2010

CONSTRUCTION MANAGEMENT TECH I

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1855

EXECUTIVE SUMMARY

Technical Assignment One is intended to present the exiting conditions and parameters that influenced the design and construction of the Millennium Science Complex. This project is around 275,000 SF with 40,000 SF of quiet labs, and 9,500 SF of nano-clean room lab space. The largest challenge with this project is the erection and detailing of the structural steel in the 150-foot cantilevered section of the building. The erection and sequencing of the steel and precast panels in this section were very carefully laid out to ensure that the façade and structure ended in the correct place after the cantilever was loaded.

Information regarding the sequencing of this task, and other key features such as, a Project Summary Schedule, a Project Cost Evaluation, a Site Logistics Study, a Constructability Study, and a Project Delivery System are included in the technical report.

The project is depicted in a summary schedule to be completed by July 7, 2010. Project cost is evaluated using online estimating software that will provide insight as to where this building is situated relative to industry standards. Due to the complexity of this building, however it was difficult to find a match to the type of building that Millennium Science Complex will be. A site logistics study was completed to assess the complexity of underground work that would have to be completed for the utilities, and the issues that would have to be dealt with, in order to uphold pedestrian and vehicular safety. Finally, a thorough analysis of the clients' intentions and visions for Millennium Science Complex are summarized and the methods of how Whiting-Turner will deliver to these expectations are explained in the project delivery and staffing plan portions of this technical report.

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SCHEDULE NARRATIVE

The Millennium Science Complex project summary schedule encompasses a selection of key activities, starting with the design, bidding and awarding of the project through building turnover to The Pennsylvania State University. The full summary schedule can be found in Appendix A. Below is a short summary made of several key construction activities and their durations and the corresponding dates.

Construction Phase	Duration (Days)	Start	Finish
Foundation/Substructure	270	2-16-09	2-26-10
Superstructure	274	7-7-09	7-23-10
Enclosure	303	11-9-09	1-5-11
Building Systems/Finishes	345	12-14-09	4-8-11
Construction Duration	758	8-12-08	7-7-11

Figure 2: Existing Site Utilities Plan

Preconstruction for this project began in March 2008 and included the design, bidding and awarding of the different project components and packages. Department General Services (DGS) project packages were decided, which are the publicly funded portions of the project. These packages consisted of primarily upfront construction activities (information on this can be found later in the report.) In addition, the qualification and evaluation of designers and contractors for the clean rooms was also decided during this time.

Primary coordination meetings and reviews began in May 2009. Per the contract, all main building system trades, such as structural steel, mechanical, electrical and plumbing, were required to model their systems using programs compatible with a 3D DWG file format. Because of the complexity of this project, the use of building information modeling and the coordination that comes from this was of the utmost importance.

The structural steel erection began in July 2009, lasting just under seven months, and was done in gradual stages. Erection began at the ends of the Material and Life Sciences wings, and progressed towards the perpendicular interception of the two wings. All levels of the structural steel for each wing were complete before the erection of the cantilever began.

Commissioning will begin in November 2010, and lasts until building turnover to The Pennsylvania State University in July 2011. Initial inspections are done after all major systems are completed, and final inspections, completion of the punchlist and closeout are set to take place starting in January 2011.

BUILDING & CONSTRUCTION SYSTEMS SUMMARY

Work Scope	Implemented System	Comments
Demolition of Existing Structures	Minor removal and demolition of existing recreational facilities	Removal of water fountains and fencing. Asphalt utilized by Whiting-Turner
Excavation Support	Multiple methods of support including shotcrete, trench boxes, and H - piles with lagging.	Piles reaching bedrock at depth of up to 20', trench boxes used at short depths and small areas.
Foundation	Mini-pile foundation	785 piles used in tension and compression.
Enclosure	334 precast panels with brick veneer, curtain wall system	Cast at High Concrete Plant in Lancaster Country, PA
Sustainability Strategy	Green roof systems	5 green roofs on 1st, 2nd, and 3rd floors

Figure 2: Existing Site Utilities Plan

Demolition of Existing Structures

Prior to construction, the Millennium Science Complex site contained two roller hockey rinks, two tennis courts, and a parking lot along the Bigler Rd. perimeter which accounted for approximately 45,000 SF of asphalt all of which was surrounded by chain link fencing. The site also contained three wooden sheds, a ticket booth, and multiple water fountains. A pedestrian sidewalk ran along the perimeter of the site as well. The remaining site of the Millennium Science Complex was an uninhabited field mostly used for recreational activities for students. As construction began, fencing and existing sheds and booths were demolished. Contractors utilized existing asphalt surfaces for employee parking while unused asphalt areas were buried under excavated soil.

Excavation Support

The Millennium Science Complex utilized multiple methods of shoring support throughout the site including: H - piles and lagging, shotcrete, and trench boxes. The use of each method depended on the scope of work at the location as well as site and soil characteristics.

H - Piles with Lagging

- H - piles and mini piles with lagging were used throughout the northern and western outer perimeter of the excavation and reached a retained height of 19'. Three sizes of steel members were used, HP 12x74, HP 14x89, and HP 14x117, spaced 8' center-to-center, and reached depths varying from 6' to 8'. H-Piles allowed for easy and efficient support around corners while allowing large retained heights. The depths of the piles were measured carefully as fractured rock was present at various elevations. Vibration during installation was monitored to reduce effects on nearby Life Science 1 labs.

Shotcrete

- Shotcrete was installed onto the mesh covered soil at 5' lifts with soil nails installed into the slope. Shotcrete allowed for quick installation while installing at 5' lifts demanded an increased amount of coordination. Shotcrete was used on the interior corner perimeter of the site where engineers deemed h-piles and lagging unnecessary.

Trench Boxes

- Trench boxes were used during early and shallow excavation throughout the site. This economical means of support allow for quick and simple installation. Trench boxes were utilized predominantly during construction of the Life Sciences tunnel where H – piles were unnecessary.

Foundation

The Millennium Science Complex requires a unique foundation system to manage the loads created by the immense cantilever. The cantilever of the Millennium Science Complex causes a rotational force on the facility demanding a foundation that can account for these upwards forces. Considering these rotational loads, a mini-pile foundation was deemed the best application as it can be applied in tension as well as compression. A total of 785 piles were used amounting in 51,213 linear feet of piles. Piles in compression reached bedrock depths of approximately 60' on average with some piles reaching 145'. The 48 piles in tension require deeper depths to resist the forces of tension. On average piles in tension reach depths of 90' with most of the piles at 100'. To accommodate the lateral loads of rotation, 157 battered piles were implemented throughout the site as well.

Enclosure

The facility is enclosed by roughly 334 6" precast panels with 2" of brick veneer on the exterior. Panels reach sizes up to 22' in length and 12' in height and are installed via crawler crane. Each panel is supported against vertical loads by a bearing connection and lateral loads by a lateral connection. The bearing connection of each panel consists of a steel plate cast in the interior face of the precast panel resting on a steel gusset plate bolted to a steel column. The lateral connection consists of a threaded rod cast in the lower horizontal lip of each precast panel and then bolted to a steel member. The Millennium Science Complex also implements a ¼" curtain wall glazing system with energy saving glazing throughout the facility's exterior.

Sustainability

The Millennium Science Complex is planning on achieving LEED Gold status upon completion. Whiting-Turner has applied many energy reducing construction methods including reducing water usage by 20%, diverting 75% of waste from landfills, and purchasing 20% of their materials from regional suppliers among other energy saving methods. Major sustainability applications in the Millennium Science Complex include 5 green roofs, which encompass the 1st, 2nd and 3rd floor roofs on each of the wings, and energy saving glazing on the curtain wall.

CONSTRUCTABILITY CONCERNS

Logistics

- Existing utilities located on Drawing C 1.3
- Poor weather conditions to be encountered during Winter months
- 20% of materials local, cutting lead time
- Mock-up and Laydown areas provided on-site
- Existing asphalt salvaged for employee parking area
- Pre-cast panels cast in Lancaster County, Pennsylvania reducing transportation time and cost
- Publicly funded work to be completed prior to privately funded work.
- Temporary pedestrian walkways provided during tunnel construction
- Delivery of steel members via Hasting Rd. to Bigler Rd. to avoid campus congestion

Construction

- Concrete required to be poured during inclement weather shall be shielded from the elements
- Standardization of steel members where applicable
- Mini-pile foundation support rotational forces and vertical forces
- Designed standardized pile cap system
- Deflections monitored at column lines on 5-10 day intervals
- Cantilever welds require three 8-hour shifts for 24 hour welding during Winter months
- Construction vibration monitored to avoid disturbances in Life Science 1 laboratories
- Loading of cantilever synchronized between Life Science and Material Science wings to assure identical deflections

PROJECT COST EVALUATION

Actual Cost Summary

Considering the sheer magnitude of this project, in combination with the complexities contained within the building systems and finishes, it was assumed early on that the cost of this project would ultimately be high. While the exact total cost of the project is not known, an approximate total cost of $215 million has been obtain, and will be assumed as the total cost of the project. In addition, all construction and systems costs were obtained based on budgets provided by Whiting-Turner (dated July 3, 2008), and may not be up-to-date.

