There is no place in this system to collect water and cause leaking and other problems like typical cavity walls. This system is collected in the brick and mortar and is ex-filtrated through the materials with the weather patterns. It is evenly distributed and released from the building and does not collect in the building because there is no air cavity. One of the reasons that this system may cost more is because in the original plan, there is supposed to be eight inch concrete masonry units sitting on top of the concrete slabs as represented in **Figure 15**below.

Figure 15: Detail 2 on Drawing A4.01 of the Emily Couric Clinical Cancer Center Drawings by Architects Zimmer-Gunsul-Frasca

The materials selected for this system are as follows in the following order:

• Cold formed structural stud: 6" 16 ga. 1-5/8" @ 16" o.c.

- 5/8" sheathing
- WP membrane
- Z
- 5/8" sheathing
- Lath
- Scratch coat
- Laticrete
- Thin brick

These materials are specific to Eastern Exterior Wall Systems, Inc. and the Emily Couric Clinical Cancer Center project. The following picture, **Figure 16**, is a general representation of how thin brick facades are constructed.

Figure 16: Thin brick construction. (<u>http://www.specifiedproductsinc.com/products_brick.htm</u>)

After fully understanding the systems and its pros and cons, it was time to calculate the cost and duration of constructing this prefabricated system. I first calculated the entire brick façade area, which is 33,472 square feet, to know how many materials are going to be needed. I then went to RS Means CostWorks and found all of the materials needed in the façade. I entered the quantities into the spreadsheet to come up with a total of **\$3,328,558.00**. The duration of the construction of the prefabricated façade was **213 days**. This was shorter than the traditional stick

built façade that was used on the Emily Couric Clinical Cancer Center. In **Table 1** below, the comparisons of the original façade and the prefabricated façade are shown.

	Original	Prefab
Schedule	244	178
Cost	\$1,836,375.00	\$3,234,414.00

 Table 1: Original vs. Prefabrication

The original schedule duration came from the schedule I received from Gilbane Building Company and the cost came from numbers also provided by Gilbane Building Company. The estimate I calculated for the prefab is included in **Appendix C**. I only priced the brick portion of the façade because that is what my study focused on. The stick built cost, including overhead and profit, of the brick façade is **\$1,836,375.00**. The prefab estimate including overhead and profit is **\$3,234,414.00**. The difference of these two is \$1,398,039.00 in which the prefabrication process costs significantly more than the original.

Although this price difference is significant, it still needs to be considered that the prefabricated façade can be installed much faster. The construction days are quite shorter for the prefab and this is still a bit misleading because the prefabricated façade can be built and stored in the factory and delivered to the site when ready. This could reduce the schedule even more.

I calculated the size of a typical panel of prefabricated façade to be the distance from column to column and between windows. This calculation is as follows:

Panel area: columns X dist between windows = 30' X 7' = 210 SF Façade area / panel area = 33472 SF X 210 SF = 159 panels

Wayne Martin, with Eastern Exterior Wall Systems, Inc., informed me that typically a crew can install eight panels a day in an eight hour day. Therefore, the amount of time needed to install these panels is calculated as follows:

159 panels / 8 panels per day = 20 days

It would take 20 days to install all of the brick façade if it was prefabricated and delivered to the job site when it was needed. This is a very significant difference from 244 days to install the façade. This takes over a month off of the schedule. Having this section of the building can allow for other tasks to get started earlier even though the curtain wall will still take 159 days to be constructed. Overall, this process allows for the substantial completion date to be moved up two months. A detailed schedule can be found in **Appendix D**.

After all of the analyses conducted on this study, the benefits of doing prefabrication definitely outweigh the negative aspects of choosing this method. Although the prefabricated system costs nearly double the traditional method costs, the prefabricated system provides a much higher quality of building because it does not allow for the leaks and mistakes like the traditional stick built process. It is constructed in a factory where it can be inspected more frequently and mistakes can be caught easier and quicker. It also does not allow for water to collect in the wall because there is no air cavity for it to collect in. There is no need for sealants at the slab edge and any weep systems. This allows the building to be more tightly enclosed and this would be of value to the University of Virginia because this building is going to be used for cancer patients who cannot be exposed to a lot of mold and germs.

Another benefit of using the prefabricated system is that it will reduce the schedule by two months and will allow the owner to take over the building and use it two months earlier. This will allow the university to start making money from the building faster. Other benefits could be that the new system provides a better R-value and has less heat loss than the planned system. This will be discussed in the next section to cover my mechanical breadth. It also improves the site logistics plan because the site is so small there is not much room for the contractors to store materials and move around the building. Prefabricating the façade reduces the amount of materials that need to be stored on the site and helps to improve the amount of space available to other contractors and keeping the site clean. Also, the amount of scaffolding will be reduced which also cuts down on the cost and site logistics.

PREFABRICATION (CONTINUED): MECHANICAL BREADTH STUDY

Background

While analyzing the options of prefabricating the brick veneer façade, it is a possibility that the façade materials could change. Changing the façade materials, changes the properties of the wall which also changes the walls ability to either hold or lose heat. With a majority of the façade being brick veneer, changing the properties of the wall would have a significant impact on the mechanical system if the R-values change too much.

Research Steps

- 1. Calculate the R-value of the designed wall.
- 2. Decide to change the materials of the façade.
- 3. Calculate the R-value of the new façade materials
- 4. Compare the R-values and heat losses of the walls.
- 5. Analyze and decide which is better and if it contributes to the pros or cons of prefabricating the brick veneer façade.

Expected Outcome

It is expected that changing the brick façade to a thin brick prefabricated system will improve the R-value of the wall from the traditional stick built brick façade. The heat losses are expected to be reduced by the new system, which could impact the mechanical system. *Analysis*

Changing from the designed brick façade to the prefabricated brick façade changes the properties of the wall which could either decrease or increase the amount of heat loss for these walls. This could be detrimental to the mechanical system and could cause more issues than benefits. To fully understand how the walls function thermally, the R-values and U-values need to be calculated.

To calculate the R-values the program H.A.M. Toolbox will be used. This program has R-values of materials already programmed into the system and will calculate the total R-value of the assembly once it is imported.

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The first step in using H.A.M. Toolbox is to select the location of the building. The closest location to Charlottesville, VA is Richmond, VA so that is what I selected to get the design

This software is licensed to: PENNSYLVANIA STATE UNIVERSITY

parameters. This gave me the design temperatures of indoor 70 degrees Fahrenheit and 75 degrees Fahrenheit for winter and summer temperatures respectively. The outdoor temperatures are 14 degrees Fahrenheit and 95 degrees Fahrenheit for winter and summer respectively. These temperatures and the rest of the calculations for R-values can be found in **Figure 17** below. These temperatures will not change because the location does not change.

The items that do change are the wall properties. In the pictures of the program results you can see the different make ups of the materials. They are represented both graphically and in a list. The two can be compared in **Figure 17** and **Figure 18**. The originally designed façade consists of the following items:

• Air Cavity Wtr temp Sum temp • Rigid Insulation 17.3 93.8 22.5 92.0 • A Transition Membrane 64.2 77.1 And 8" CMU Block 64.5 76.9 70.0 75.0 These items are much different than the prefabricated façade materials which • Cold formed structural stud: 6" 16 ga. 1-5/8" @ 16" o.c.

• Brick

35

(95.0)

- 5/8" sheathing
- WP membrane
- Z
- 5/8" sheathing
- Lath
- Scratch coat
- Laticrete
- Thin brick

The R-values calculated for each of these assemblies are **10.63** for the originally designed brick façade and **13.28** for the prefabricated façade. These values can be seen in **Figure 17** and **Figure 18** which are shown above and below.

Figure 18: Prefabricated Facade (H.A.M. Toolbox)

Now that the R-values are calculated, the U-values can be calculated by taking the reciprocal of R-value. The U-value is more valuable because you can calculate the heat loss with this value. The R-value simply helps get the U-value. The following equation is used to calculate heat loss for a flat surface: The area used will be 33,472 SF for the brick façade and the temperature difference will be 56 degrees and -20 degrees for winter and summer respectively.

$\mathbf{Q} = \mathbf{UAT}$ U = Conductance

A = Surface Area T = Temperature Difference

Table 2, on the next page, is a chart of the U-values and the heat loss of each of the two different facades.

	U-Value	U-Value	Winter Heat Loss	Summer Heat
	Equation			Loss
Originally Designed Façade	1/10.63	0.0941	176,384 BTU/HR	-62,994 BTU/HR
Prefabricated Façade	1/13.28	0.0753	141,145 BTU/HR	-50,409 BTU/HR
3				

 Table 2: U-Values and Heat Loss Calculations

These values show that the prefabricated façade has a much better insulation factor that results in less heat loss than the originally designed brick façade. This could be another pro to choosing the prefabricated façade. Overall, the prefabricated is definitely a better choice than the other design even though it is more costly, there are many benefits and having less heat loss is one of them since it will cost less to heat the building because of the reduced heat loss. \

CONCLUSIONS

This thesis has covered many different topics but each one involving the façade in some way. Critical industry research has been conducted, value engineering ideas have been introduced and analyzed, there was constructability reviews completed and a schedule reduction analysis completed.

The first analysis discussed was the use of BIM technologies for façade construction. This topic consisted of a survey given to industry members to complete and provide insight as to how BIM was currently being used in the industry for façade construction. It also gave them the opportunity to express how they feel about the technology and what they would like to see happen in the future with the technology. It was determined that using BIM on the Emily Couric Clinical Cancer Center would have been beneficial, at least to use on mockups, because it reduces the conflicts in the field and shop drawings can be created and coordinated from this process. Using BIM would have made the coordination process go a lot smoother and probably take less time than the traditional methods of coordination.

The second analysis was the analysis that focused on incorporating solar panels into curtain wall of the building. This served an electrical breadth and was determined not beneficial to the project. The energy savings was not significant enough to have an impact on payback period. To be implemented into the project, the payback would need to be around five to ten years, not the 41 years that it was calculated to be.

The third and final analysis was the prefabrication of the brick façade. This analysis served as a construction management depth and mechanical breadth. It discussed the advantages and the disadvantages of using the prefabricated system. The biggest disadvantage is the cost of the prefabricated façade is much more expensive. There are many advantages though include it can reduce the schedule significantly and also increases the insulation which has an impact on the mechanical system. It loses less heat and helps to save on energy bills in the winter. The quality of the prefabricated façade is also a large benefit because it does not have space for water to collect and damage the building by leaks and mold.

All of these analyses have been very educational and I will use all of the information learned here in everyday life as a construction manager. The lessons learned have been very valuable from how important time management is to the very tiny details of how the prefabrication process is used and implemented.

WORKS CITED

Centennial Solar. Web. 2010. < http://www.centennialsolar.com/>.

The City of Charlottesville. Web. 2010. < http://www.charlottesville.org/Index.aspx?page=1291>.

Dunn, Fred. Telephone interview. Oct. 2009.

Eastern Exterior Wall Systems, Inc. Web. 2010. < http://www.eews.com/index-2.html>.

Facilities Management. The University of Virginia. Web. 2010.

<http://www.fm.virginia.edu/fpc/FeaturedProjects/EmilyCouric/EmilyCouric.htm>.

Martin, Wayne. Telephone interview. Mar. 2010.

Poulin, Mike. Telephone interview. Sept. 2009.

Roof Wise. Roof Wise Southern Ltd. Web. 2010. < http://www.roofwise-

se.com/index.php?page=product>.

Specified Products. Web. 2010. < http://www.specifiedproductsinc.com/products_brick.htm>.

Trina Solar. Product Catalog. Trina Solar. Trina Solar Product Catalog. Web. 2010.

<http://www.trinasolar.com/us/pdf/TSL-Product%20Catalog-US.pdf>.