Total Cost	Total Cost Per Square Foot
$215,000,000	$788/SF

Construction Cost*	Construction Cost Per Square Foot
$139,176,843	$510/SF

***Construction Cost does not include contingency, general conditions, insurance and fees.**

Building System	Percentage of Project Cost	Cost	Cost Per Square Foot
Structure	17.6%	$24,559,974	$90.06/SF
Plumbing	4.8%	$6,731,107	$24.68/SF
Fire Protection	1.0%	$1,362,000	$4.99/SF
HVAC	18.1%	$25,159,105	$92.26/SF
Electrical	8.9%	$12,313,658	$45.15/SF

Figure 2: Existing Site Utilities Plan

Because of the limitations of RS Means, combined with the complexity of the project, it was not practical to price the Millennium Science Complex directly via a square foot method. However, evaluations were still made for other basic building types with some relevance to the building type of Millennium Science Complex. The three basic building types chosen for square foot estimates were an office building, a hospital and a college laboratory. These were chosen based upon the fact that these buildings share components with what is contained within the Millennium Science Complex building. Select recently constructed buildings from The Pennsylvania State University campus were included to provide a relative scale versus other high profile buildings on the campus. Finally, The New York Times Building was included because its relative scale and complexity is comparable to that of the Millennium Science Complex. Their costs can be seen below, with cost breakdowns and sources available in Appendix B.

Building Type	Cost	Cost Per Square Foot
Office Building	$47,772,500	$183.74/SF
Hospital	$77,436,500	$224.46/SF
College Laboratory	$15,325,000	$144.85/SF
The New York Times Building*	$1 billion	$667.00/SF
The New Dickinson School of Law – Katz Building*	$60,000,000	$530.97/SF
Life Sciences Building*	$37,790,085	$245.39/SF
Student Health Center*	$26,000,000	$406.25/SF

Figure 2: Existing Site Utilities Plan

**Table.* *These costs are based on student work and evaluations. References can be found in Appendix B.*

As can be clearly seen, the Millennium Science Complex does not compare at all with any of the three basic building type square foot costs. With a total cost per square foot at $788/SF, it is upwards of four times the magnitude of any of the three basic building types. This is due to the detail and complexities evident in the construction of the building. The building systems are far more unique and advanced compared to those assumed by RS Means, and the building includes many high complexity laboratories and clean rooms. With this in mind, it is clear why these examples pale in comparison to the Millennium Science Complex.

When compared to the assumed square foot cost of The New York Times Building, the Millennium Science Complex still outweighs the cost by over $100/SF. While The New York Times Building may be an extremely large building, its square foot cost is lower because it does not include the advanced building systems required of the Millennium Science Complex.

In comparison with these other recently constructed buildings on The Pennsylvania State University campus, the Millennium Science Complex outweighs them all by a great amount. This project will be the most expensive project per square foot on campus in recent years, and is a testament to the extreme detail and requirements placed on this state-of-the-art research and laboratory building.

While these examples do not provide an excellent comparison, it does give a rough idea of where the cost of the Millennium Science Complex falls. And, in comparison to these selected buildings, it's easy to see that the magnitude of the cost of the Millennium Science Complex is on the high end of this scale.

PROJECT SITE LOGISTICS

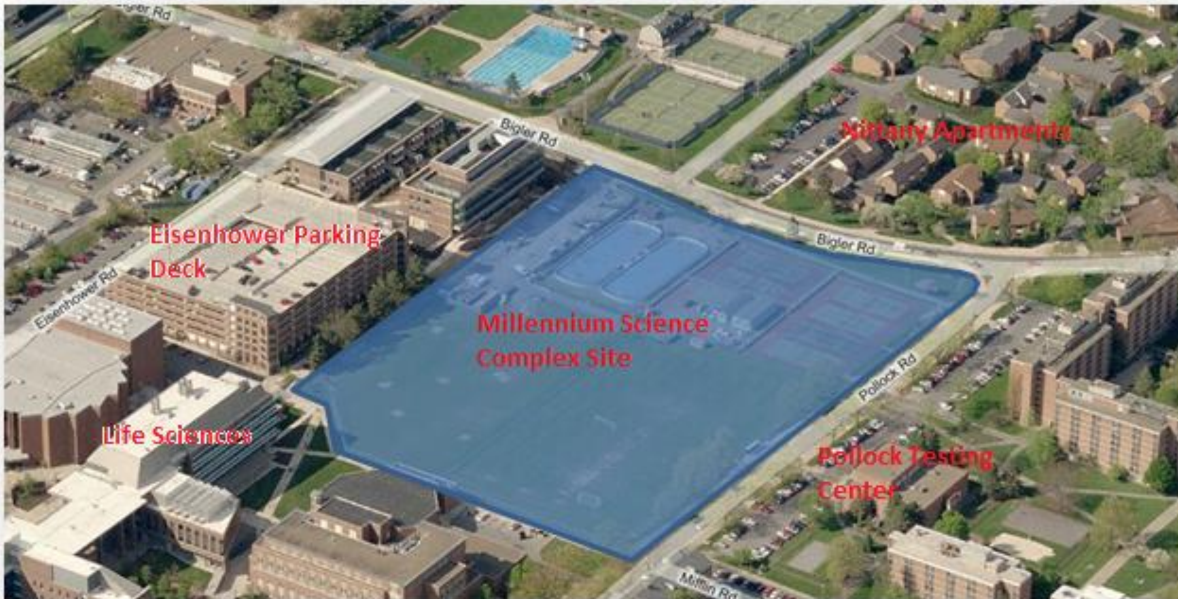

Figure 1: Bing Map of Millennium Science Complex Site

The project site is located on The Pennsylvania State University campus at the corner of Bigler Rd and Pollock Rd, directly across from the Pollock Testing Center. Figure 1 above shows the site for Millennium Science Complex and some of the surrounding buildings. To the North of the project site is the Eisenhower Parking Deck, to the East is Nittany Apartments, to the South is the Pollock Testing Center, and to the West is the existing Life Sciences building.

The site was originally occupied by two roller hockey rinks, tennis courts, and intramural sports fields. The site for Millennium Science Complex is also surrounded by a variety of different building types, and vast amounts of student and vehicular traffic. To the East, across Bigler Rd, is Nittany Apartments, where students must be easily able to arrive from and depart for class safely. To the North of the site, along Eisenhower Parking Deck, is a main artery of student travel in which safety is a main concern. On the South edge of the Life Sciences Wing, the building cantilevers over the pedestrian walkway, in which case a temporary structure has to be built in order to protect pedestrian safety.

Another main concern during the construction of Millennium Science Complex is the amount of vehicle traffic that is on Bigler Rd and Pollock Rd. CATABUS Community Service Lines use both Bigler Rd and Pollock Rd as part of their routes, and the Blue Loop also comes up Bigler Rd and turns onto Pollock Rd to continue its campus loop. Vehicle and pedestrian traffic are a main consideration in the Site Logistics planning for the Millennium Science Complex.

Aside from the complexities that Whiting-Turner had to deal with outside of the site, creating a site logistics plan for the building has also proved to be cumbersome. Whiting-Turner first began with a two phase site logistics plan. The first plan would cover from site preparation through the foundation being complete. The second phase site logistics plan would cover from steel erection to interior finishes. Both Site Logistics plans are shown below.

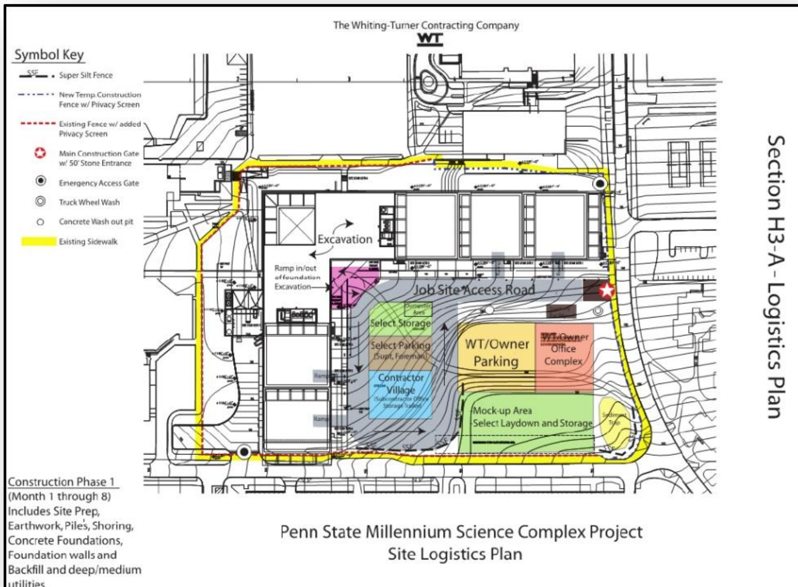

Figure 2: Existing Site Utilities Plan

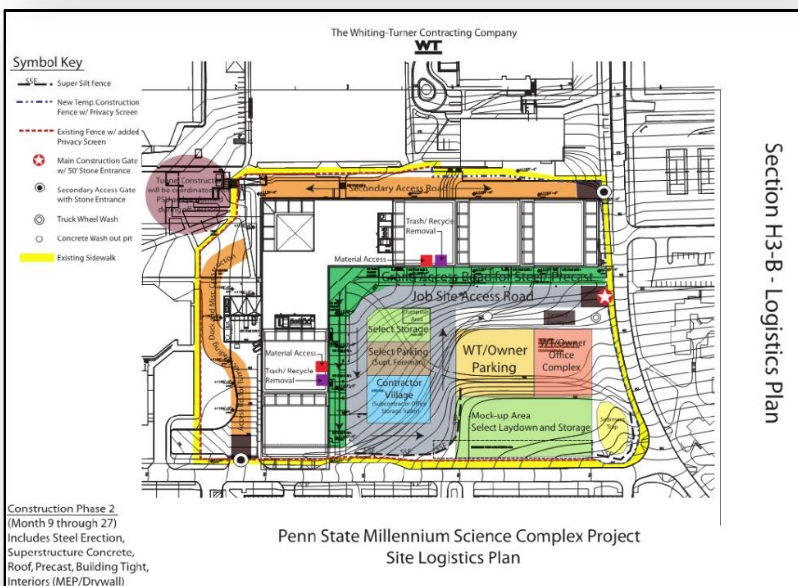

Figure 2: Existing Site Utilities Plan

The location of utilities is one of the main issues a construction team faces when building a new project. In Figure 2 above, the location of some of the utilities is identified. To the North, along Eisenhower Parking Deck is an underground Sanitary Sewer Return line, an underground Compressed Air line, an underground Steam line, and an underground Electrical line. The Sanitary Sewer line also runs along the West side of the site. The precise location of these utilities is vital to the excavation for the foundation of the building, and the excavation of the chemical tunnel between the Life Sciences Building and the Life Sciences Wing of Millennium Science Complex.

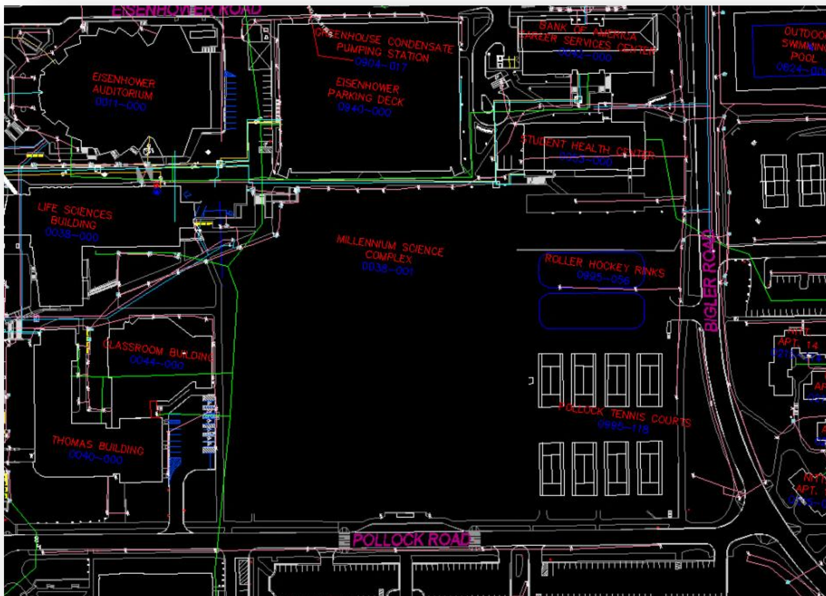

Figure 2: Existing Site Utilities Plan

The Millennium Science Complex contains a tunnel for transporting chemicals and materials between the Life Sciences Building and the Life Sciences wing of the Millennium Science Complex. The phasing of this tunnel was extremely important because the pedestrian paths in this area are a main source of travel for students, and the location of the utilities were unknown, so excavation was closely monitored. The construction of this tunnel consisted of three phases as seen in the images below.

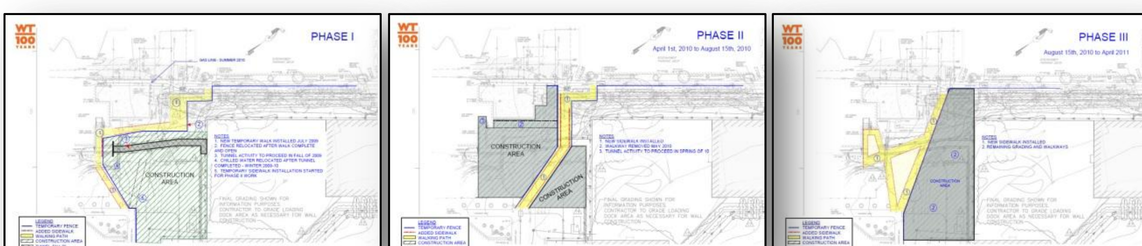

Figure 2: Existing Site Utilities Plan

The final location of the utilities provided to Millennium Science Complex is shown below.

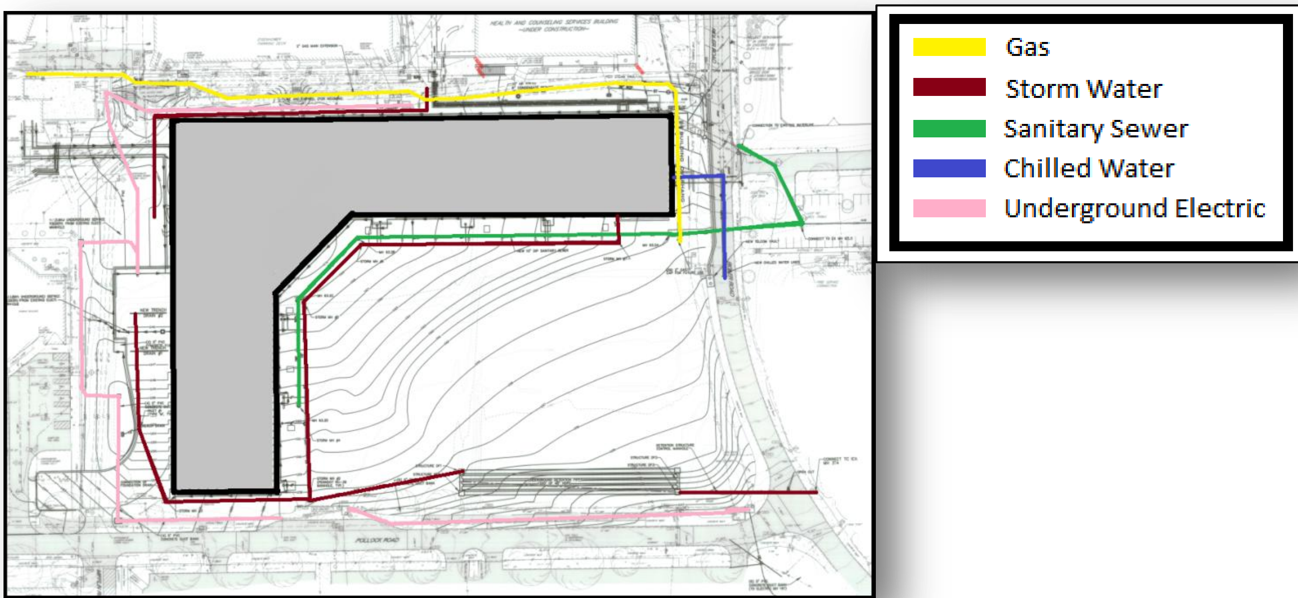

Figure 2: Existing Site Utilities Plan

PROJECT STAFFING & BIM DELIVERY

Whiting-Turner is staffing the project based on the project size and complexity. A simplified staffing plan is shown below, and a full staffing plan is attached in Appendix D. This particular project has two Sr. Project Managers, four Project Managers, a Sr. Superintendent, two Superintendents, and five Project Engineers.

The project is overseen by Dick Tennant, an owner's representative Construction Manager. Both the project management and field supervision staff are placed on site in the trailer complex. Typically the management staff holds weekly subcontractor coordination meetings.

The project management staff will handle all project submittals, most of the RFI's, and review the payment requisitions from the subcontractors. As for the Superintendents and their assistant, they handle all field installations using approved submittal and shop drawings. Superintendents also supervise the subcontractor's daily activities. Whiting-Turner's Safety efforts are in the mind of everyone on the staff; however Cesar Sastoque, a Safety Specialist Superintendent, is responsible to help create a safe environment by preventing dangerous practices on site. He is accountable for being aware of proper procedures and safe construction methods during the hours of construction.