APPENDIX A: DETAILED PROJECT SCHEDULE

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B Nuch Wali 61 days Wei 10300 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wei 123100 B Belaci Walis 61 days Much 100 Wie 12300 B B Much 100 Wie 11 Mich 100 Wie 113100 Fin 100 Wie 11300 Wie 12300 B B Much 100 Wie 11 Mich 100 Wie 11300 Wie 12300 Wie 12300W	20		Vault Slabs/Lids	33 days	Tue 12/16/08	Thu 1/29/09													9					-				
Image: Section Walk If 6 urgs Mon 1500 Won 1200 Won 1200 <td>21</td> <td>313</td> <td>North Walls</td> <td>61 days</td> <td>Wed 10/8/08</td> <td>Wed 12/31/08</td> <td></td> <td>-</td> <td></td> <td></td> <td></td> <td></td>	21	313	North Walls	61 days	Wed 10/8/08	Wed 12/31/08																		-				
Colume Line 2-C If days Mon 22009	22		Exterior Walls	18 days	Mon 1/5/09	Wed 1/28/09																						
Bedent 1 Wale 5. dopu More 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 5. dopu Fig 2008 Fig 2008 Bedent 2 Wale 6. dopu Fig 2008 Fig 2008 Bedent 2 Wale 6. dopu Fig 2008 Fig 2008 Bedent 2 Wale 6. dopu Fig 2008 Fig 2008 Bedent 2 Wale 6. dopu Fig 2008 Fig 2008 Bedent 2 Wale 6. dopu Fig 2008 Fig 2008	23		Column Line Z-C	16 days	Mon 2/2/09	Mon 2/23/09																						
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Image: Start Hoor Hop-Hop-Charler Basins 1 12 copie Thu 311000 Fin 41000 Image: Start Hoor Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hoor Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Hop-Hop-Hop-Hop-Charler Basins 1 12 copie Thu 411000 Fin 41000 Image: Start Hop-Hop-Hop-Hop-Hop-Hop-Hop-Hop-Hop-Hop-	28		Mezzanine Prep/Place	2 days	Tue 3/10/09	Wed 3/11/09														I								
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■ Atth Floor Prep/Pice/Pice/Pice/Pice/Pice/Pice/Pice/Pice	31		3rd Floor Prep/Place/Pan Stairs	12 days	Thu 4/16/09	Fri 5/1/09																		-			1	
B Roof PropPlace/Pain State 11 dong? Mon 511800 Mon 511800 Mon 511800 B Mezzanine FromPlace 2 day Thu 40000 Fue 14000 Fue 14000 B Mezzanine FromPlace 2 day Mun 541800 Fue 14000 Fue 140000 B 1 for PropPlace/Pains/Pain State 10 days Mun 541800 Fue 14000 Fue 14000 B 2 und Hour PropPlace/Pains/Pains 3 day Mon 541800 Fue 14000 Fue 14000 B Ath Foor PropPlace/Pains State 10 days Mun 541800 Fue 140000 Fue 14000 B Ath Foor PropPlace/Pains/Pains 5 day Mon 30000 Fue 12000 Fue 12000 B East 5 day Mon 30000 Fue 12000 Mon 30000 Fue 12000 B East 4 day Mon 30000 Fue 12000 Mon 30000 Fue 12000 B East 4 day Mon 30000 Fue 12000 Mon 30000 Fue 12000 B Beoinfacing Soq 3 2 day Mon 30000 Fue 12000 Mon 30000 Fue 12000 B Beoinfacing Soq 3 2 day	32		4th Floor Prep/Place/Pan Stairs	14 days	Thu 4/30/09	Tue 5/19/09																						
Stab Pours West 90 daye Thu 42009 West 7/100 It Horzanies Frozies Conject Thu 42009 Frid 1000 It Horzanies Frozies Frid 1000 Mon 35009 Thu 57006 It Horzanies Frozies Frid 1000 Mon 32000 Frid 1000 Mon 32000 It Stabildeeting Seq 4 17 copy Frid 1000 Mon 32000 Mon 32000 It Stabildeeting Seq 5 23 copy Mon 32000 Mon 32000 Mon 32000 It Stabildeeting Seq 6 4 copy Mon 32000 Mon 32000 Mon 32000 Stabildeeting Seq 7 It	33	-	Roof Prep/Place/Pan Stairs	11 days?	Mon 5/18/09	Mon 6/1/09																						
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Image: State Stat	36		1st Floor Prep/Place/Pan Stairs	12 days	Mon 4/20/09	Tue 5/5/09																						
Image: State Stat	37	111	2nd Floor Prep/Place/Pan Stairs	10 days	Mon 5/4/09	Fri 5/15/09																		-				
 	38		3rd Floor Prep/Place/Pan Stairs	13 days	Mon 5/18/09	Wed 6/3/09																		-				
Image: Stab Con Grade 51 days Mon 38/08 The 38/09 The 52008 Image: Stab Con Grade 51 days Mon 38/08 The 42008 Image: Stab Con Grade 42 days Mon 38/08 The 42008 Image: Stab Con Grade 42 days Mon 38/08 The 42008 Image: Stab Con Grade 42 days Mon 38/08 The 42008 Image: Stab Con Grade 42 days Mon 38/08 The 42008 Image: Stab Con Grade 42 days Mon 38/08 The 52008 Image: Stab Con Grade 42 days Mon 38/08 The 52008 Image: Stab Con Grade 23 days Mon 38/08 The 25/09 Image: Stab Con Grade 17 days Fin 32009 Mon 38/08 Image: Stab Con Grade 18 days Mon 38/09 Mon 38/09 Image: Stab Con Grade 18 days Mon 38/09 Mon 38/09 Image: Stab Con Grade 18 days Mon 38/09 Mon 38/09 Image: Stab Con Grade 18 days Mon 38/09 Mon 38/09 Image: Stab Con Grade 18 days Mon 38/09 Mon 38/09 Image: Stab Con Grade 10 days	39		4th Floor Prep/Place/Pan Stairs	14 days	Tue 6/2/09	Fri 6/19/09														-								
Stab On Grade 57 days Mon 38/00 Tue 5/28/00 Image: Stab On Grade 34 days Mon 38/00 Tue 5/28/00 Image: Stab On Grade 34 days Mon 38/00 Tue 5/28/00 Image: Stab On Grade 42 days Mon 32/00 Tue 5/28/00 Image: Stab On Grade 42 days Mon 32/00 Mon 32/00 Image: Stab/decking Seq 1 26 days Mon 32/00 Mon 32/00 Image: Stab/decking Seq 3 20 days Thu 2/5/00 Mon 32/00 Image: Stab/decking Seq 4 17 days Mon 32/00 Fin 3/3/00 Image: Stab/decking Seq 5 22 days Weed 2/2000 Mon 32/00 Image: Stab/decking Seq 6 4 days Weed 2/2000 Mon 32/00 Image: Stab/decking Seq 16 18 days Tue 3/3/00 Mon 32/00 Image: Stab/decking Seq 16 18 days Tue 3/3/00 Mon 32/00 Image: Stab/decking Seq 10 22 days Mon 32/00 Mon 32/00 Image: Stab/decking Seq 11 20 days Tue 3/10/00 Wed 4/8/00 Image: Stab/decking Seq 11 20 days Tue 3/10/00 Wed 4/8/00 Image: Stab/decking Seq 1 Stab	40		Roof Prep/Place/Pan Stairs	10 days	Thu 6/18/09	Wed 7/1/09																						
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Superstructure 84 days Mon 2/2/09 Thu 5/28/09 Image: Stock/docking Seq 1 226 days Mon 2/2/09 Thu 5/28/09 Image: Stock/docking Seq 2 23 days Fin 2/3/09 Mon 3/8/09 Image: Stock/docking Seq 3 20 days Tue 2/10/09 Mon 3/8/09 Image: Stock/docking Seq 3 20 days Tue 2/10/09 Mon 3/8/09 Image: Stock/docking Seq 4 17 days Fin 2/3/09 Fin 3/2/09 Image: Stock/docking Seq 5 23 days Wed 2/2/09 Mon 3/2/09 Image: Stock/docking Seq 6 4 days Wed 2/2/09 Mon 3/2/09 Image: Stock/docking Seq 10 22 days Tue 3/3/09 Wed 4/8/09 Image: Stock/docking Seq 11 20 days Tue 3/10/09 Wed 4/8/09 Image: Stock/docking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Stock/docking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Stock/docking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Stock/docking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Stock/docking Seq 7 18 days Mon 3/16/09 Wed 4/8/09	43		West	42 days	Mon 3/30/09	Tue 5/26/09														1 7								
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Image: Steel/decking Seq 10 22 days Tue 3/10/09 Wed 4/8/09 Image: Steel/decking Seq 11 20 days Tue 3/10/09 Wed 4/8/09 Image: Steel/decking Seq 12 19 days Fri 3/13/09 Wed 4/8/09 Image: Steel/decking Seq 12 19 days Fri 3/13/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Milestone External Tasks Deadline Image: Steel/decking Seq 7 Split Milestone Project Summary External Milestone Image: Steel/decking Seq 7	52		Steel/decking Seg 9	23 days	Mon 3/9/09	Wed 4/8/09																						
Image: Steel/decking Seq 11 20 days Thu 3/12/09 Wed 4/8/09 Image: Steel/decking Seq 12 19 days Fri 3/13/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Med 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Med 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Med 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Milestone External Tasks Deadline Image: Steel/decking Seq 7 Summary Image: Steel/decking Seq 7 Deadline Umage: Steel/decking Seq 7 Image: Steel/decking Seq 7 Summary Image: Steel/decking Seq 7 Deadline Umage: Steel/decking Seq 7 Image: Steel/decking Seq 7 Summary Image: Steel/decking Seq 7	53		Steel/decking Seg 10	22 days	Tue 3/10/09	Wed 4/8/00														=								
Image: Steel/decking Seq 12 19 days Fri 3/13/09 Wed 4/8/09 Image: Steel/decking Seq 12 19 days Fri 3/13/09 Wed 4/8/09 Image: Steel/decking Seq 7 18 days Mon 3/16/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Wed 3/18/09 Wed 4/8/09 Image: Steel/decking Seq 8 16 days Progress Summary External Tasks Deadline Image: Steel/decking Seq 8 Split Milestone Project Summary External Milestone Image: Steel/decking Seq 8 Deadline	54		Steel/decking Seg 10	22 uays 20 dave	Thu 3/12/00	Wed 4/6/09														1 📜								
Image: Steel/decking Seq 7 18 days 11 or	55		Steel/decking Seg 12	10 days	Fri 3/42/00	Wed 4/9/09														-				-				
Image: Steel/decking Seq 8 16 days Wed 4/8/09 Image: Steel/decking Seq 8 16 days Progress External Tasks Deadline Image: Steel/decking Seq 8 Milestone Project Summary External Milestone External Milestone	56		Steel/decking Sec 7	18 days	Mon 2/46/00	Wed 4/0/09														📜								
Image: Stream of the start	50		Steel/decking Sec 0	10 days	Wed 2/40/09	Wed 4/0/09														1								
ct: Detailed Thesis Project Scher Mon 4/5/10 Milestone Milestone Milestone Project Summary Project Summary External Tasks Deadline	ə <i>r</i>	<u></u>	steer/decking Seq 8	16 days	wea 3/18/09	vved 4/8/09																						
ct: Detailed Thesis Project Schec Lash Progress Summary External Tasks Deadline V Mon 4/5/10 Split Milestone Project Summary External Milestone External Milestone			Test			Drograss	_			C	_			External Table	_			ad		0								
Split Milestone Project Summary External Milestone Commercial Summary Stress Summary Stress Summary Stress	Project	: Detaile	ed Thesis Project Schec Bask			Progress				Summary				∟xternal Lask	s		D	eadline		0								
	Jate: N	10n 4/5/	Split			Milestone	•			Project Su	ummary 🤍			External Miles	tone 🔶													