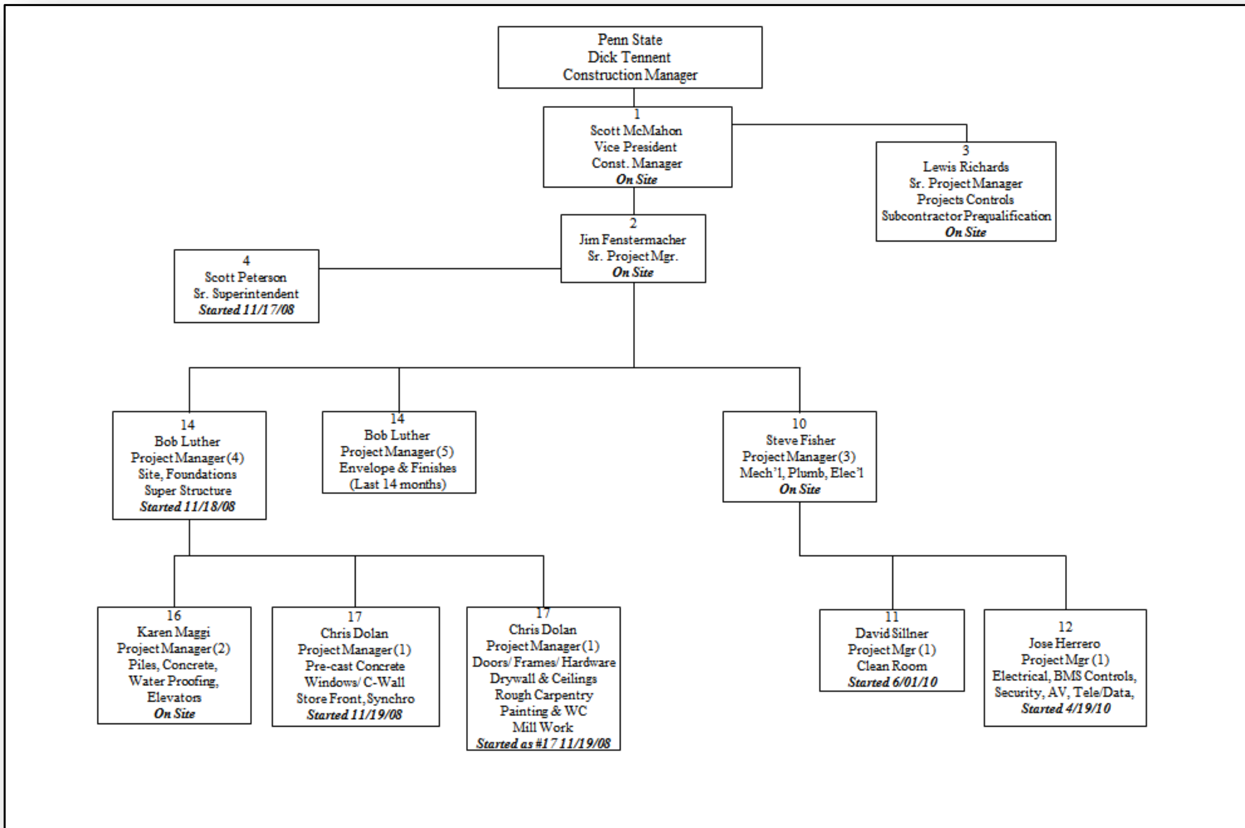

Figure 2: Existing Site Utilities Plan

The Building Information Modeling (BIM) effort by Whiting-Turner was primarily focused on the coordination of the trades. The use of BIM on Millennium Science Complex enabled Whiting-Turner to facilitate a smooth and efficient execution of the project and also provide a close to "as-built" set of 3D design documents.

Whiting-Turner is responsible for collecting and combining the 3D models from the subcontractors to create the single consolidated master model. All of the subcontractors are responsible for generating a 3D model that will be used for coordination, that is operational in both Autodesk Revit based programs, and Autodesk Navisworks. Whiting-Turner requires that all files are to be exported as a 3D DWG format, and will not be drawn as wire frames. Each subcontractor is also assigned a color for their model to use within the Navisworks file.

The entire BIM Process Coordination Guidelines that were used on Millennium Science Complex are laid out in Appendix E.

PROJECT DELIVERY METHOD

The Millennium Science Complex is primarily a Design-Bid-Build delivery system, with a form of Construction Management Agency and Fee in place with Whiting-Turner Contracting. Because this project does have Department General Services (DGS) funding, Penn State University is required to hold the contracts which are publicly funded directly. These contracts and packages, which primarily consist of activities which are upfront in the construction of the building, can be seen in Appendix F. This project encompasses an interesting set up in that the owner, Penn State University, holds contracts with both a construction manager, as well as subcontractors. Whiting-Turner, in effect, acts as a construction management agent to Penn State University, and is held responsible for overseeing, managing and coordinating the trades with which Penn State University holds contracts directly. At the same time, Whiting-Turning maintains contracts will all other subcontractors on site, and must maintain their responsibilities to manage their own subcontractors. Through their contract with Penn State University, Whiting-Turner performs their work for a fee, and because they are not self-performing any work, they are not at risk with Penn State University for the work performed by their subcontractors.

One unique aspect of this project was in the bid and award process used for the clean rooms within the basement of the building. Because of their complexity and importance to the facility, these were not bid out as the rest of the building was done. Instead, these rooms were done with a Design-Build method, selecting contractors and designers who would be given permission to submit proposals for the design and construction of these laboratories. This process was much more tedious than the selection of the remaining bids for the building in that each proposal was scored and ranked based on specific technical and design criteria before the cost of the proposal was made public and evaluated. For this evaluation process, the scientists who would be using these spaces were brought in to place opinions and input on the proposals based on their wants and needs, which would ultimately result in laboratory space customized to what was required by them. This ensured initial rankings based on quality rather than cost. However, it was not confirmed whether Penn State University ultimately chose the designer and contractor based on the input of the scientists or the lowest cost.

CLIENT INFORMATION

The owner of this project is The Pennsylvania State University, however the Office of the Physical Plant (OPP) manages facility construction and maintenance on the University Park campus. For Millennium Science Complex, they are overseeing the construction of the new Life Sciences and Material Sciences building.

Recently, The Pennsylvania State University has deep interest in generating a building that will bring together faculty and students from Chemistry, Engineering, Biology, Physics, and Medicine. That building will be a state of the art research facility, which will become a gateway for interdisciplinary research of Life Sciences and Material Sciences.

Penn State has relatively high expectations for this project, especially for the benefits to education that this building will be able to provide. In any situation there are three expectations that an owner can have for a project; cost, quality, and time. Typically an owner can set priorities on two of these expectations, but the third will be sacrificed to an extent. For this project, the owner clearly has a priority on quality, with time as a secondary priority, and cost as a third priority. Based on the design of this project, construction quality has to be of the highest priority. The details in the vibration sensitive lab facilities are very complex and need to be constructed at the highest quality to ensure that the building will be able to produce quality research. Major coordination efforts are necessary to incorporate a complex collection of overhead systems. This project requires skilled contractors to perform quality work. To ensure a high-quality finished project, Penn State requires all contractors interested in bidding on the project to be pre-qualified, and for coordination efforts, Whiting-Turner requires that all subcontractors generate a 3D model to be used for coordination.

The fourth expectation that an owner can have (that should always be a top priority) is safety for workers and occupants after project completion. Whiting-Turner attempts to ensure project safety during construction by requiring workers to wear hard hats and safety glasses as well as providing other incentives for job wide safety.

APPENDIX A – Project Summary Schedule

APPENDIX B – RS Means Costworks Reports

Square Foot Cost Estimate Report

Estimate Name: Untitled

Building Type:	Office, 2-4 Story with Face Brick with Concrete Block Back-up / Steel Joists
Location:	STATE COLLEGE, PA
Stories Count (L.F.):	4.00
Stories Height	18.00
Floor Area (S.F.):	92,000.00
LaborType	Union
Basement Included:	Yes
Data Release:	Year 2008
Cost Per Square Foot	$158.48
Total Building Cost	$14,580,500

Costs are derived from a building model with basic components. Scope differences and market conditions can cause costs to vary significantly.

		% of Total	Cost Per SF	Cost
A Substructure		8.7%	13.15	$1,209,500
A1010	Standard Foundations		7.62	$701,500
	Strip footing, concrete, reinforced, load 11.1 KLF, soil bearing capacity 6 KSF, 12" deep x 24" wide			
	Spread footings, 3000 PSI concrete, load 200K, soil bearing capacity 6 KSF, 6' - 0" square x 20" deep			
A1030	Slab on Grade		1.01	$92,500
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	Basement Excavation		0.64	$59,000
	Excavate and fill, 10,000 SF, 8' deep, sand, gravel, or common earth, on site storage			
A2020	Basement Walls		3.88	$356,500
	Foundation wall, CIP, 12' wall height, pumped, .444 CY/LF, 21.59 PLF, 12" thick			
B Shell		44.1%	66.88	$6,152,500
B1010	Floor Construction		22.15	$2,038,000
	Cast-in-place concrete column, 12" square, tied, 200K load, 12' story height, 142 lbs/LF, 4000PSI			
	Flat slab, concrete, with drop panels, 6" slab/2.5" panel, 12" column, 15'x15' bay, 75 PSF superimposed load, 153 P			
	Floor, concrete, slab form, open web bar joist @ 2' OC, on W beam and wall, 25'x25' bay, 26" deep, 75 PSF superim			
	Floor, concrete, slab form, open web bar joist @ 2' OC, on W beam and wall, 25'x25' bay, 26" deep, 75 PSF superim			
	Fireproofing, gypsum board, fire rated, 2 layer, 1" thick, 14" steel column, 3 hour rating, 22 PLF			
B1020	Roof Construction		1.48	$136,000
	Floor, steel joists, beams, 1.5" 22 ga metal deck, on columns and bearing wall, 25'x25' bay, 20" deep, 40 PSF superi			
	Floor, steel joists, beams, 1.5" 22 ga metal deck, on columns and bearing wall, 25'x25' bay, 20" deep, 40 PSF superi			
B2010	Exterior Walls		32.28	$2,970,000
	Brick wall, composite double wythe, standard face/CMU back-up, 8" thick, perlite core fill			
B2020	Exterior Windows		8.49	$781,000
	Windows, aluminum, awning, insulated glass, 4'-5" x 5'-3"			
B2030	Exterior Doors		0.82	$75,000
	Door, aluminum & glass, with transom, narrow stile, double door, hardware, 6'-0" x 10'-0" opening			
	Door, aluminum & glass, with transom, bronze finish, hardware, 3'-0" x 10'-0" opening			
	Door, steel 18 gauge, hollow metal, 1 door with frame, no label, 3'-0" x 7'-0" opening			

		% of Total	Cost Per SF	Cost
B3010	Roof Coverings		1.66	$152,500
	Roofing, asphalt flood coat, gravel, base sheet, 3 plies 15# asphalt felt, mopped			
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Roof edges, aluminum, duranodic, .050" thick, 6" face			
	Flashing, aluminum, no backing sides, .019"			
	Gravel stop, aluminum, extruded, 4", duranodic, .050" thick			
C Interiors		16.9%	25.65	$2,359,500
C1010	Partitions		5.01	$460,500
	Metal partition, 5/8" water resistant gypsum board face, no base layer, 3-5/8" @ 24" OC framing ,same opposite face			
	1/2" fire ratedgypsum board, taped & finished, painted on metal furring			
C1020	Interior Doors		3.75	$345,000
	Door, single leaf, kd steel frame, hollow metal, commercial quality, flush, 3'-0" x 7'-0" x 1-3/8"			
C1030	Fittings		0.93	$86,000
	Toilet partitions, cubicles, ceiling hung, plastic laminate			
C2010	Stair Construction		3.82	$351,000
	Stairs, steel, cement filled metal pan & picket rail, 16 risers, with landing			
C3010	Wall Finishes		0.88	$80,500
	Painting, interior on plaster and drywall, walls & ceilings, roller work, primer & 2 coats			
	Vinyl wall covering, fabric back, medium weight			
C3020	Floor Finishes		6.30	$579,500
	Carpet, tufted, nylon, roll goods, 12' wide, 36 oz			
	Carpet, padding, add to above, minimum			
	Vinyl, composition tile, maximum			
	Tile, ceramic natural clay			
C3030	Ceiling Finishes		4.97	$457,000
	Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support			
D Services		30.2%	45.74	$4,208,000
D1010	Elevators and Lifts		13.13	$1,208,000
	6 - Hydraulic, passenger elevator, 3500 lb, 2 floors, 100 FPM			
	Hydraulic passenger elevator, 3000 lb, 3 floors,12' story height, 2 car group,125 FPM			
D2010	Plumbing Fixtures		1.66	$153,000
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, vanity top, PE on CI, 20" x 18"			
	Service sink w/trim, PE on CI, corner floor, wall hung w/rim guard, 24" x 20"			
	Water cooler, electric, wall hung, 8.2 GPH			
	Water cooler, electric, wall hung, wheelchair type, 7.5 GPH			
D2020	Domestic Water Distribution		0.06	$5,500
	Gas fired water heater, commercial, 100< F rise, 240 MBH input, 230 GPH			
D2040	Rain Water Drainage		0.07	$6,000
	Roof drain, CI, soil,single hub, 4" diam, 10' high			
	Roof drain, CI, soil,single hub, 4" diam, for each additional foot add			
D3050	Terminal & Package Units		14.77	$1,359,000
	Rooftop, multizone, air conditioner, offices, 25,000 SF, 79.16 ton			
D4020	Standpipes		0.18	$16,500
	Wet standpipe risers, class I, steel, black, sch 40, 4" diam pipe, 1 floor			
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, additional floors			
D5010	Electrical Service/Distribution		0.89	$81,500
	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 1000 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 1000 A			

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		% of Total	Cost Per SF	Cost
	Switchgear installation, incl switchboard, panels & circuit breaker, 1200 A			
D5020	**Lighting and Branch Wiring**		10.14	$933,000
	Receptacles incl plate, box, conduit, wire, 16.5 per 1000 SF, 2.0 W per SF, with transformer			
	Miscellaneous power, 1.2 watts			
	Central air conditioning power, 4 watts			
	Motor installation, three phase, 460 V, 15 HP motor size			
	Fluorescent fixtures recess mounted in ceiling, 2 watt per SF, 40 FC, 10 fixtures @40 watt per 1000 SF			
D5030	**Communications and Security**		4.64	$426,500
	Telephone wiring for offices & laboratories, 8 jacks/MSF			
	Communication and alarm systems, includes outlets, boxes, conduit and wire, fire detection systems, 25 detectors			
	Internet wiring, 8 data/voice outlets per 1000 S.F.			
D5090	**Other Electrical Systems**		0.21	$19,000
	Generator sets, w/battery, charger, muffler and transfer switch, gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 7			
	Uninterruptible power supply with standard battery pack, 15 kVA/12.75 kW			
E Equipment & Furnishings		0.1%	0.19	$17,500
E1090	**Other Equipment**		0.19	$17,500
	2 - Hydraulic passener elevators, for number of stops over 2, add			
F Special Construction		0.0%	0.00	$0
G Building Sitework		0.0%	0.00	$0
Sub Total		100%	$151.60	$13,947,000
Contractor's Overhead & Profit		1.5%	$2.27	$209,000
Architectural Fees		3.0%	$4.61	$424,500
User Fees		0.0%	$0.00	$0
Total Building Cost			$158.48	$14,580,500

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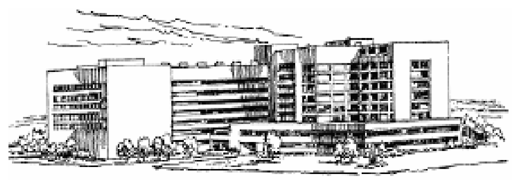
Square Foot Cost Estimate Report

Estimate Name:	Untitled
Building Type:	Hospital, 4-8 Story with Precast Concrete Panels With Exposed Aggregate / Steel Frame
Location:	STATE COLLEGE, PA
Stories Count (L.F.):	8.00
Stories Height	18.00
Floor Area (S.F.):	345,000.00
LaborType	Union
Basement Included:	Yes
Data Release:	Year 2008
Cost Per Square Foot	$224.46
Total Building Cost	$77,436,500



Costs are derived from a building model with basic components. Scope differences and market conditions can cause costs to vary significantly.

		% of Total	Cost Per SF	Cost
A Substructure		3.7%	6.62	$2,285,500
A1010	Standard Foundations		4.71	$1,625,500
	Strip footing, concrete, reinforced, load 14.8 KLF, soil bearing capacity 6 KSF, 12" deep x 32" wide			
	Spread footings, 3000 PSI concrete, load 400K, soil bearing capacity 6 KSF, 8' - 6" square x 27" deep			
A1030	Slab on Grade		0.50	$173,500
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	Basement Excavation		0.32	$110,500
	Excavate and fill, 10,000 SF, 8' deep, sand, gravel, or common earth, on site storage			
A2020	Basement Walls		1.09	$376,000
	Foundation wall, CIP, 12' wall height, pumped, .52 CY/LF, 24.29 PLF, 14" thick			
B Shell		27.3%	48.99	$16,900,500
B1010	Floor Construction		19.88	$6,857,500
	Cast-in-place concrete column, 16" square, tied, 400K load, 12' story height, 251 lbs/LF, 4000PSI			
	Steel column, W10, 200 KIPS, 10' unsupported height, 45 PLF			
	Flat slab, concrete, with drop panels, 6" slab/2.5" panel, 12" column, 15'x15' bay, 75 PSF superimposed load, 153 P			
	Floor, composite metal deck, shear connectors, 5.5" slab, 30'x30' bay, 26.5" total depth, 75 PSF superimposed load,			
	Fireproofing, gypsum board, fire rated, 2 layer, 1" thick, 10" steel column, 3 hour rating, 17 PLF			
B1020	Roof Construction		0.93	$320,000
	Floor, steel joists, beams, 1.5" 22 ga metal deck, on columns, 30'x30' bay, 28" deep, 40 PSF superimposed load, 62			
B2010	Exterior Walls		18.24	$6,294,000
	Exterior wall, precast concrete, flat, 8" thick, 10' x 10', white face, 2" rigid insulation, low rise			
B2020	Exterior Windows		8.34	$2,876,000
	Windows, aluminum, sliding, insulated glass, 5' x 3'			
B2030	Exterior Doors		0.66	$227,500
	Door, aluminum & glass, with transom, full vision, double door, hardware, 6'-0" x 10'-0" opening			
	Door, aluminum & glass, with transom, non-standard, double door, hardware, 6'-0" x 10'-0" opening			
	Door, steel 18 gauge, hollow metal, 1 door with frame, no label, 3'-0" x 7'-0" opening			
B3010	Roof Coverings		0.92	$316,000