ID	6	Task Name		Duration	Start	Finish		2005	00		2006		00 01	2007	0.0	00 0	2008		00 01	2009
58		Steel/decking Seg 14		20 days	Eri 3/20/09	Thu 4/16/09	Q4		Q2 0	Q3 Q4	Q1	Q2	Q3 Q4	Q1	Q2	Q3 Q4	4 01	Q2	Q3 Q4	
59		Steel/decking Seg 15		18 days	Tue 3/24/09	Thu 4/16/09														
60		Steel/decking Seg 13		16 days	Thu 3/26/09	Thu 4/16/09														-
61		Steel/decking Seg 17	,	16 days	Mon 3/30/09	Mon 4/20/09														
62		Structure Top out		0 days	Thu 5/28/09	Thu 5/28/09														- 5
63		Fire Proofing		35 days	Thu 4/23/09	Wed 6/10/09														
64		Fire Proofing		35 days	Thu 4/23/09	Wed 6/10/09														
65		West Terrace Structure		12 days	Thu 5/14/09	Eri 5/29/09														
66		West Terrace		12 days?	Thu 5/14/09	Fri 5/29/09														
67		Loading Dock Structure		68 dave	Thu 5/14/09	Mon 8/17/09														
68		Loading Dock Structure	Ire	68 days	Thu 5/14/09	Mon 8/17/09														
69		Eacade		168 days	Mon 5/18/09	Wed 1/6/10														
70		East/North Column E		62 days	Mon 5/18/09	Tue 8/11/09														
71		North/West Elevation	e	67 days	Tue 6/9/09	Wed 9/9/09														
72		Penthouse	0	00 days	Tue 6/30/09	Fri 11/13/09														
73		South Elevation		16 days	Mon 11/16/09	Mon 12/7/09														
74		Curtain Wall All Eleva	ations	150 days	Eri 5/29/09	Wed 1/6/10														
74		Poof	ations	104 days	Fri 5/29/09	Wed 10/21/09														
76		Roof		104 days	Fri 5/29/09	Wed 10/21/09														
70		MED		70 days	FII 5/29/09	Thu: 0/47/00														
70		MEP MED Bough in East F	Piecera	10 days	Fri 6/12/09	Thu 9/17/09														
70		MEP Rough-in East P	Risers	10 days	FIT 6/12/09	Thu 6/25/09														
79		MEP Rougn-in West	Risers	47 days	Wed 7/15/09	Thu 9/17/09														
80	-	Finishes		263 days	Mon 12/28/09	Wed 12/29/10														
81	111	Finisnes		263 days	Mon 12/28/09	Wed 12/29/10														
82		Interiors		517 days?	Mon 1/5/09	Wed 12/29/10														
83	-	Ground East		165 days	Fri 4/24/09	Thu 12/10/09														
84		Fire Proofing		10 days	Fn 4/24/09	nu 5/7/09														<u> </u>
85	111	Frame walls		56 days	Fri 5/8/09	Fri 7/24/09														
86		Duct Rough-in		16 days	Wed 5/20/09	Wed 6/10/09														
87		Electrical Rooms	s/Equipment	26 days	Thu 6/4/09	hu 7/9/09														
88		HVAC/Plumbing	Piping	36 days	Thu 6/4/09	Thu 7/23/09														
89		Duct Branches/S	Sprinkler Main	16 days	Thu 6/11/09	Thu 7/2/09														
90		Plumbing Rough	n-in	20 days	Mon 7/27/09	Fri 8/21/09														
91		Medical Gas Rou	ugh-in	5 days	Mon 7/27/09	Fri 7/31/09														
92	111	Electrical Rough	-in	54 days	Thu 7/2/09	Tue 9/15/09														
93		Inspections		2 days	Wed 9/16/09	Thu 9/17/09														
94		Pull Wire		21 days	Thu 11/12/09	Thu 12/10/09														
95		Ground West		454 days	Mon 1/5/09	Thu 9/30/10														÷
96	111	Fire Proofing		10 days	Wed 5/27/09	Tue 6/9/09														
97		Frame Walls		55 days	Wed 6/10/09	Tue 8/25/09														
98		Duct Rough-in		16 days	Mon 6/22/09	Mon 7/13/09														
99	111	Electrical Rooms	s/Equipment	31 days	Mon 6/22/09	Mon 8/3/09														
100		HVAC/Plumbing	Piping	35 days	Tue 7/7/09	Mon 8/24/09														
101		Duct Branches/S	Sprinkler Main	16 days	Tue 7/14/09	Tue 8/4/09														
102	11.	Plumbing Rough	n-in	21 days	Wed 8/26/09	Wed 9/23/09														
103		Medical Gas Rou	ugh-in	5 days	Wed 8/26/09	Tue 9/1/09														
104		Electrical Rough	-in	50 days	Fri 8/7/09	Thu 10/15/09														
105		Inspections		2 days	Fri 10/16/09	Mon 10/19/09														
106	111	Pull Wire		22 days	Fri 12/11/09	Mon 1/11/10														
107		Main Electrical	Room	269 days	Mon 1/5/09	Thu 1/14/10														÷
108		Main Electri	ical Room	269 days	Mon 1/5/09	Thu 1/14/10														
109		Finishes		231 days	Thu 11/12/09	Thu 9/30/10														
110		Partitions/C	eilings/Soffits/Fi	85 days	Thu 11/12/09	Wed 3/10/10														
111		Light Fixture	es	20 days	Thu 3/4/10	Wed 3/31/10														
112		Casework		21 days	Fri 5/7/10	Fri 6/4/10														
113		Plumbing Fi	ixtures	20 days	Mon 5/31/10	Fri 6/25/10														
114		Misc. Finish	ies	66 days	Mon 6/28/10	Mon 9/27/10														
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Proied	t. Detail	ed Thesis Project Schec	Task			Progress				Summary				Externa	al Tasks			Dead	line	Ŷ
Date:	Mon 4/5/	10	Split			Milestone				Project S	immen/			Externa	al Milector	•		-		
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	ID	6	Task Name	Duration	Start	Finish		2005	0.0	0.0	0.1	2006	0.0	0.0	~ ~ ~	2007	00	0.0	0.1	2008	00	0.0	0.1	2009	
┢	115		TAR	3 days	Tue 9/29/10	Thu 9/30/10	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
⊢	116		Mazzanina/Sub Basement M	Judy:	5 Tue 5/20/10	En: 4/16/10	-																		_
┢	117		Mechanical Equipment/S	prinklor 27 days	5 Thu 5/21/09	Fri 4/16/10	-																		
⊢	117		Mechanical Equipment/S	prinkiel 37 days	s 1110 5/2 1/09	FIT 7/10/08																			
	118	H	HVAC Piping	26 days	s Fri 6/19/09	Fri 7/24/09																			
	119	-	Electrical Rough-in	56 days	s Fri 6/19/09	Fri 9/4/09																			ļ
L	120		Electrical Conduit Feeder	r/Equip: 27 days	s Mon 7/13/09	Tue 8/18/09																			
L	121		Frame Walls	4 days	s Thu 7/30/09	Tue 8/4/09																			
	122		Inspections	1 da	y Tue 9/8/09	Tue 9/8/09																			
	123		Pull Wire	10 days	s Thu 11/12/09	Wed 11/25/09																			
	124	=	Hang/Finish Drywall	13 day:	s Thu 11/12/09	Mon 11/30/09																			
F	125		Pneumatic Tube Equipme	ent 10 days	s Tue 12/1/09	Mon 12/14/09	i i																		
F	126		Test Electrical Equipmen	t 3 days	s Fri 12/4/09	Tue 12/8/09																			
F	127		Paint	4 days	s Tue 12/15/09	Fri 12/18/09																			
┢	128		Install Fixtures	3 day	s Mon 12/21/09	Wed 12/23/09	-																		
\vdash	129		Misc Finishes	9 day	s Tue 3/23/10	Fri 4/2/10	-																		
┢	130		TAR	10 days	Mon 4/5/10	Fri 4/16/10																			
┢	121		1ot Elear East	161 doy:	5 Thu 4/20/00	Thu 12/10/08	-																		_
┢	101		Frame Wells	TOT days	5 Thu 4/30/09	Mod 8/5/00	-																		
⊢	102		Frame walls	70 days	s Thu 4/30/09	Wed 6/5/09																			
	133		HVAC/Plumbing Piping	22 days	s Tue 5/12/09	Wed 6/10/09	-																		
	134		Electrical Rough-in	81 days	s Fri 6/5/09	Fri 9/25/09																			
L	135		Electrical Conduit Feeder	r/Equipr 36 days	s Thu 6/11/09	Thu 7/30/09																			
	136		Duct Branches/Mech. Eq	uip. Shi 39 day	s Tue 6/23/09	Fri 8/14/09																			
Γ	137		Medical Gas Rough-in	5 days	s Thu 8/6/09	Wed 8/12/09																			
	138		Elevator Shafts	5 days	s Mon 8/17/09	Fri 8/21/09																			
	139		Plumbing Rough-in	20 days	s Thu 8/6/09	Wed 9/2/09																			
F	140		Inspections	2 days	s Mon 9/28/09	Tue 9/29/09																			
F	141		Pull Wire	21 days	s Thu 11/12/09	Thu 12/10/09																			
\vdash	142		1st Floor West	160 days	Tue 6/2/09	Mon 1/11/10	-																		
┢	1/13		Frame Walls	69 days	5 Tue 6/2/09	Fri 9/4/00	-																		
┢	145			09 days	5 Tue 0/2/09	Fit 9/4/03	-																		-
⊢	144		HVAC/Plumbing Piping	46 days	s Fri 6/12/09	Fri 8/14/09																			
	145		Electrical Rough-in	98 days	s Fri 6/12/09	Tue 10/27/09																			
L	146		Electrical Conduit Feeder	r/Equipi 33 days	s Thu 7/16/09	Mon 8/31/09																			
L	147	=	Duct Branches/Mech. Eq	uip. Sh 50 days	s Fri 7/24/09	Thu 10/1/09																			
	148		Medical Gas Rough-in	5 days	s Tue 9/8/09	Mon 9/14/09																			
Γ	149		Plumbing Rough-in	20 days	s Tue 9/8/09	Mon 10/5/09																			
	150	111	Inspections	2 days	s Wed 10/28/09	Thu 10/29/09																			
	151		Pull Wire	22 days	s Fri 12/11/09	Mon 1/11/10																			
F	152	-	Lobby	167 days	s Thu 2/11/10	Fri 10/1/10																			
F	153		Lobby	167 days	s Thu 2/11/10	Fri 10/1/10																			
┢	154		2nd Floor East	173 days	2 Thu 5/14/09	Mon 1/11/10	-																		
\vdash	155		Frame Walls	68 days	2 Thu 5/14/09	Mon 8/17/09	-																		×
⊢	156		HVAC/Plumbing Dining	46 days	2 Wed 5/27/00	Wed 7/20/09	-	-																	_
\vdash	157		Electrical Pauch in	40 udys	2 Thu 6/11/00	Eri 10/0/00																			-
\vdash	150			v/Caujo 50 dave	- THU 0/11/09	Thu 0/07/08	-																		
⊢	156		Electrical Conduit Feeder	r/Equipr 52 days	/ Wed 6/17/09	Thu 8/27/09																			
	159	<u></u>	Duct Branches/Mech. Eq	uip. Sn 35 days	? Mon 7/6/09	Fri 8/21/09																			
L	160		Medical Gas Rough-in	5 days	? Tue 8/18/09	Mon 8/24/09																			
	161	===	Elevator Shafts	5 days'	? Mon 8/24/09	Fri 8/28/09																			
L	162		Plumbing Rough-in	21 days	? Tue 8/18/09	Tue 9/15/09																			
	163	111	Inspections	2 days	? Mon 10/12/09	Tue 10/13/09																			
Γ	164		Pull Wire	22 days	? Fri 12/11/09	Mon 1/11/10																			
	165		2nd Floor West	170 days	7 Tue 6/16/09	Mon 2/8/10																			
	166		Frame Walls	68 days	? Tue 6/16/09	Thu 9/17/09																			6
	167		HVAC/Plumbing Piping	46 days	? Fri 6/26/09	Fri 8/28/09																			-
\vdash	168		Electrical Rough-in	98 davs	? Fri 6/26/09	Tue 11/10/09																			
F	169		Duct Branches/Mech Eq	uip. Sh 47 dave	? Wed 8/5/09	Thu 10/8/09																			
\vdash	170		Electrical Conduit Feeder	r/Equip: 34 days	7 Thu 8/13/09	Tue 9/29/09																			
\vdash	171		Medical Gas Rough-in	5 days	7 Fri 9/18/00	Thu 9/24/09																			
\vdash	17.1	141	medical Gas Rougil-III	5 udys	113/10/09	Thu 5/24/05																			
						Drograd	-			_ ^	100 00 0 -				_	Ex.**	I Teelin	_				dlin -		1	
	Projec	t: Detailed	d Thesis Project Schec			Progress				Su	immary		-			Externa	ai Tasks				Dea	aine	4	7	
	Date: I	vion 4/5/1	0 Split			Milestone	•	•		Pro	oject Su	ummary	-			Externa	al Milesto	ne 🔶							
1																									

ID	6	Task Name	Duration	Start	Finish		2005				2006				2007				2008				2009	
172		Plumbing Pough in	20 days2	Eri 0/18/00	Thu 10/15/00	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
172		Fluitibility Rough-in	20 days?	FII 9/10/09	Thu 10/15/09																			
173		Inspections	2 days?	Tue 1/12/10	Man 2/0/40																			
174			20 days?	Tue 1/12/10	Wion 2/8/10																			
1/5		Lobby	203 days	Thu 11/12/09	Mon 8/23/10																			
176	111	Lobby	203 days	Thu 11/12/09	Mon 8/23/10																			
177		3rd Floor East	180 days?	Tue 6/2/09	Mon 2/8/10																			Ψ.
178		Frame Walls	63 days?	Tue 6/2/09	Thu 8/27/09																			
179		HVAC/Plumbing Piping	46 days?	Tue 6/9/09	Tue 8/11/09																			
180	111	Electrical Rough-in	103 days?	Wed 6/17/09	Fri 11/6/09																			
181	111	Electrical Conduit Feeder/Equip	52 days?	Thu 7/16/09	Fri 9/25/09																			
182		Duct Branches/Mech. Equip. Sh	32 days?	Thu 7/16/09	Fri 8/28/09																			
183		Medical Gas Rough-in	5 days?	Fri 8/28/09	Thu 9/3/09																			
184	111	Elevator Shafts	5 days?	Mon 8/31/09	Fri 9/4/09																			
185		Plumbing Rough-in	21 days?	Fri 8/28/09	Fri 9/25/09																			
186		Inspections	2 days?	Mon 11/9/09	Tue 11/10/09																			
187	11.	Pull Wire	20 days?	Tue 1/12/10	Mon 2/8/10																			
188	-	3rd Floor West	178 days?	Thu 7/2/09	Mon 3/8/10																			
189		Frame Walls	64 days?	Thu 7/2/09	Tue 9/29/09																			
190	111	HVAC/Plumbing Piping	46 days?	Fri 7/10/09	Fri 9/11/09																			
191		Electrical Rough-in	109 days?	Eri 7/10/09	Wed 12/9/09																			
192		Duct Branches/Mech, Equip, Sh	44 days?	Mon 8/17/09	Thu 10/15/09																			
102		Electrical Conduit Feeder/Equip	33 days?	Eri 9/11/09	Tue 10/27/09																			
193		Medical Gas Bough-in	5 days?	Wed 9/30/09	Tue 10/2//09																			
104		Blumbing Bough in	20 days:	Wed 9/30/09	Tue 10/27/09																			
195		Inspections	20 uays?	Thu 12/10/00	Fri 12/11/09																			
190		Inspections Dull Wire	2 days?	Tuo 2/0/10	FIT 12/11/09																			
197	111		20 days?	Tue 2/9/10	Word 9/4/10																			
198		Lobby	168 days	Mon 12/14/09	Wed 8/4/10																			
199		Lobby	168 days	Mon 12/14/09	Wed 8/4/10																			_
200		4th Floor East	182 days?	Fri 6/12/09	Mon 2/22/10																			
201		Frame Walls	52 days?	Fri 6/12/09	Mon 8/24/09																			
202		HVAC/Plumbing Piping	46 days?	Tue 6/30/09	Tue 9/1/09																			
203		Electrical Rough-in	93 days?	Wed 6/24/09	Fri 10/30/09																			
204		Electrical Conduit Feeder/Equip	20 days?	Mon 9/28/09	Fri 10/23/09																			
205		Duct Branches/Mech. Equip. Sh	29 days?	Tue 7/28/09	Fri 9/4/09																			
206	111	Elevator Shafts	5 days?	Tue 9/8/09	Mon 9/14/09																			
207		Plumbing Rough-in	5 days?	Tue 8/25/09	Mon 8/31/09																			
208		Inspections	2 days?	Mon 11/2/09	Tue 11/3/09																			
209		Pull Wire	10 days?	Tue 2/9/10	Mon 2/22/10																			
210		4th Floor West	179 days?	Wed 7/15/09	Mon 3/22/10																			
211	111	Frame Walls	52 days?	Wed 7/15/09	Thu 9/24/09																			
212	111	HVAC/Plumbing Piping	46 days?	Mon 7/27/09	Mon 9/28/09																			
213		Electrical Rough-in	93 days?	Mon 7/27/09	Wed 12/2/09																			
214		Duct Branches/Mech. Equip. Sh	41 days?	Thu 8/27/09	Thu 10/22/09																			
215		Electrical Conduit Feeder/Equip	20 days?	Wed 10/28/09	Tue 11/24/09																			
216		Plumbing Rough-in	5 days?	Fri 9/25/09	Thu 10/1/09																			
217		Inspections	2 days?	Thu 12/3/09	Frl 12/4/09																			
218		Pull Wire	10 days?	Tue 3/9/10	Mon 3/22/10																			
219		Roof Garden	240 days	Fri 5/29/09	Thu 4/29/10																			
220		Roof Garden	240 days	Fri 5/29/09	Thu 4/29/10																			, in the second se
221	-	Penthouse	253 days?	Tue 6/30/09	Thu 6/17/10																			
222		AHU's/Mechanical Equipment	123 days?	Tue 6/30/09	Thu 12/17/09																			
223		Bough-in Electrical/Pull Wire	72 days?	Thu 11/19/09	Eri 2/26/10																			
224		Duct/piping/sprinkler	62 days?	Fri 11/27/09	Mon 2/22/10																			
224		Plumbing Rough-in	4 dave?	Mon 2/15/10	Thu 2/18/10																			
220		Frame/finish wells	Q2 dour0	Tuo 2/0/10	Thu 2/10/10																			
220			so uays?	Tue 2/9/10	110 0/17/10																			
227		Substantial Completion	0 days	Wed 12/29/10	Wed 12/29/10																			
228		Substantial Completion	0 days	wed 12/29/10	wed 12/29/10																			
					-				-															
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Date:	Mon 4/5/	10 Split			Milestone	4			Pro	oject Su	ummary	$\overline{\nabla}$			Externa	al Milesto	ne 🔶							
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APPENDIX B: SURVEY RESULTS