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		% of Total	Cost Per SF	Cost
	Roofing, single ply membrane, reinforced, PVC, 48 mils, fully adhered, adhesive			
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Roof edges, aluminum, duranodic, .050" thick, 6" face			
	Flashing, copper, no backing, 16 oz, < 500 lbs			
B3020	**Roof Openings**		0.03	$9,500
	Roof hatch, with curb, 1" fiberglass insulation, 2'-6" x 3'-0", galvanized steel, 165 lbs			
C Interiors		20.8%	37.21	$12,838,500
C1010	**Partitions**		6.33	$2,182,500
	Metal partition, 5/8" vinyl faced gypsum board face, 5/8"fire rated gypsum board base, 3-5/8" @ 24",s ame opposite			
	Gypsum board, 1 face only, 5/8" with 1/16" lead			
C1020	**Interior Doors**		8.60	$2,967,000
	Door, single leaf, kd steel frame, hollow metal, commercial quality, flush, 3'-0" x 7'-0" x 1-3/8"			
	Door, single leaf, kd steel frame, metal fire, commercial quality, 3'-0" x 7'-0" x 1-3/8"			
C1030	**Fittings**		0.83	$285,500
	Partitions, hospital curtain, ceiling hung, poly oxford cloth			
C2010	**Stair Construction**		1.13	$390,500
	Stairs, steel, cement filled metal pan & picket rail, 12 risers, with landing			
C3010	**Wall Finishes**		6.15	$2,121,500
	Glazed coating			
	Painting, interior on plaster and drywall, walls & ceilings, roller work, primer & 2 coats			
	Vinyl wall covering, fabric back, medium weight			
	Ceramic tile, thin set, 4-1/4" x 4-1/4"			
C3020	**Floor Finishes**		8.37	$2,889,000
	Composition flooring, epoxy terrazzo, maximum			
	Terrazzo, maximum			
	Vinyl, composition tile, maximum			
	Tile, ceramic natural clay			
C3030	**Ceiling Finishes**		5.80	$2,002,500
	Plaster ceilings, 3 coat prl, 3.4# metal lath, 3/4" crc, 12"OC furring, 1-1/2" crc, 36" OC support			
	Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support			
D Services		39.9%	71.64	$24,715,000
D1010	**Elevators and Lifts**		5.45	$1,879,000
	Traction, geared hospital, 6000 lb, 6 floors, 12' story height, 2 car group, 200 FPM			
D2010	**Plumbing Fixtures**		5.91	$2,039,500
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, stall type			
	Lavatory w/trim, wall hung, PE on CI, 19" x 17"			
	Kitchen sink w/trim, raised deck, PE on CI, 42" x 21" dual level, triple bowl			
	Laundry sink w/trim, PE on CI, black iron frame, 48" x 21" double compartment			
	Service sink w/trim, PE on CI, corner floor, wall hung w/rim guard, 22" x 18"			
	Bathtub, recessed, PE on CI, mat bottom, 5'-6" long			
	Shower, stall, baked enamel, terrazzo receptor, 36" square			
	Water cooler, electric, wall hung, wheelchair type, 7.5 GPH			
D2020	**Domestic Water Distribution**		2.56	$884,000
	Electric water heater, commercial, 100< F rise, 1000 gal, 480 KW 1970 GPH			
D2040	**Rain Water Drainage**		0.29	$99,000
	Roof drain, CI, soil,single hub, 5" diam, 10' high			
	Roof drain, CI, soil,single hub, 5" diam, for each additional foot add			
D3010	**Energy Supply**		2.90	$1,002,000
	Hot water reheat system for 200,000 SF hospital			

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		% of Total	Cost Per SF	Cost
D3020	**Heat Generating Systems**		0.33	$112,500
	Boiler, electric, steel, steam, 510 KW, 1,740 MBH			
D3030	**Cooling Generating Systems**		2.51	$867,000
	Chiller, reciprocating, water cooled, standard controls, 100 ton			
	Chiller, reciprocating, water cooled, standard controls, 150 ton			
	Chiller, reciprocating, water cooled, standard controls, 200 ton			
D3090	**Other HVAC Systems/Equip**		24.61	$8,489,500
	Ductwork for 200,000 SF hospital model			
	Boiler, cast iron, gas, hot water, 2856 MBH			
	Boiler, cast iron, gas, hot water, 320 MBH			
	AHU, rooftop, cool/heat coils, VAV, filters, 5,000 CFM			
	AHU, rooftop, cool/heat coils, VAV, filters, 10,000 CFM			
	AHU, rooftop, cool/heat coils, VAV, filters, 20,000 CFM			
	VAV terminal, cooling, hot water reheat, with actuator / controls, 200 CFM			
	AHU, rooftop, cool/heat coils, VAV, filters, 30,000 CFM			
	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 1500 CFM			
	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 2750 CFM			
	Commercial kitchen exhaust/make-up air system, rooftop, gas, 5000 CFM			
	Plate heat exchanger, 400 GPM			
D4010	**Sprinklers**		1.97	$679,500
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF			
	Wet pipe sprinkler systems, steel, light hazard, each additional floor, 10,000 SF			
D4020	**Standpipes**		0.41	$141,500
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor			
	Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, additional floors			
	Cabs, hose rack assembly, & extinguisher, 2-1/2" x 1-1/2" valve & hose, steel door & frame			
	Alarm, electric pressure switch (circuit closer)			
	Escutcheon plate, for angle valves, polished brass, 2-1/2"			
	Fire pump, electric, with controller, 5" pump, 100 HP, 1000 GPM			
	Fire pump, electric, for jockey pump system, add			
	Siamese, with plugs & chains, polished brass, sidewalk, 4" x 2-1/2" x 2-1/2"			
	Valves, angle, wheel handle, 300 lb, 2-1/2"			
	Cabinet assembly, includes. adapter, rack, hose, and nozzle			
D5010	**Electrical Service/Distribution**		2.14	$739,500
	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 2000 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 2000 A			
	Switchgear installation, incl switchboard, panels & circuit breaker, 2000 A			
D5020	**Lighting and Branch Wiring**		16.87	$5,820,000
	Receptacles incl plate, box, conduit, wire, 20 per 1000 SF,2.4 W per SF, with transformer			
	Wall switches, 5.0 per 1000 SF			
	Miscellaneous power, 1.2 watts			
	Central air conditioning power, 4 watts			
	Motor installation, three phase, 460 V, 15 HP motor size			
	Motor feeder systems, three phase, feed to 200 V 5 HP, 230 V 7.5 HP, 460 V 15 HP, 575 V 20 HP			
	Fluorescent fixtures recess mounted in ceiling, 1 watt per SF, 20 FC, 5 fixtures @40 watts per 1000 SF			
D5030	**Communications and Security**		1.73	$596,000
	Communication and alarm systems, includes outlets, boxes, conduit and wire, fire detection systems, 100 detectors			
	Internet wiring, 8 data/voice outlets per 1000 S.F.			
D5090	**Other Electrical Systems**		3.96	$1,366,000
	Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 100 kW			

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		% of Total	Cost Per SF	Cost
	Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 400 kW			
	Uninterruptible power supply with standard battery pack, 15 kVA/12.75 kW			
E Equipment & Furnishings		8.3%	14.89	$5,138,000
E1020	**Institutional Equipment**		11.25	$3,880,500
	Architectural equipment, laboratory equipment glassware washer, distilled water, economy			
	Architectural equipment, sink, epoxy resin, 25" x 16" x 10"			
	Architectural equipment, laboratory equipment eye wash, hand held			
	Fume hood, complex, including fixtures and ductwork			
	Architectural equipment, medical equipment sterilizers, floor loading, double door, 28"x67"x52"			
	Architectural equipment, medical equipment, medical gas system for large hospital			
	Architectural equipment, kitchen equipment, commercial dish washer, semiautomatic, 50 racks/hr			
	Architectural equipment, kitchen equipment, food warmer, counter, 1.65 KW			
	Architectural equipment, kitchen equipment, kettles, steam jacketed, 20 gallons			
	Architectural equipment, kitchen equipment, range, restaurant type, burners, 2 ovens & 24" griddle			
	Architectural equipment, kitchen equipment, range hood, including CO2 system, economy			
	Special construction, refrigerators, prefabricated, walk-in, 7'-6" high, 6' x 6'			
	Architectural equipment, darkroom equipment combination, tray & tank sinks, washers & dry tables			
E1090	**Other Equipment**		0.00	$0
E2020	**Moveable Furnishings**		3.64	$1,257,500
	Furnishings, hospital furniture, patient wall system, no utilities, deluxe , per room			
F Special Construction		0.0%	0.00	$0
G Building Sitework		0.0%	0.00	$0
Sub Total		100%	$179.36	$61,877,500
Contractor's Overhead & Profit		21.5%	$38.56	$13,303,500
Architectural Fees		3.0%	$6.54	$2,255,500
User Fees		0.0%	$0.00	$0
Total Building Cost			**$224.46**	**$77,436,500**

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Square Foot Cost Estimate Report

Estimate Name: Untitled

Building Type:	College, Laboratory with Face Brick with Concrete Brick Back-up / Steel Frame
Location:	STATE COLLEGE, PA
Stories Count (L.F.):	1.00
Stories Height	18.00
Floor Area (S.F.):	105,800.00
LaborType	Union
Basement Included:	Yes
Data Release:	Year 2008
Cost Per Square Foot	$144.85
Total Building Cost	$15,325,000

Costs are derived from a building model with basic components. Scope differences and market conditions can cause costs to vary significantly.