- 1. Have you worked on projects that both used traditional detailing/coordination of the façade and projects that have used BIM technologies for the façade construction?
 - i. 75% Yes
 - ii. 25% No
- 2. Rate your experience with using BIM for the façade construction.

Comments:

- a. Approximately 150,000 sf.
- b. 150,000 sf glazed facade on Pharma building in Wuxi, China sticks out
- c. Most of the projects we work on here are certainly over 100,000 sq ft. But as a range we work on projects from 75,000 sqft to 450,000 sq ft.
- d. The current software applications that allow facade (curtain wall and metal panels) modeling to not have the level of detail required to produce shop drawings and actually utilize to construct the building in the field.

We have been successful tracking exterior facade materials utilizing BIM and integrating our schedule.

Higher education jobs usually have more complex skins where there are multiple materials and scopes coming together. This is where the real benefits of BIM can be unlocked.

e. We've done some work looking at mock-up of facade, but nothing formal. We are just starting a project that will require detailed facade construction modeling that is a good case example, but we won't have any good models until June. The project in question is a complex replacement of an existing curtain wall.

3. Using BIM has increased the constructability of a complex façade.

Comments:

- a. Structural analysis and details
- b. Mostly in the coordination of the project between all disciplines, Architectural, Structural, mechanical, and electrical. It can help with civil engineering especially if the civil engineer is working in BIM. Often times we find that they are reluctant, and stick with 2d methods.
- c. I think it helps decrease the schedule and properly sequence trades and required equipment such as scaffolding. It may not be easier to construct but contractors can be more efficient.
- d. While I don't see modeling a whole project in the required level of detail yet, I can see where performing a detailed virtual mock-up of how building facades tie-into each other will be beneficial on many of our projects. Unfortunately, only a few skin subs do any modeling, so being able to use 3D modeling for fabrication drawings is a minimal use that I would like to see expanded in the industry.
- 4. Using BIM has increased the productivity of façade construction.

Comments:

- a. I'm an ae so not sure if those filthy construction workers get er done quicker
- b. The BIM model can be sent to the contractor as well as any of the subs involved. It can be sent to the curtain wall manufacturer as a means of coordination. It is often used as a means of verifying the design intent and a communicative link between architect and contractors.
- c. The sequencing and scheduling of multiple trades and equipment is much easier to visualize and therefore communicate with the entire project team.
- d. It will definitely be useful to plan execution, which will prevent conflicts, increasing productivity. Hopefully once we start to do more of this we'll see data where projects that do this level of mock-up have less leaks.
- 5. BIM is beneficial for façade analysis and coordination.

Comments:

- a. passive lighting, coordinating with structural components
- b. It is a beneficial to be able to quantify different materials in the facade for energy analysis. However, we are not inputting the raw data into the different materials in a facade at this point. For instance, glass has many properties; shading coefficients, percentage of transparencies and so on that our mechanical and electrical engineers rely on to meet energy codes. So far that information has not made it into the BIM model. We do, however, import that information from the BIM to a third party software at times.
- c. At this point the analysis of facade systems to better understand possibilities for water infiltration or energy loss due to air gaps is not possible with the current software providers. Tekla is making huge strides in making this a reality. Once that is the case facade analysis will be extremely beneficial and contractors will gain a significant amount of benefits with the ability to add intelligence to these objects. Coordination and sequencing will always be a benefit!

6. The learning curve negatively affected the productivity of the use of BIM for the facade.

Comments:

- a. I'm a little confused by the question but I'll try to answer. Absolutely, a staff fresh out of the gate will struggle with anything related to change/new process. In my experience I was already working with experienced staff though.
- b. You do need someone who is more experienced in BIM for modeling the exterior. As a student, this is the one area where BIM should be used, and learned.
- c. If you can find the right people to detail the productivity in the field will always benefit from having this as a visual tool and centralized database.
- d. We would supplement the skills of our team with modelers who can use tools like Revit or sketch-up to model these complex conditions and present a model for the team to use.
- 7. Using BIM for the façade construction helps to reduce the cost of the façade significantly.

Comments:

a. Tolerances can be adhered to that are cost driven, i.e. the radius of a curved wall must stay outside a certain dimension otherwise the manufacturer and/or installer will charge more.

- b. I think BIM again helps save on expensive errors and mistakes during construction.
- c. The increase in productivity helps to reduce cost. The ability to do more in shop prefabrication allows for less field waste and a higher quality product which reduces the chances for re-work.
- d. I can't see this happening. It's not like MEP work where you avoid uninstalling and reinstalling. Facades usually have a clearer picture of who installs first. The material costs won't really change, but perhaps could be some efficiency in labor with less rework.
- 8. Please explain what the most difficult part was about using BIM for facade construction. **Comments:**
 - a. Learning curve in software, thinking out of the box to construct pieces as needed.
 - b. Training people to do it correctly
 - c. Editing the facade (archicad)
 - d. Developing parts specific to the selected system...then reacting to a change in that system late in design development stage.
 - e. Determining when to stop drawing in BIM
 - f. There is not one difficult part, but I think it is taking BIM to the next level to be able to put more info in and get more analysis out. That is where the difficulties lie.
 - g. Lack of much needed detail in the models not everything shown on a shop drawing is present in most modeling software platforms for curtain wall and metal panels.
 - h. Modeling efforts involved. Without many subcontractors modeling, it is hard to build a model with the right level of expertise to get the most benefit.
- 9. Please explain what is most beneficial about using BIM for facade construction.

Comments:

- a. Coordination, identifying issues early.
- b. can create shop drawings from it
- c. managing costs
- d. Coordination between trades.
- e. The idea that I could sent the model off to a sub-contractor to develop shop drawings for the facade.
- f. After building a BIM model, you will have a very good sense of the design. BIM will definitely help with window and door scheduling, material identification via mapping of material textures in the elevations. There are less mistakes made by the contractor is the BIM model is used through the entire design and construction documents process.
- g. Increase of field productivity.
- h. Slab edge as-built conditions, curtain wall and precast shop drawings are where we can get some better information to avoid tolerance conflicts.
- 10. Please provide any additional comments you have on this topic.

a. All bim tools (revitarchicadbentlybim) do not create facades equally. archicad stinks revit is much better, not sure about bentley). knowing the tool used to create facades seems like it will be critical to quantify the data you gather in this survey

APPENDIX C: PREFABRICATION COST ANALYSIS (FROM COST WORKS)

ECCCC

Charlottes[,]VA

Unit Cost Estimate Data Release : Year 2010

Quantity	LineNumber	Description	Crew	Daily	Days	Labor	Unit	Ma	aterial	Lab	or	Total		Ext. Mat.		Ext. Labor	Ext	. Total
				Output		Hours												
		Elastomeric sheet waterproofing,																
		polyethylene and rubberized asphalt															l l	
33472	071353102200	sheets, 1/8" thick	3	550	20	0.029	S.F.	\$	0.85	\$	2.00	\$	2.85	\$ 28,4	51.20	\$ 66,944.00	\$	95,395.20
		Extruded polystyrene insulation, rigid, for																
		walls, 25 PSI compressive strength, 2"															l l	
33472	072113101940	thick, R10	4	730	11	0.011	S.F.	\$	1.03	\$	1.80	\$	2.83	\$ 34,4	76.16	\$ 60,249.60	\$	94,725.76
		Thin brick veneer, modular, 2-2/3" x 5/8"																
		x 8", includes 3% brick and 25% mortar															l	
		waste, excludes scaffolding, grout and															l l	
33472	042113140020	reinforcing	4	92	91	0.174	S.F.	\$	10.93	\$	10.00	\$	20.93	\$ 365,8	48.96	\$334,720.00	\$	700,568.96
33472	096616100500	Scratch Coat	4	75	112	0.107	S.F.	\$	0.72	\$	2.40	\$	3.12	\$ 24,0	99.84	\$ 80,332.80	\$	104,432.64
		Partition, galv LB studs, 16 ga x 6" W																
		studs 16" O.C. x 8' H, incl galv top &															l l	
		bottom track, excl openings, headers,															l l	
25167	054113304400	beams, bracing & bridging	4	64	197	0.25	L.F.	\$	10.84	S	9.43	\$	20.27	\$ 272,8	10.28	\$237,324.81	\$	510,135.09
		Metal Lath, for use with diamond lath, for																
33472	092236230600	15 lb asphalt sheathing paper, add	4	100	84		S.F.	\$	0.54	\$	1.60	\$	2.14	\$ 18,0	74.88	\$ 53,555.20	\$	71,630.08
		Sheathing, wood fiber, regular, no vapor																
66944	061636103100	barrier, 5/8" thick	3	1200	19	0.013	S.F.	\$	0.50	\$	1.00	\$	1.50	\$ 33,4	72.00	\$ 66,944.00	\$	100,416.00
Total					178									\$ 777,2	33.32	\$900,070.41	\$ 1	,677,303.73

Ма	it. O&P	Lat O&	oor P	Tof O&	tal P	Ext. Labor O&P	Ext	. Total O&P	Labor Type	Data Release
\$	0.94	\$	0.83	\$	1.77	\$ 27,781.76	\$	59,245.44	STD	Year 2010
\$	1.13	\$	0.36	\$	1.49	\$ 12,049.92	\$	49,873.28	STD	Year 2010
\$	12.05	\$	4.48	S	16.53	\$149,954.56	\$	553,292.16	STD	Year 2010
\$	0.79	\$	3.51	S	4.30	\$117,486.72	\$	143,929.60	STD	Year 2010
\$	11.93	\$	14.51	\$	26.44	\$365,173.17	\$	665,415.48	STD	Year 2010
\$	0.59	\$	-	\$	0.59	\$ -	\$	19,748.48	STD	Year 2010
\$	0.55	\$	0.43	\$	0.98	\$ 28,785.92	\$	65,605.12	STD	Year 2010

Final Total \$ 3,234,413.29

APPENDIX D: PREFAB REDUCED SCHEDULE

	Task Name		Duration	Start	Finish		2005	2006	2007	2	008		2009			2010			2011	
- U	Deelan Bhaea		749 dave	Wed 6/1/05	Er: 4/11/09	Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q	4 Q1 Q2	Q3 Q4	Q1 Q2	Q3 Q4	Q1	Q2 (23 Q4	Q1	Q2	Q3 Q4	Q1	Q2
2 💷	Design Phase		748 days	Wed 6/1/05	Eri 4/11/08		•				_									
3	Sitework& Site Iltilitie	٥	391 dave	Set 4/12/08	Fri 10/9/09					1										
4 📼	CCC Ground Brea	a kina	0 days	Sat 4/12/08	Sot 4/12/08						A/12						-			
5 🖬	Garage Demolition	king .	50 dave	Mon 4/14/08	Eri 6/20/08						4 /12									
6 1	Site Utilities		244 days	Tuo 6/17/08	Fri 10/20/08															
7	Site Offices		Ed dovo2	The 0/11/08	Wod 7/1/09															
/	Substructure		142 days?	Thu 2/28/08	Ved //1/09						·									
8 🛄	Foundations		143 days	Thu 2/28/08	Fri 9/12/08									_						
9	Backfill		30 days	Thu 4/2/09	Wed 5/13/09															
10	Column Line F-K		51 days	Wed 10/15/08	Wed 12/24/08															
10	Elevator Pits		18 days	Wed 10/15/08	FIT 11/7/08							-								
12 🛄	F/P/C/S Secu	on waiis 1-3	39 days	FIT 10/31/08	Wed 12/24/08															
13	Column Line C-F		108 days	Tue 9/2/08	Thu 1/29/09															
14	Build Grade E	seam Cages Sectio	19 days	Tue 9/2/08	Fri 9/26/08							_								
15	Excavate For	m and Place Sectio	21 days	Thu 9/18/08	Thu 10/16/08															
16	Section 1 Wa	115	22 days	Fri 10/10/08	Won 11/10/08															
17	Section 2 Wa	lls	10 days	Mon 11/10/08	Fri 11/21/08							0								
18	Section 3 Wa	lis	10 days	Fri 11/21/08	Thu 12/4/08															
19 🗰	Section 4 Wa	lis	9 days	Wed 12/3/08	Mon 12/15/08															
20	Vault Slabs/L	ids	33 days	Tue 12/16/08	Thu 1/29/09															
21	North Walls		61 days	Wed 10/8/08	Wed 12/31/08															
22	Exterior Walls	;	18 days	Mon 1/5/09	Wed 1/28/09												-			
23	Column Line Z-C		16 days	Mon 2/2/09	Mon 2/23/09								ΨΨ.							
24	Section 1 Wa	ls	5 days	Mon 2/2/09	Fri 2/6/09								1							
25	Section 2 Wa	lls	5 days	Fri 2/6/09	Thu 2/12/09								Q.							
26 📰	Section 3 Wa	lls	5 days	Tue 2/17/09	Mon 2/23/09								Q							
27	Slab Pours East		60 days?	Tue 3/10/09	Mon 6/1/09															
28	Mezzanine Pr	ep/Place	2 days	Tue 3/10/09	Wed 3/11/09								I				-			
29 🔳	1st Floor Pres	D/Place/Pan Stairs	12 days	Thu 3/19/09	Fri 4/3/09															
30 🔳	2nd Floor Pre	p/Place/Pan Stairs	12 days	Thu 4/2/09	Fri 4/17/09															
31 📅	3rd Floor Pre	p/Place/Pan Stairs	12 days	Thu 4/16/09	Fri 5/1/09															
32 💼	4th Floor Prep	p/Place/Pan Stairs	14 days	Thu 4/30/09	Tue 5/19/09															
33 🛅	Roof Prep/Pla	ace/Pan Stairs	11 days?	Mon 5/18/09	Mon 6/1/09															
34	Slab Pours West		60 days	Thu 4/9/09	Wed 7/1/09															
35 🔳	Mezzanine Pr	ep/Place	2 days	Thu 4/9/09	Fri 4/10/09									[
36 🔳	1st Floor Prep	/Place/Pan Stairs	12 days	Mon 4/20/09	Tue 5/5/09															
37 🔳	2nd Floor Pre	p/Place/Pan Stairs	10 days	Mon 5/4/09	Fri 5/15/09															
38 🔳	3rd Floor Pre	p/Place/Pan Stairs	13 days	Mon 5/18/09	Wed 6/3/09															
39 📖	4th Floor Prep	/Place/Pan Stairs	14 days	Tue 6/2/09	Fri 6/19/09															
40 🛅	Roof Prep/Pla	ce/Pan Stairs	10 days	Thu 6/18/09	Wed 7/1/09															
41	Slab On Grade		57 days	Mon 3/9/09	Tue 5/26/09															
42 🔳	East		34 days	Mon 3/9/09	Thu 4/23/09															
43 🔳	West		42 days	Mon 3/30/09	Tue 5/26/09															
44	Superstructure		84 days	Mon 2/2/09	Thu 5/28/09									_						
45 📖	Steel/decking Sea	1	26 days	Mon 2/2/09	Mon 3/9/09									-						
46 🕅	Steel/decking Sea	2	23 days	Thu 2/5/09	Mon 3/9/09															
47	Steel/decking Sea	3	20 days	Tue 2/10/09	Mon 3/9/09															
48 📖	Steel/decking Seg	4	17 davs	Fri 2/13/09	Mon 3/9/09															
49	Steel/decking Sea	5	23 days	Wed 2/18/09	Fri 3/20/09												-			
50	Steel/decking Sea	6	4 days	Wed 2/25/09	Mon 3/2/09												1			
51 💷	Steel/decking Seg	16	18 days	Tue 3/3/09	Thu 3/26/09															
52	Steel/decking Seg	9	23 days	Mon 3/9/09	Wed 4/8/09								_							
53	Steel/decking See	10	22 days	Tue 3/10/00	Wed 4/8/00															
54	Steel/decking Seg	11	22 days	Thu 3/12/00	Wed 4/8/09								_							
55 📼	Steel/decking Seq	12	10 days	Eri 2/12/09	Wed 4/0/09															
56	Steel/decking Seq	7	18 days	Mon 2/10/09	Wed 4/8/09															
57	Steel/decking Sed	<i>I</i>	16 days	Word 2/10/09	Wed 4/8/09															
o/ 🛄	Steel/decking Seq	ö	16 days	vved 3/18/09	vved 4/8/09															
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58	111	Steel/decking Seq 14	20 day	s Fri 3/20/09	Thu 4/16/09							,											(
59	111	Steel/decking Seq 15	18 day	s Tue 3/24/09	Thu 4/16/09														2 2 2 2 2				ſ	
60		Steel/decking Seq 13	16 day	s Thu 3/26/09	Thu 4/16/09																			
61	111	Steel/decking Seq 17	16 day	s Mon 3/30/09	Mon 4/20/09																			
62	111	Structure Top out	0 day	s Thu 5/28/09	Thu 5/28/09																			
63		Fire Proofing	35 day	s Thu 4/23/09	Wed 6/10/09																			
64	111	Fire Proofing	35 day	s Thu 4/23/09	Wed 6/10/09																			
65	1	West Terrace Structure	12 days	? Thu 5/14/09	Fri 5/29/09																			
66		West Terrace	12 days	? Thu 5/14/09	Fri 5/29/09																			
67	1	Loading Dock Structure	68 day	s Thu 5/14/09	Mon 8/17/09																			_
68	111	Loading Dock Structure	68 day	s Thu 5/14/09	Mon 8/17/09																			
69	1	Façade	168 day	s Mon 5/18/09	Wed 1/6/10																			
70		Brick Façade	20 day	s Mon 5/18/09	Fri 6/12/09																			
71	111	Curtain Wall All Elevations	161 day	s Wed 5/27/09	Wed 1/6/10																			
72	1	Roof	104 day	s Fri 5/29/09	Wed 10/21/09																			-
73	111	Roof	104 day	s Fri 5/29/09	Wed 10/21/09																			
74	1	MEP	70 day	s Fri 6/12/09	Thu 9/17/09														-					-
75		MEP Rough-in East Risers	10 day	s Fri 6/12/09	Thu 6/25/09																			
76	111	MEP Rough-in West Riser	s 47 day	s Wed 7/15/09	Thu 9/17/09																			
77	1	Finishes	263 day	s Mon 7/27/09	Wed 7/28/10														-					
78		Finishes	263 day	s Mon 7/27/09	Wed 7/28/10																			
79		Interiors	432 days	? Mon 1/5/09	Tue 8/31/10																		<u> </u>	
80		Ground East	165 day	s Fri 4/24/09	Thu 12/10/09																			
81		Fire Proofing	10 day	s Fri 4/24/09	Thu 5/7/09																			
82		Frame Walls	56 day	s Fri 5/8/09	Fri 7/24/09																			
83	111	Duct Rough-in	16 day	wed 5/20/09	Wed 6/10/09																			
84		Electrical Rooms/Equ	ipment 26 day	s Thu 6/4/09	Thu 7/9/09														- - - - - - -					
85		HVAC/Plumbing Pipin	g 36 day	s Thu 6/4/09	Thu 7/23/09																			
86		Duct Branches/Sprink	ler Main 16 day	s Thu 6/11/09	Thu 7/2/09														-					
87		Plumbing Rough-in	20 day	s Mon 7/27/09	Fri 8/21/09																			_
88		Medical Gas Rough-ir	n 5 day	s Mon 7/27/09	Fri 7/31/09																			
89	111	Electrical Rough-in	54 day	s Thu 7/2/09	Tue 9/15/09														- - - -					
90	T	Inspections	2 day	s Wed 9/16/09	Thu 9/17/09														-					
91		Pull Wire	21 day	s Thu 11/12/09	Thu 12/10/09														-					
92		Ground West	343 day	s Mon 1/5/09	Wed 4/28/10														-				<u> </u>	
93	T	Fire Proofing	10 day	s Wed 5/27/09	Tue 6/9/09														-				Ĩ.	
94		Frame Walls	55 day	wed 6/10/09	Tue 8/25/09														- - - -					
95		Duct Rough-in	16 day	s Mon 6/22/09	Mon 7/13/09																			
96		Electrical Rooms/Equ	ipment 31 day	s Mon 6/22/09	Mon 8/3/09																			
97		HVAC/Plumbing Pipin	g 35 day	s Tue 7/7/09	Mon 8/24/09																			-
98	111	Duct Branches/Sprink	ler Main 16 day	s Tue 7/14/09	Tue 8/4/09																			
99	III	Plumbing Rough-in	21 day	s Wed 8/26/09	Wed 9/23/09																			
100		Medical Gas Rough-in	n 5 dav	s Wed 8/26/09	Tue 9/1/09																			
101		Electrical Rough-in	50 day	s Fri 8/7/09	Thu 10/15/09																			
102		Inspections	2 day	s Fri 10/16/09	Mon 10/19/09																			
103		Pull Wire	22 day	s Fri 12/11/09	Mon 1/11/10																			
104	1	Main Electrical Room	n 269 dav	s Mon 1/5/09	Thu 1/14/10																		÷	
105	III	Main Electrical R	oom 269 dav	s Mon 1/5/09	Thu 1/14/10																			
106	1	Finishes	229 dav	s Fri 6/12/09	Wed 4/28/10																			
107	111	Partitions/Ceiling	s/Soffits/Fi 85 day	s Fri 6/12/09	Thu 10/8/09																			
108		Light Fixtures	20 dav	s Mon 9/28/09	Fri 10/23/09																			-
109		Casework	21 day	s Mon 12/7/09	Mon 1/4/10																			
110		Plumbing Fixture	s 20 day	s Mon 12/28/09	Fri 1/22/10																			
111		Misc. Finishes	66 dav	s Mon 1/25/10	Mon 4/26/10																			
112		TAB	3 dav	s Mon 4/26/10	Wed 4/28/10																			
113	<u> </u>	Mezzanine/Sub Basemen	t Mechani 237 dav	s Thu 5/21/09	Fri 4/16/10																			
114		Mechanical Equipmen	t/Sprinkler 37 dav	s Thu 5/21/09	Fri 7/10/09																			· ·
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	6	Task Name	Duration	Start	Finish	01	2005	02	02	04	2006	02	02	04	2007	02	02	01	2008	02	02	04	2009	01
115		HVAC Piping	26 days	Fri 6/19/09	Fri 7/24/09			042	0.0	Q4		Q2	0.5	4	<u></u>	92	00	4		02	020	4	<u></u>	(22
116		Electrical Rough-in	56 days	Fri 6/19/09	Fri 9/4/09																			
117		Electrical Conduit Feeder/F	quip: 27 days	Mon 7/13/09	Tue 8/18/09																			-
118		Erame Walls	4 days	Thu 7/30/09	Tue 8/4/09																			
110			- udys 1 day	Tue 9/8/09	Tue 9/8/09																			
120		Bull Wire	10 days	Thu 11/12/00	Wod 11/25/09																			
120		Pull Wire	10 days	Thu 11/12/09	Wed 11/25/09																			
121		Hang/Finish Drywall	13 days	Thu 11/12/09	Mon 11/30/09																			
122	111	Pneumatic Tube Equipmen	10 days	Tue 12/1/09	Wion 12/14/09																			
123	<u> </u>	Test Electrical Equipment	3 days	Fri 12/4/09	Tue 12/8/09																			
124	111	Paint	4 days	Tue 12/15/09	Fri 12/18/09																			
125	111	Install Fixtures	3 days	Mon 12/21/09	Wed 12/23/09																			
126	111	Misc. Finishes	9 days	Tue 3/23/10	Fri 4/2/10																			
127		TAB	10 days	Mon 4/5/10	Fri 4/16/10																			
128		1st Floor East	161 days	Thu 4/30/09	Thu 12/10/09																			
129	111	Frame Walls	70 days	Thu 4/30/09	Wed 8/5/09	1																		
130	111	HVAC/Plumbing Piping	22 days	Tue 5/12/09	Wed 6/10/09	1																		
131		Electrical Rough-in	81 days	Fri 6/5/09	Fri 9/25/09																			
132		Electrical Conduit Feeder/E	quipr 36 days	Thu 6/11/09	Thu 7/30/09																			
133	111	Duct Branches/Mech. Equir	. Sh: 39 days	Tue 6/23/09	Fri 8/14/09																			
134		Medical Gas Rough-in	5 days	Thu 8/6/09	Wed 8/12/09																			
135		Elevator Shafts	5 days	Mon 8/17/09	Eri 8/21/09																			
136	100	Plumbing Rough in	20 days	Thu 8/6/00	Wed 9/2/09																			
130			20 days	Mon 0/28/00	Tuo 9/29/09																			
137		Dull Mire	2 days	Thu 11/12/00	Tue 9/29/09																			
130			21 days		110/09																			
139	_	1st Floor West	160 days	Tue 6/2/09	Mon 1/11/10																			
140		Frame Walls	69 days	Tue 6/2/09	Fri 9/4/09																			
141		HVAC/Plumbing Piping	46 days	Fri 6/12/09	Fri 8/14/09																			
142	111	Electrical Rough-in	98 days	Fri 6/12/09	Tue 10/27/09																			
143	111	Electrical Conduit Feeder/E	quipi 33 days	Thu 7/16/09	Mon 8/31/09																			
144	111	Duct Branches/Mech. Equip	. Sh 50 days	Fri 7/24/09	Thu 10/1/09																			
145	111	Medical Gas Rough-in	5 days	Tue 9/8/09	Mon 9/14/09	1																		
146	111	Plumbing Rough-in	20 days	Tue 9/8/09	Mon 10/5/09	1																		
147	111	Inspections	2 days	Wed 10/28/09	Thu 10/29/09	1																		
148		Pull Wire	22 days	Fri 12/11/09	Mon 1/11/10	1																		
149		Lobby	167 days	Mon 1/11/10	Tue 8/31/10																			
150		Lobby	167 days	Mon 1/11/10	Tue 8/31/10																			
151	-	2nd Floor East	173 days?	Thu 5/14/09	Mon 1/11/10																			
152	111	Erame Walls	68 days?	Thu 5/14/09	Mon 8/17/09																			
153		HVAC/Plumbing Piping	46 days?	Wed 5/27/09	Wed 7/29/09																			
154		Electrical Rough-in	87 days?	Thu 6/11/09	Eri 10/9/09																			
154		Electrical Conduit Eeeder/E	guine 52 days?	Wed 6/17/09	Thu 9/27/09																			_
150		Duct Branchoo/Moch. Equit	Quipi 52 days?	Mop 7/6/00	Eri 9/21/09																			
150		Madical Cas Davah in	5 days?	WOIT //6/09	FII 6/2 1/09																			
157		Flour Charles Rough-In	5 days?	Tue 8/18/09	Nion 8/24/09																			
158		Elevator Shafts	5 days?	Mon 8/24/09	Fri 8/28/09																			
159	—	Plumbing Rougn-in	21 days?	Tue 8/18/09	Tue 9/15/09																			
160		Inspections	2 days?	Mon 10/12/09	Tue 10/13/09																			
161	111	Pull Wire	22 days?	Fri 12/11/09	Mon 1/11/10																			
162		2nd Floor West	170 days?	Tue 6/16/09	Mon 2/8/10																			-
163	111	Frame Walls	68 days?	Tue 6/16/09	Thu 9/17/09																			
164	121	HVAC/Plumbing Piping	46 days?	Fri 6/26/09	Fri 8/28/09																			(
165		Electrical Rough-in	98 days?	Fri 6/26/09	Tue 11/10/09																			(
166	111	Duct Branches/Mech. Equip	. Sh 47 days?	Wed 8/5/09	Thu 10/8/09																			
167	111	Electrical Conduit Feeder/E	quip: 34 days?	Thu 8/13/09	Tue 9/29/09	1																		
168		Medical Gas Rough-in	5 days?	Fri 9/18/09	Thu 9/24/09	1																		
169		Plumbing Rough-in	20 days?	Fri 9/18/09	Thu 10/15/09	1																		
170		Inspections	2 davs?	Wed 11/11/09	Thu 11/12/09																			
171		Pull Wire	20 days?	Tue 1/12/10	Mon 2/8/10																			
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Projec	t: Propos Mon 4/5/1	ed Pretab Schedule							- 50			·		-	= c					_ Dea			r	
Date.	4/3/1	Split			Milestone	4	•		Pro	ject Su	mmary				Externa	ai Milesto	one 🌩							