		% of Total	Cost Per SF	Cost
A Substructure		9.3%	10.79	$1,141,500
A1010	Standard Foundations		1.87	$197,500
	Strip footing, concrete, reinforced, load 11.1 KLF, soil bearing capacity 6 KSF, 12" deep x 24" wide			
	Spread footings, 3000 PSI concrete, load 100K, soil bearing capacity 6 KSF, 4' - 6" square x 15" deep			
A1030	Slab on Grade		4.03	$426,000
	Slab on grade, 4" thick, non industrial, reinforced			
A2010	Basement Excavation		2.56	$270,500
	Excavate and fill, 10,000 SF, 8' deep, sand, gravel, or common earth, on site storage			
A2020	Basement Walls		2.34	$247,500
	Foundation wall, CIP, 12' wall height, pumped, .444 CY/LF, 21.59 PLF, 12" thick			
B Shell		33.0%	38.24	$4,046,000
B1010	Floor Construction		18.78	$1,987,000
	Cast-in-place concrete column, 12" square, tied, 200K load, 12' story height, 142 lbs/LF, 4000PSI			
	Flat slab, concrete, with drop panels, 6" slab/2.5" panel, 12" column, 15'x15' bay, 75 PSF superimposed load, 153 P			
	Floor, concrete, slab form, open web bar joist @ 2' OC, on W beam and column, 35'x35' bay, 41" deep, 125 PSF sup			
	Floor, concrete, slab form, open web bar joist @ 2' OC, on W beam and column, 35'x35' bay, 41" deep, 125 PSF sup			
	Fireproofing, gypsum board, fire rated, 2 layers, 1" thick, 8" steel column, 3 hour rating, 14 PLF			
B1020	Roof Construction		6.90	$730,500
	Floor, steel joists, beams, 1.5" 22 ga metal deck, on columns, 25'x30' bay, 25" deep, 40 PSF superimposed load, 60			
B2010	Exterior Walls		4.56	$482,500
	Brick wall, composite double wythe, standard face/CMU back-up, 8" thick, perlite core fill			
B2020	Exterior Windows		1.81	$191,000
	Aluminum flush tube frame, for 1/4"glass,1-3/4"x4", 5'x6' opening, no intermediate horizontals			
	Glazing panel, plate glass, 1/4" thick, clear			
B2030	Exterior Doors		1.72	$182,000
	Door, aluminum & glass, with transom, narrow stile, double door, hardware, 6'-0" x 10'-0" opening			
	Door, aluminum & glass, with transom, non-standard, hardware, 3'-0" x 10'-0" opening			
B3010	Roof Coverings		4.32	$457,500

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		% of Total	Cost Per SF	Cost
	Roofing, asphalt flood coat, gravel, base sheet, 3 plies 15# asphalt felt, mopped			
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Roof edges, aluminum, duranodic, .050" thick, 6" face			
	Flashing, aluminum, no backing sides, .019"			
	Gravel stop, aluminum, extruded, 4", mill finish, .050" thick			
B3020	**Roof Openings**		0.15	$15,500
	Skylight, plastic domes, insulated curbs, 30 SF to 65 SF, single glazing			
	Roof hatch, with curb, 1" fiberglass insulation, 2'-6" x 3'-0", galvanized steel, 165 lbs			
	Smoke hatch, unlabeled, galvanized, 2'-6" x 3', not incl hand winch operator			
C Interiors		18.9%	21.92	$2,319,000
C1010	**Partitions**		7.15	$756,500
	Concrere block (CMU) partition, light weight, hollow, 6" thick, no finish			
	Concrere block (CMU) partition, light weight, hollow, 8" thick, no finish			
C1020	**Interior Doors**		0.93	$98,500
	Door, single leaf, kd steel frame, kalamein fire, commercial quality, 3'-0" x 7'-0" x 1-3/4"			
C1030	**Fittings**		0.03	$3,500
	Lockers, steel, single tier, 5' to 6' high, per opening, minimum			
C3010	**Wall Finishes**		4.28	$453,000
	2 coats paint on masonry with block filler			
	Painting, masonry or concrete, latex, brushwork, primer & 2 coats			
	Wall coatings, epoxy coatings, maximum			
C3020	**Floor Finishes**		4.56	$482,000
	Carpet tile, nylon, fusion bonded, 18" x 18" or 24" x 24", 35 oz			
	Composition flooring, epoxy, minimum			
	Vinyl, composition tile, maximum			
C3030	**Ceiling Finishes**		4.97	$525,500
	Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support			
D Services		37.5%	43.45	$4,596,500
D2010	**Plumbing Fixtures**		10.10	$1,069,000
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, wall hung, PE on CI, 18" x 15"			
	Lab sink w/trim, polyethylene, single bowl, double drainboard, 54" x 24" OD			
	Service sink w/trim, vitreous china, wall hung 22" x 20"			
	Shower, stall, fiberglass 1 piece, three walls, 36" square			
	Water cooler, electric, wall hung, wheelchair type, 7.5 GPH			
D2020	**Domestic Water Distribution**		0.53	$56,000
	Gas fired water heater, commercial, 100< F rise, 600 MBH input, 576 GPH			
D2040	**Rain Water Drainage**		0.31	$33,000
	Roof drain, DWV PVC, 4" diam, diam, 10' high			
	Roof drain, DWV PVC, 4" diam, for each additional foot add			
D3050	**Terminal & Package Units**		17.40	$1,840,500
	Rooftop, multizone, air conditioner, schools and colleges, 25,000 SF, 95.83 ton			
D4010	**Sprinklers**		2.06	$217,500
	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 50,000 SF			
D5010	**Electrical Service/Distribution**		0.77	$81,500
	Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 1000 A			
	Feeder installation 600 V, including RGS conduit and XHHW wire, 1000 A			
	Switchgear installation, incl switchboard, panels & circuit breaker, 1200 A			
D5020	**Lighting and Branch Wiring**		9.39	$993,500

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		% of Total	Cost Per SF	Cost
	Receptacles incl plate, box, conduit, wire, 8 per 1000 SF, .9 W per SF, with transformer			
	Wall switches, 2.0 per 1000 SF			
	Miscellaneous power, 1 watt			
	Central air conditioning power, 3 watts			
	Fluorescent fixtures recess mounted in ceiling, 2 watt per SF, 40 FC, 10 fixtures @40 watt per 1000 SF			
D5030	**Communications and Security**		2.76	$292,000
	Communication and alarm systems, includes outlets, boxes, conduit and wire, fire detection systems, 50 detectors			
	Internet wiring, 8 data/voice outlets per 1000 S.F.			
D5090	**Other Electrical Systems**		0.13	$13,500
	Generator sets, w/battery, charger, muffler and transfer switch, gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 1			
	Uninterruptible power supply with standard battery pack, 15 kVA/12.75 kW			
E Equipment & Furnishings		1.2%	1.35	$142,500
E1020	**Institutional Equipment**		1.35	$142,500
	Architectural equipment, laboratory equipment glassware washer, distilled water, deluxe			
	Architectural equipment, laboratory equipment glove box, fiberglass, radio isotope			
	Architectural equipment, laboratory equipment, cabinets, wall, open			
	Architectural equipment, laboratory equipment, cabinets, base, drawer units			
	Architectural equipment, laboratory equipment fume hoods, not including HVAC, deluxe including fixtures			
E1090	Other Equipment		0.00	$0
F Special Construction		0.0%	0.00	$0
G Building Sitework		0.0%	0.00	$0
Sub Total		100%	$115.74	$12,245,500
Contractor's Overhead & Profit		21.5%	$24.89	$2,633,000
Architectural Fees		3.0%	$4.22	$446,500
User Fees		0.0%	$0.00	$0
Total Building Cost			**$144.85**	**$15,325,000**

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APPENDIX C – Cost Analysis References

The cost information referenced for The New York Times Building, The Dickinson School of Law, the Life Sciences Building, and the Student Health Center are all based on student-provided work from previous thesis projects. Names and websites have been provided below as references to credit those whose information was used for this project.