O Part Part of all Part		ID	_	Task Name	Duration	Start	Finish		2005				2006				2007				2008				2009	
The Deck in Bit of Pare Last Bit			0		Baration			Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
The set of	Ľ	172		3rd Floor East	180 days?	Tue 6/2/09	Mon 2/8/10																			-
Physical Physi	Ľ	173		Frame Walls	63 days?	Tue 6/2/09	Thu 8/27/09																			C
The second frage Executed frage Status The second frage Status The second frage Status StatusStatus	Ľ	174		HVAC/Plumbing Piping	46 days?	Tue 6/9/09	Tue 8/11/09																			
Product Description Council Framework File 2000 Product State Statework Statework Statework Statework Statework Product Statework Statework Statework Statework Statework Product Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework Statework	Ľ	175	11	Electrical Rough-in	103 days?	Wed 6/17/09	Fri 11/6/09																			ļ
TY Direct Encode-Backed Perior. So Servey The Triffed File Stade TY Direct Encode-Backed Perior. So Servey So Servey Son Se	Ľ	176		Electrical Conduit Feeder/Equip	or 52 days?	Thu 7/16/09	Fri 9/25/09																			
170 100 1	Ľ	177		Duct Branches/Mech. Equip. Sh	n: 32 days?	Thu 7/16/09	Fri 8/28/09																			
TP3 Elevator Subto 2 dept Mon 8100 Fri 4600 TP3 Elevator Subto 2 dept Mon 8100 Fri 4600 TP3 Elevator Subto 2 dept Fri 4600 Fri 4600 TP3 Elevator Subto TP3 dept Fri 4600 Fri 4600 Fri 4600 TP3 Elevator Subto TP3 dept Fri 4600 Fri 7000	Ľ	178	111	Medical Gas Rough-in	5 days?	Fri 8/28/09	Thu 9/3/09																			
Image: The Human Bought in 21 deccyl Frieddolog	Ľ	179	11	Elevator Shafts	5 days?	Mon 8/31/09	Frl 9/4/09																			
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182 3 Chu Wre 120 days Tut 1210 Mon 2810 193 4 Phace West 178 days Tut 1210 Mon 2810 193 4 Phace West 178 days Tut 1210 Mon 2810 193 4 Phace West 178 days Phace West Phace West 193 4 Phace West 178 days Phace West Phace West 193 4 Phace West 178 days Phace West Phace West 193 4 Phace West 182 days Phace West Phace West 193 4 Monard Gas Roghon 5 days Phace West 19900 Non 34700 193 4 Monard Gas Roghon 5 days Phace West 19900 Non 34700 193 4 Monard Gas Roghon 5 days Phace West 19900 Non 34700 193 4 Monard Gas Roghon 5 days Phace West 19900 Non 34700 193 4 Monard Gas Roghon 5 days Phace West 19900 Non 34700 193 4 Monard Gas Roghon 5 days Phace West 19900 Non 34700 193 4 Phace Roghon 5 days Phace Roghon Non 34700 193		81	11	Inspections	2 days?	Mon 11/9/09	Tue 11/10/09																			
183 3 of Proc. West 172 days The 2009	Ľ	182	111	Pull Wire	20 days?	Tue 1/12/10	Mon 2/8/10																			
184 B France Walls 64 days? The 7000 The 90000 185 B Herkel Walls 64 days? The 7000 The 90000 185 B Herkel Walls 100 days? The 7000 The 90000 186 B Herkel Walls 100 days? The 7000 The 90000 187 B Herkel Walls 100 days? The 10000 187 B Herkel Walls 3 days? The 100000 187 B Herkel Walls 3 days? The 100000 187 B Herkel Walls 2 days? The 100000 188 B Herkel Walls 2 days? The 100000 189 B Herkel Walls 2 days? The 2000 The 100000 189 B Herkel Walls 10 days? The 2000 The 100000 189 B Deckraa Roughs 10 days? The 2000 The 100000		183		3rd Floor West	178 days?	Thu 7/2/09	Mon 3/8/10																			
185 20 FWACPumbing Piping 46 days? FM 71000 FM 91109 197 20 Duction accessible 1 days 44 days? FM 71000 FM 91109 197 20 Duction accessible 1 days 44 days? FM 71000 FM 91109 197 20 Duction accessible 1 days 44 days? FM 91109 FM 91109 197 20 Duction accessible 1 days 44 days? FM 91109 FM 91109 197 20 Duction accessible 1 days 44 days? FM 91109 FM 91109 197 20 FM 97109 FM 91109 FM 91109 FM 91109 197 20 FM 97109 FM 9100 FM 91109 FM 91109 197 20 FM 9100 FM 9100 FM 9100 FM 9100 FM 9100 197 20 FM 9100 FM 9100 FM 91000 FM 91000 FM 91000 FM 91000 197 20 FM 91000		184	111	Frame Walls	64 days?	Thu 7/2/09	Tue 9/29/09																			
186 2 Electrical Rough Mont, Elgui, Su, 400, 400, 400, 400, 400, 400, 400, 40		185	111	HVAC/Plumbing Piping	46 days?	Fri 7/10/09	Fri 9/11/09																			
187 B Duct Brackbarkerb, Edgis B 44 syrt Media 12700 The 101705 187 B Media Cas Roughan 5 syrt Wei 3000 Tue 102706 187 B Media Cas Roughan 5 syrt Wei 3000 Tue 102706 187 B Media Cas Roughan 5 syrt Wei 3000 Tue 102706 187 B Media Cas Roughan 2 syrt Wei 3000 Tue 102706 187 B Media Cas Roughan 2 syrt Wei 3000 Mas 2270 188 B Floor East 112 syrt Tue 2000 Floor East 101 189 B Exterior Committing Piping 46 syrt Tue 2000 Floor East 101 189 B Dut Beackeshellon, Edgis Byrt Tue 2000 Floor East 100 Mas 2270 189 B Dut State State Byrt Tue 2000 Floor East 100 Mas 2270 180 B Dut State State Byrt Tue 2000 Floor East 100 Mas 2270 180 B Dut State State Byrt Tue 2000 Floor East 100 Mas 2270 180 Dut Sta	· ·	86	11.	Electrical Rough-in	109 days?	Fri 7/10/09	Wed 12/9/09																			
198 3 Electral Conduit Federicus 33 eyy? 1101100 Tue 10000 190 3 Hadda da Reght 2 eyy? Weid 3000 Tue 10000 190 3 Electral Conduit Federicus 33 eyy? 1101100 Tue 10000 190 3 Electral Conduit Federicus 33 eyy? 1101100 Tue 10000 190 3 Electral Conduit Federicus 33 eyy? 1101100 Tue 10000 190 3 Electral Rough 1 2 eyy? Tue 2010 Non 30400 190 3 Electral Conduit Federicus 20 eyy? Non 30400 Fin 10000 Fin 10000 197 3 Electral Rough 1 5 eyy? Tue 8000 Fin 10000 Fin 10000 197 3 Electral Rough 1 5 eyy? Tue 8000 Non 30400 Fin 10000 197 3 Electral Rough 1 5 eyy? Tue 8000 Non 30400 197 3 Electral Rough 1 5 eyy? Tue 8000 Non 32216 197 3 Electral Rough 1 5 eyy? Tue 1200		187	111	Duct Branches/Mech. Equip. Sh	1 44 days?	Mon 8/17/09	Thu 10/15/09																			
188 Dial Medical Gas Rough-in 6 days ¹ Weigh 3000 The 10000 191 Dial Inspections 2 days ² The 120100 Fil 121100 191 Dial Part Weigh 3000 The 120100 Fil 121100 Fil 121100 191 Dial Part Weigh 3000 The 120100 Fil 121100 Fil 121100 191 Dial Contract Weigh 1000 Fil 121100 Fil 121100 Fil 121100 191 Dial Contract Weigh 1000 Fil 121100 Fil 1211000 Fil 1211000 191 Dial Field 2000 Field 2000 The 2 days ¹ The 3 days ¹ Field 2000 191 Dial Field 2000 Field 2000 The 3 days ¹ <		88		Electrical Conduit Feeder/Equip	a 33 days?	Fri 9/11/09	Tue 10/27/09																			
100 20 Primetry Rough-In 20 days? The 400700 The 1200700 101 21 Impaction 2 days? The 20100 Mon 32010 102 21 Paul Wite 20 days? The 20100 Mon 32010 103 11		189	111	Medical Gas Rough-in	5 days?	Wed 9/30/09	Tue 10/6/09																			
If if Impectors 2 days The 12/100 Fn 12/100 If if Impectors 2 days The 2000 Mon 22210 If if Impectors Frid K200 Mon 22210 Mon 22210 If if Impectors Frid K200 Mon 22210 Mon 22210 If if Impectors Frid K200 Mon 22210 Frid K200 Mon 22210 If if Impectors Impectors Impectors Frid K200 Mon 22210 If if Impectors Impectors<		190	111	Plumbing Rough-in	20 days?	Wed 9/30/09	Tue 10/27/09																			
192 3 Put Wire 20 days? Tuz 2010 Mon 3810 193 44 Picor Est 152 days? Fridroop Mon 22210 Mon 22210 194 3 Frame Walls 52 days? Fridroop Mon 22210 Mon 22210 194 3 Frame Walls 52 days? Fridroop Mon 22210 Mon 22010 196 3 Electrical Chaugh-In 33 days? Tue 20200 Fridroop Mon 22010 196 3 Electrical Chaugh-In 33 days? Tue 20200 Fridroop Mon 32100 197 3 Electrical Chaugh-In 53 days? Tue 20200 Fridroop Mon 32100 200 3 Impection 17 days? Tue 20200 Fridroop Mon 32100 201 3 Impection 17 days? Tue 20200 Fridroop Mon 32000 201 3 Impection 17 days? Tue 20200 Tue 32000 Tue 32000 202 3 Fridroop Min 43 days? Tue 20200 Tue 32000 Tue 42000 Tue 42000 203 3 Fridroop Min 43 days? Tue 20200 Tue 42000 Tue 42000 Tue 42000	—	91	11	Inspections	2 days?	Thu 12/10/09	Fri 12/11/09																			
163 400 Floor East 112 days 7 Fri 61/2006 Min 8/2400 175 113 <td></td> <td>192</td> <td></td> <td>Pull Wire</td> <td>20 days?</td> <td>Tue 2/9/10</td> <td>Mon 3/8/10</td> <td></td>		192		Pull Wire	20 days?	Tue 2/9/10	Mon 3/8/10																			
194 Frame Walk 02 days? Fri 01209 Mun 87400 195 3 HVACPMunking Piping 66 days? Te 610209 196 3 Electrical Rough in 93 days? Wed 612409 Fri 103209 197 3 Electrical Rough in 93 days? Wed 612409 Fri 103209 198 3 Duct tanches/tech: Equip. Shi 20 days? Tue 72800 Fri 043209 200 3 Duct tanches/tech: Equip. Shi 20 days? Tue 82099 Min 03109 201 3 Intrgetorin 5 days? Tue 82091 Min 03109 202 3 Pulvine 10 days? Tue 82091 Min 03109 202 4 Pulvine 10 days? Tue 82001 Min 032200 203 4 Hitor Mets 10 days? Tue 82700 Tuu 82700 203 Electrical Rough in 5 days? Tue 82700 Tuu 82700 203 Detectrical Rough in 5 days? Tue 82700 Tuu 107200 203 Detectrical Rough in 5 days? Tue 82700 Tuu 107200 210 Integeotin<	-	93		4th Floor East	182 days?	Fri 6/12/09	Mon 2/22/10																			
195 1 11/10.42Punuting Piping 46 days? The 61/0300 196 1 Electrical Conduit Federization 20 days? The 10/0300 197 1 Electrical Conduit Federization 20 days? The 10/0300 197 1 Electrical Conduit Federization 20 days? The 10/0300 198 2 Duct Standhellock Equ. 50 40 days? The 10/0300 199 1 Electrical Conduit Federization 2 days? The 10/0300 201 2 Inspectors 2 days? The 10/0300 The 10/0300 201 2 Punuting Piping 4 days? The 30/030 The 30/030 202 3 France Wals 40 days? The 30/030 The 10/0300 203 4 France Wals 40 days? The 30/030 The 10/0300 203 5 France Wals 40 days? The 30/030 The 10/0300 204 5 France Wals 40 days? The 30/030 The 10/0400 203 5 Decodant Addate Hederization 5 days? The 30/030 The 10/0400		94	11	Frame Walls	52 days?	Fri 6/12/09	Mon 8/24/09																			(
196 3 Electrical Rough-in 93 days? Wei 62409 Fri 103009 197 3 Duct Branches/Mech. Equip. Sh 20 days? Mon 82409 Fri 103009 198 3 Duct Branches/Mech. Equip. Sh 20 days? Mon 83109 200 3 Plunking Rough-in 5 days? Tue 82509 Mon 83109 200 3 Plunking Rough-in 5 days? Tue 20410 Mon 822010 202 3 Plunking Rough-in 5 days? Tue 20410 Mon 822010 203 4th Floor Wet 10 days? Mon 82009 Mon 82009 205 3 Plunking Rough-in 5 days? Tue 20410 Mon 82009 205 3 Plunking Rough-in 5 days? Mon 82009 Mon 82009 206 3 Electrical Conduit FederEupp? 20 days? Mon 82009 Tue 20410 206 3 Electrical Conduit FederEupp? 20 days? Fi 52090 Tuu 42010 206 3 Electrical Conduit FederEupp? 20 days? Fi 52090 Tuu 42910 210 3 Bod Garden		195		HVAC/Plumbing Piping	46 days?	Tue 6/30/09	Tue 9/1/09																			
197 B Electrical Conduit FeaderEquip 20 days1 Mon 928009 Pri 10/2309 198 B Duck Tancherliken: Equip. 83 20 days1 The 98/090 Mon 974009 199 B Elevator Shafa 5 days1 The 98/090 Mon 974009 200 B Elevator Shafa 5 days1 The 98/090 Mon 974009 201 B Elevator Shafa 5 days1 The 98/090 Mon 974009 201 B Elevator Shafa 2 days1 Won 72709 Wol 11/209 The 19/090 203 B Hut Mills 2 days1 Won 72709 Mon 72709 <td>·</td> <td>196</td> <td></td> <td>Electrical Rough-in</td> <td>93 days?</td> <td>Wed 6/24/09</td> <td>Fri 10/30/09</td> <td></td>	·	196		Electrical Rough-in	93 days?	Wed 6/24/09	Fri 10/30/09																			
168 Duct Brances/Mech. Equip. Si: 29 org? Tue 7/2000 Fn 94400 169 Elevate Shafa Sday? Tue 7/2000 Fn 94400 200 3 Plumbing Exugit-in Sday? Tue 8/2000 Mon 8/1400 200 3 Plumbing Exugit-in Sday? Tue 8/2000 Mon 8/1400 200 3 Plumbing Exugit-in 10 day? Tue 8/2000 Mon 8/1400 200 3 Plumbing Exugit-in 10 day? Tue 8/2000 Tue 8/2000 200 3 Plumbing Exugit-in 10 day? Tue 8/2000 Tue 8/2000 200 3 Plumbing Exugit-in 20 day? Wed 7/1500 Tue 2/2010 201 3 Frame Walis 52 day? Wed 7/15000 Tue 2/2010 202 3 Duck BianceMach. Equit-Bian 20 day? Tie 2/2010 Tue 2/2010 203 4 HVAC-Plumes/Much. Equit-Bian 20 day? Tie 2/2010 Tue 2/2010 Tue 2/2010 204 Electrical Conduct Feder/Equit 20 day? Trie 2/2010 Tue 2/2010 Tue 2/2010 Tue 2/2010 Tue 2/2010 210 <t< td=""><td>-</td><td>97</td><td></td><td>Electrical Conduit Feeder/Equip</td><td>1 20 days?</td><td>Mon 9/28/09</td><td>Fri 10/23/09</td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	-	97		Electrical Conduit Feeder/Equip	1 20 days?	Mon 9/28/09	Fri 10/23/09	1																		
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203 4th Floor West 179 days Wed 715009 Mon 32210 204 12 Frame Walls 52 days Mon 72709 Mon 92800 205 12 HVAC/Plumbing Piping 46 days Mon 72709 Mon 92800 206 12 Electrical Rough-In 93 days Mon 72709 Wed 12206 208 12 Electrical Condult FederEquip 120 days Wed 12206 Thu 102209 208 12 Electrical Condult FederEquip 120 days Thu 12209 Fini 120209 210 13 Inspections 2 days Thu 120209 Fini 120409 210 13 Hinspections 2 days Thu 120209 Thu 42040 213 13 Bool Garden 20 days Fini 120409 Thu 201700 214 Penthouse 23 days Thu 201700 Thu 201700 Fini 1201700 214 Penthouse 23 days Tue 1201700 Fini 1201700 Fini 1201700 215 14 Penthouse 23 days Fini 1202100 Fini 120210 <td></td> <td>202</td> <td></td> <td>Pull Wire</td> <td>10 days?</td> <td>Tue 2/9/10</td> <td>Mon 2/22/10</td> <td></td>		202		Pull Wire	10 days?	Tue 2/9/10	Mon 2/22/10																			
204 Image: Prame Walls 55 days? Wed 7/1600 Thu 8/2/09 205 Image: Prame Walls 55 days? Mon 7/2709 Wed 1/2/09 206 Image: Prame Walls 93 days? Mon 7/2709 Wed 1/2/09 206 Image: Prame Walls 93 days? Mon 7/2709 Wed 1/2/09 207 Image: Prame Walls 93 days? Mon 7/2709 Wed 1/2/09 207 Image: Prame Walls 93 days? Mon 7/2709 Wed 1/2/09 208 Image: Prame Walls 93 days? Mon 7/2709 Wed 1/2/09 208 Image: Prame Walls 93 days? Mon 7/2709 Wed 1/2/09 209 Image: Prame Walls 93 days? Mon 7/2709 Tu 1/1/09 210 Image: Prame Walls 92 days? Thu 4/2010 Thu 4/2010 211 Prolipherine 10 days? Thu 4/2010 Thu 4/2010 213 Monologing Prame Walls 93 days? Tu 4/2010 Thu 4/2010 214 Prologing Prame Walls 93 days? Thu 2/2010 Thu 1/2010		203	_	4th Floor West	179 days?	Wed 7/15/09	Mon 3/22/10																			
206 19 HVAC/Plumbing Pping 46 days? Mon 7/27/09 Mon 928/09 206 10 Electrical Rough-In 93 days? Mon 7/27/09 Wei 928/09 206 10 Duck Branches/Mech, Equip, Sh, 41 days? Thu 8/27/09 Thu 1/2/209 Tru 1/2/209 208 10 Electrical Conduit Feeder/Equip 20 days? Fri 1/2/209 Thu 1/2/209 Thu 1/2/209 209 10 Plumbing Rough-In 10 days? Thu 2/209 Thu 1/2/209 210 11 10 Inspections 2 days? Thu 2/209 211 11 Pull Wre 10 days? Thu 2/209 Thu 1/2/209 212 Roof Garden 2 do days Fri 5/29/09 Thu 4/29/10 Thu 4/29/10 213 B Roof Garden 2 do days? Thu 6/009 Thu 1/21/70 214 Penthouse 283 days? Thu 6/009 Thu 1/21/70 215 B AtU/Watchaniel Equipment 123 days? Thu 6/20/10 Fri 10/21/10 217 Ductriping/sprinkier <		204		Frame Walls	52 days?	Wed 7/15/09	Thu 9/24/09																			
206 Image: State of the state		205	111	HVAC/Plumbing Piping	46 days?	Mon 7/27/09	Mon 9/28/09																			
207 Image: Substantial Completion 1 days? Thu 10/2009 208 Image: Substantial Completion 2 days? Thu 10/2009 209 Image: Substantial Completion 2 days? Thu 10/2009 211 Image: Substantial Completion 2 days? Thu 12/2009 Thu 12/2009 211 Image: Substantial Completion 2 days? Thu 4/28/10 213 Image: Substantial Completion 2 days? Thu 4/28/10 214 Penthouse 228 days? Thu 6/3009 Thu 4/28/10 215 Image: Root Garden 240 days Thu 4/28/10 Image: Root Garden 216 Image: Root Garden 240 days? Thu 6/3009 Thu 4/28/10 216 Image: Root Garden 12 days? Thu 6/3009 Thu 10/109 217 Image: Root Garden 12 days? Thu 10/2009 Thu 2/26/10 217 Image: Root Garden 12 days? Thu 10/2009 Thu 2/26/10 217 Image: Root Garden 0 days? Tri 10/2010 Tri 10/2010 219 Image: Root		206		Electrical Rough-in	93 days?	Mon 7/27/09	Wed 12/2/09																			
208 Image: Constraint Conduct Feeder/Equip 20 days Wed 10/2809 The 11/24/09 200 Image: Constraint Conduct Feeder/Equip 5 days Fri 9/25/09 Thu 10/109 210 Image: Constraint Conduct Feeder/Equip 10 days Fri 9/25/09 Thu 10/109 211 Image: Constraint Conduct Feeder/Equip 10 days The 3/9/10 Mon 3/22/10 212 Roof Carden 240 days Fri 9/28/09 Thu 4/28/10 Image: Constraint Conduct Feeder/Equip Image: Constraint Conduct Feeder/Equip 213 Image: Constraint Conduct Feeder/Equip 263 days The 6/2009 Thu 4/28/10 Image: Constraint Conduct Feeder/Equip		207	T	Duct Branches/Mech. Equip. Sh	1: 41 days?	Thu 8/27/09	Thu 10/22/09																			
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Split