The New York Times Building

Matthew Hedrick, Justin Miller, Christopher Wiacek

http://www.engr.psu.edu/ae/thesis/portfolios/2010/msh5020/Documents/IPD%20BIM%20CM%20Tech%201.pdf

The New Dickinson School of Law – Katz Building

Steven K. Ayer

http://www.engr.psu.edu/ae/thesis/portfolios/2008/ska124/buildingstatistics.htm

Life Sciences Building

Kirk M. Stauffer

http://www.engr.psu.edu/ae/thesis/portfolios/2008/kms491/building-stats.htm

Student Health Center

Jacob Brambley

http://www.engr.psu.edu/ae/thesis/portfolios/2010/jkb207/BuildingStatistics.html

APPENDIX D – Project Staffing Plan

APPENDIX E – BIM Process Guidelines

SECTION I [ADD 1]

BIM PROCESS
COORDINATION GUIDELINES

Penn State Millennium Science Complex

Introduction

The purpose of using BIM (Building Information Modeling) on the PSU MSC project is to supplement the coordination process between trades and design disciplines. This will enable all parties to develop a solid understanding of the complexities of the project and assist in resolving potential conflicts early when they are easy to correct. The end product will not only facilitate a smooth and efficient execution of the project in the field but will also provide as close to an "as built" set of 3D design documents, providing the PSU MSC facilities management team with an extremely useful additional tool for the maintenance and operation of the facility.

Process Overview

1. A dedicated FTP site will be established for uploading the 3D models produced by the designers and subcontractors. These models will be accessible to all parties for individual coordination purposes on a trade by trade basis. Whiting-Turner will be responsible for maintaining and integrating all of the 3D trades models into a single consolidated master model (BIM). This master building information model will be available to all parties for review. The master model will be updated weekly and ready for a download from the FTP site.

2. Each party will have a distribution list of participants and must notify all participants every time a file is uploaded to the FTP site. Whiting-Turner will do the same when posting the consolidated 3D model.

3. The integrated master BIM will be provided in a Navisworks file format and will include view sets of clashes and/or other design/constructability issues that Whiting-Turner uncovers during this process. The individual team members will be responsible for reviewing the saved views one by one prior to the next coordination meeting. To this end, all team members must have at their disposal one copy of Navisworks Roamer.

   Whiting-Turner will create a 3D grid for incorporation into the Navisworks file. This will provide the viewer with a quick point of reference when navigating through the model.

4. Whiting-Turner will review the consolidated master model and the saved views in the coordination meeting with the designers and subcontractors who will be expected to discuss and resolve the identified problems and adjust their 3D models accordingly. These revised models will be uploaded to a central server and be integrated into the consolidated Navisworks file. We will run another series of clashes and the process will be reiterated for the duration of the coordination session which can be expected to run for six to eight hours. Any unresolvable clashes will be noted and translated into an RFI by the contractor or a decision will be made as to what action should be taken and by whom. A supplementary Navisworks file will be saved and posted with the date of that meeting in a separate "meetings" folder in the 3D Navisworks Coordination folder. See Appendix A. Detailers are expected to bring a laptop computer, with the appropriate 3D modeling software, to the coordination meetings. This will allow changes to be made to the model during the coordination meetings.

5. The designers are expected to be available by telephone and webcast during the coordination

meetings. Many issues can be resolved in this way without the necessity of generating RFI's. Occasionally, one or more of the designers may be requested to be present at a coordination meeting where their input and interaction with the detailers can result in the most practical solution to a given issue.

6. Any outstanding clashes at the end of the coordination session should be rectified and resulting corrected models uploaded during the course of the ensuing week.

7. This process will be repeated until all parties have confidence in the constructability of the coordinated design (sign-off).

Requirements for 3D models, Formats and Model Structures

1. **File format**: All files should be exported to 3D DWG format. Object enablers for trade specific software should be uploaded to the ftp site in the folder provided.
2. **3D Solids**: All objects must be modeled as 3D solids, not wire frames or lines.
3. **Model Structure**: Models should be created on a floor by floor basis from top of slab to top of slab. We will keep a separate Navisworks file for each floor. The model may be broken down into smaller components to make each piece less cumbersome and easier to Navigate. This may include breaking down the model by floor, then by wing (Life Science and Material Science), etc.
4. **Layer names**: Layer names should reflect the nature of the group of objects that the layer includes, such as walls, beams, etc. and as a subset more specific descriptors such as wall type, beam type, etc.
5. **Trade colors**: Each trade will be identifiable by a single color within Navisworks with the exception of architectural and structural elements as follows:

   Structural concrete: grey
   Structural steel: maroon
   Architectural walls: beige
   Ceilings: orange
   Lab Casework: blue
   Fire protection: red
   Plumbing: magenta
   HVAC Duct: light green (supply), pink (return)
   HVAC Pipe: green
   Electrical: cyan

6. **Common Reference Point**: once established, every trade must use the same reference point or global coordinate system. A reference point identifier will be distributed to all detailers/3D modelers and these should be incorporated into and saved with the 3D model when uploading to the ftp site.
7. **Elevations**: all elements must be modeled at the correct elevation so that when all of the levels are composited together, every trade will be at the correct elevation relative to project 0.

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8. **"Clean" models —** no x-refs: the 3D DWG model submitted should only contain relevant 3D data and no extraneous 2D data, nor should it contain any x-referenced files.

9. **Self intersecting models**: with reference specifically to the MEP trades. Each trade should check their model carefully for self intersecting elements and should modify their model accordingly, should they occur.

10. **Filenames**: The following filename convention will apply to all trades:

    Project Acronym_Trade_Level_date

    Examples:

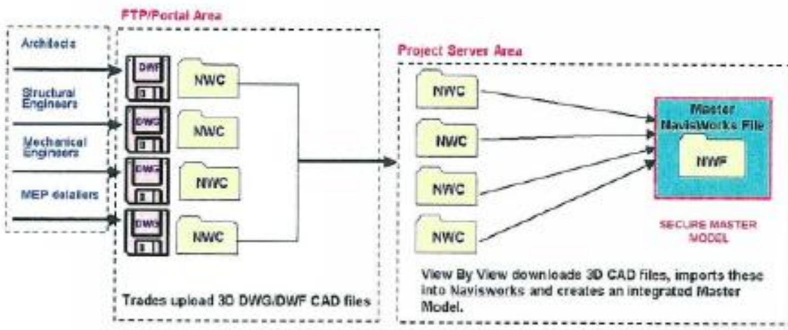
    PSUMSC_Arch_L1_2008-09-15
    PSUMSC_Struct_L1_2008-09-15
    PSUMSC_Elect_L1_2008-09-15
    PSUMSC_MDuct _L1_2008-09-15
    PSUMSC _MPipe_L1_2008-09-15
    PSUMSC_Plbg_L1 _2008-09-15
    PSUMSC_Fire_L1_2008-09-15

- **3D MODEL**
  - **Architectural**
  - **Structural**
  - **Electrical**
  - **FireProtection**
  - **HVACDuct**
    - **L0 - Basement**
    - **L1 - First Floor**
      - **PSUMSC_MDuct_L0_2008-10-31.dwg**
      - **PSUMSC_MDuct_L0_2008-11-14.dwg**
    - **L2 - Second Floor**
    - **L3 - Third Floor**
    - **L4 - Mechanical Penthouse**
  - **HVACPiping**
  - **Plumbing**

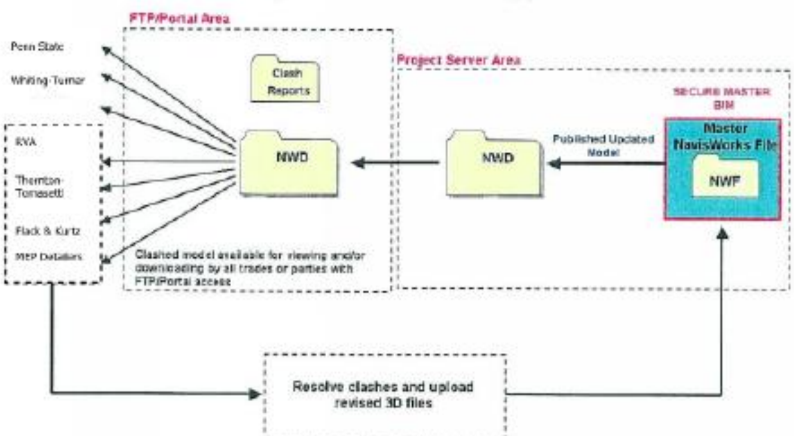
- **NAVIS 3D COORDINATION**
  - **First Floor**
    - **PSUMSC_3D Coord_L1_2008-11-07**
    - **PSUMSC_3D Coord_L1_2008-11-21**

APPENDIX A

Design Review Process (Input)



Design Review Process (Communicating)



APPENDIX F – Project Delivery