Milestone

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Project Summary 🛛 🛡

External Milestone 🔶

APPENDIX E: TRINA SOLAR PANEL CUT SHEETS

Monocrystalline Solar Modules

Trinasolar

STRENGTHS

- Tolerance ± 3% 3 Bus Bar Configuration Plug & Play Connectors High Transmission, Low Iron Tempered Glass Can beer loads up to 5400 Pascals (IEC 61215 2rd)

WARRANTY Manufacturing Manufacturing: 5 years Power production: 90% : 10 years 80% : 25 years

TRINA TSM-DA05, 220W to 240W

TYPICAL ELEC	TRICAL	CHARACTE	RISTICS	
Туре	TSM-DA05	220	230	240
Max-Power	Pm(W)	220	230	240
Power Tolerance	(%)	±3	±3	±3
Max-Power Voltage	Vm(V)	29.8	30,0	30,6
Max-Power Current	lm(A)	7.39	7.66	7.84
Open-Circuit Voltage	Voc(V)	36.8	37.0	37.5
Short-Circuit Current	lsc(A)	8,00	8,18	8,38
Max-System Voltage	(VDC)		600	
Cell Efficiency	ηc (%)	15.5	16.2	16.9
Module Efficiency	ηm (%)	13.4	14.1	14.7
Number, type and arrangement of cells		60 pcs. N	Mono-Crystalline Silice	on (6x10)
Cell Size		6"	x 6" 156 mm x 156 r	nm
No. of Bypass Diodes	(pcs_)		3	
Max, Series Fuse	(A)		14	
Pm Temperature Coefficient	(%/℃)		- 0_45	
Isc Temperature Coefficient	(%/°C)		0.05	
Voc Temperature Coefficient	(%/°C)		- 0.35	
NOCT- Nominal Operating Cell Temperature	(°C)		47±2	

MECHANICAL CHARACTERISTICS

Cable Type, Diameter and Length	3.31 mm² (12AWG), UL Certified
Type of Connector	Тусо
Dimension A*B*C	1650*992*46 (mm) 64.96*39.05*1.81 (in.)
Weight	19.5 Kg 43 lb
No. of Draining Holes In Frame	8
Glass, Type and Thickness	High Transmission, Low Iron, Tempered Glass 3.2 mm 0.12" in.

PACKAGING CONFIGURATION

Packing Configuration	20 pcs./ box
Quantity/Pallet	1 box / pallet
Loading Capacity	520 pcs/40ft or 120 pcs/10ft

ABSOLUTE RATINGS

Dielectric Insulation Voltage	(VDC)	3000 max.
Operating Temperature	(°C)	-40~+85
Storage Temperature	(°C)	-40~+85

*STC Conditions(1000W/m²; 1.5 AM and 25°C Cell temperature)

APPENDIX F: RETSCREEN RESULTS

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atituda Vinit angilude T levalion f. levalion f. levalion f. levalion f. ocoling design temperature of f. cooling design temperature of f. cooling design temperature f. cooling design temperature of f. cooling design temperature f. cooling design temperat	Climate data location F 37.5 -77.3 164 19.4 92.1 34.5 Air temperature °F 35.8 38.7 47.8 57.4 65.8 77.2 75.7 60.3 58.1 49.5 40.5 58.1 75.7 7	Relative humidity % 6773 164 164 8 679% 656% 60.7% 60.7% 60.7% 74.8% 77.2% 76.0% 77.3% 60.7% 60.7% 60.7% 60.7% 60.7% 60.7% 77.2% 76.0% 60.1% 60.1% 76.0% 77.0% 76.0% 70.0%	Daily solar radiation - horizontal Whim?id 2.26 3.03 4.11 5.17 5.81 6.25 5.98 5.44 4.52 5.98 5.44 4.52 3.52 2.49 2.01	Atmoopheric procoure kPa 1013 1012 101.1 101.0 101.0 101.0 101.1 101.1 101.1 101.1 101.1 101.1 101.1 101.3 101.3 101.3 101.4 101.4 101.4 101.4 101.4 10.5 10.5 10.5 10.5 10.5 10.5 10.5 10.5	Wind speed mph 8.1 9.2 9.0 8.1 7.4 6.7 6.5 6.5 6.5 7.6 7.6 7.6 7.8	Earth temporature %F 35.5 48.6 57.9 78.9 70.7 70.2 59.1 48.7 38.4 38.4 38.4 38.4	Heating degree days *F d 837 721 513 211 0 0 0 0 0 0 0 195 448 753 0 0 0 0 0 0 0 0 0 0 0 0 0	Cooling degree dayo %F.d 0 0 221 491 713 843 798 578 251 0 0 0 0 0
unit N ongitude T isvation ft	Climate data location P 37.5 77.7 164 19.4 92.1 34.5 Air temperature °F 35.8 36.7 47.8 57.4 65.8 77.2 75.7 60.3 58.1 49.5 57.5	Relative humidity 36 67.0% 65.6% 67.0% 65.6% 62.0% 60.7% 60.7% 60.0% 77.2% 76.0% 77.2% 76.0% 73.7% 63.1% 63.0% 70.0%	Delly solar radiation - horizontal kWh/m³/d 2.26 3.03 4.11 5.17 5.81 6.25 5.98 6.44 4.52 5.98 6.44 4.52 2.49 2.01 4.22	Atmospheric processed kPa 1013 1012 101.1 101.0 101.0 101.0 101.0 101.1 101.0 101.1 101.3 101.3 101.3 101.4 101.4 101.2	Wind speed mph 8.1 9.2 9.0 8.1 7.4 6.7 6.5 6.9 7.6 7.6 7.7 7.7 32.8	Earth temporature °F 35.1 38.8 46.6 57.9 67.9 70.7 70.2 59.1 48.7 38.4 57.9 0.0	Heating degree days *F.d 887 721 513 211 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Cooling degree dayo *F.d 0 0 221 491 /13 843 708 578 578 578 251 0 0 0 3,895
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posed case power system						
Technology		Photovoltaic				
	_					
Analysis type	• •	Method 1 Method 2				
Resource assessment						
Solar tracking mode		Fixed				
Slope	•	90.0				
Azimuth		52.0				
	Show data					
		Daily solar radiation -	Daily solar	Electricity export	Electricity	
	Month	horizontal	radiation - tilted	rate	exported to grid	
		kWh/m³/d	kWh/m²/d	\$/MWh	MWh	
	Eebouary	2.26	2.48	81.0	5.582	
	March	4 11	3.06	81.0	6.806	
	Apri	5.17	3.15	81.0	6,710	
	May	5.81	3.18	81.0	0.858	
	June	6.25	3.20	81.0	6.687	
	July	5.98	3.16	81.0	6.750	
	August	5.44	3.23	81.0	6.861	
	October	4.52	3.10	81.0	6.3/9	
	November	2.49	2.60	81.0	5.496	
	December	2.01	2.34	81.0	5.218	
	Annual	4.22	2.94	81.00	76.634	
Annual solar radiation - horizontal	MWh/m²	1.54				
Annual solar radiation tilted	MWh/m ²	1.07				
Photovoltaic						
Туре		mono-Si				
Power capacity Manufacturer	RVV	82.00 Tripa Salar				See product data
Manufacturer		TSM.D405		1 unit(s)		
Efficiency	%	14.7%		1 · Grin(4)		
Nominal operating cel temperature	°C	45		۴F	113.0	
Temperature coefficient	%/°C	0.40%				
Solar collector area	m²	558		ft ^z	6,010	
Miscellaneous losses	%	5.0%				
inverter						
Efficiency	96	96.0%				
Capacity	kW	100.0				
Miscellaneolus losses	76	5.0%	I			
Summary	~	10.52				
Lapacity tactor		10.5%				
Electricity exported to grid	MWh	75.534				
				36Wb	0.081	

Sattinge						
Method 1	Notes/Ran	7 0				
Method 2	Second cu	nteuch Ac	Notes/Range		None	
Method 2	Cost alloca	ation	notesnange		None	
nitial costs (credits)	Unit	Quantity	Unit cost		Amount	Relative costs
Feasibility study						
Feasibility study	cost			\$		
Sub-total:				_ s		0.0%
Development				_		
Development	cost	1	\$ 228,000	\$	228,000	
Sub-total:				\$	228,000	27.7%
Engineering				-		
Engineering	cost	1	\$ 20,000	5	20,000	
Sub-lotal:				\$	20,000	2.4%
Power system						
Photovoltaic	kW	82.08	\$ 7,000	n s	574,560	
Road construction	km			\$	-	
Transmission line	km			_ s		
Substation	project			ş	-	
Energy efficiency measures	project			s	-	
User-defined	cost			- 2	-	
Cuch totals				1º	574 560	CO CO/
Sub-total:				\$	574,560	63.5%
Spare pade	0.5			•		
Transportation	project			- *		
Training & commissioning	project p-d			š		
User-defined	cost			13		
Contingencies	26		\$ 622.560	5		
Interest during construction			\$ 822,560	ĴŚ		
Sub-total:		Enter number of r	nonths	Ś		0.0%
Total initial costs				\$	822.560	100.0%
Annual costs (credits)	Unit	Quantity	Unit cost		Amount	
08M						
Parts & labour	project			\$		
User-defined	cost			\$		
Contingencies	%		\$	· \$		
Sub-total:				\$		
	11-14	Maaa	11-14 a soft	_		
eriodic costs (credits)	Unit	Year	Unit cost		Amount	
Lines defined				_		
User-defined	cost			-2	•	
User-defined	cost			s		

20100	,,	. ,						
Emission Analysis								
Method 1								
Method 1								
"Method 2								
Internod 3								
e case electricity system (Base	line)							
			GHG emission					
			factor	T&D	GHG emission			
			(excl. T&D)	losses	factor	-		
ountry - region		Fuel type	tCO2/MWh	%	tCO2/MWh			
United States of America		All types	0.558		0.558			
Baseline changes during project	life							
case system GHG summary ()	Baseline)							
						Fuel	GHG emission	
Fuelture	Fuelmix					consumption	factor	GHG emission
Fuel type	%					MWN	tCO2/MWh	1002
Electricity	100.0%					76	0.558	42.1
i otai	100.0%					76	0.556	42.1
oosed case system GHG summ	ary (Power proje	ict)						
						Fuel	GHG emission	
	Fuel mix					consumption	factor	GHG emission
Fuel type	%					MWh	tCO2/MWh	tCO2
Solar	100.0%					76	0.000	0.0
Total	100.0%					76	0.000	0.0
				T&D losses				
Electricity exported to grid	MWh	76				0	0.558	0.0
							Total	0.0
emission reduction summary								
						Gross annual		Net annual
		Base case	Proposed case			GHG emission	GHG credits	GHG emission
		GHG emission	GHG emission			reduction	transaction fee	reduction
ower project		42.1	0.0			42.1	70	42.1
Net annual GHG emission reduc	tion	42.1	1CO2	is equivalent to	7.7	Cars & light trucks	not used	

RETScreen Financial Analysis - Power	r project									
Financial parameters			Project costs and savings/income	summary			Yearly c	ash flows		
General Fuel cost escalation rate	0.	2.04	Initial costs				Year	Pre-tax	After-tax	Cumulative
Inflation rate	96	3.0%	Development	27.7%	\$	228,000	0	-822,560	-822.560	-822.560
Discount rate	96		Engineering	2.4%	\$	20,000	1	6,424	6,424	-816,136
Project life	yr	50	Power system	69.9%	\$	574,560	2	6,745	6,745	-809,391
Finance							4	7,083	7,083	-802,308
Incentives and grants	\$						5	7,809	7,809	-787,063
Debt ratio	96			0.004			6	8,199	8,199	-778,864
			Balance of system & misc.	100.0%	5	822 560	8	9,609	8,609	-770,255
							9	9,491	9,491	-751,724
							10	9,966	9,966	-741,758
			Appual costs and debt payments				11	10,464	10,464	-731,294
			O&M		\$	0	13	11,537	11,537	-708,769
Income tax analysis		Г	Fuel cost - proposed case		\$	0	14	12,114	12,114	-696,656
			Total annual costs		\$	0	15	12,719	12,719	-683,936
			i otar annuar costs		•	Ĩ	17	14,023	14,023	-656,558
			Periodic costs (credits)				18	14,724	14,724	-641,833
							19	15,460	15,460	-626,373
							20	17.045	17.045	-593.094
			A second second				22	17,897	17,897	-575,197
L			Annual savings and income				23	18,792	18,792	-556,405
Annual income			Electricity export income		5	6,118	25	19,732 20,719	19,732 20,719	-536,673
Electricity export income			Elocation, onport moorino			0,110	26	21,754	21,754	-494,200
Electricity exported to grid	MWh	76					27	22,842	22,842	-471,358
Electricity export rate Electricity export income	\$/MWh	81.00					28	23,984	23,984	-447,373
Electricity export escalation rate	96	5.0%	Total annual savings and incom	e	\$	6,118	30	26,443	26,443	-395,747
254 12						25	31	27,765	27,765	-367,982
GHG reduction income		Г					32	29,153	29,153	-338,829
Net GHG reduction	tCO2/yr	42	Financial viability				34	32,141	32,141	-276,078
Net GHG reduction - 50 yrs	ICO2	2,106	Pre-tax IRR - equity		96	1.5%	35	33,748	33,748	-242,329
			Pre-tax IRR - assets		96	1.5%	36	35,436	35,436	-206,894
			After-tax IRR - equity		96	1.5%	38	39,068	39,068	-130,618
			After-tax IRR - assets		96	1.5%	39	41,021	41,021	-89,597
			Simple cautack		115	124.4	10	43,072	43,072	-46,525
Customer premium income (rebate)		Г	Equity payback		vr	> project	42	47,487	47,487	46,188
16 16 19			and the second second		5.0		43	49,862	49,862	96,050
			Net Present Value (NPV)		\$	522,322	44	52,355	52,355	148,405
			Annual life cycle savings		Styl	10,440	45	57,721	57,721	261.098
			Benefit-Cost (B-C) ratio			1.63	47	60,607	60,607	321,705
			Encourse duction and		C.A.R.A.L.	10.54	48	63,637	63,637	385,342
			Energy production cost GHG reduction cost		\$/MVVD \$//CO2	(248)	49	70 160	70 160	452,162
Other income (cost)		Г				(# 10)		1,01140	10,100	
			Cumulative cash flows graph							
			600,000							
Clean Energy (CE) production income		-	400,000							
			200.000							
			200,000							
			90 O							
			01234567	8 9 1011121	3141516171	81920212223242	52627282	293031323334353	3637383910414243	44454647484950
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