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Cancer Institute
Penn State Milton S. Hershey Medical Center
Hershey, Pennsylvania

EXISTING CONSTRUCTION CONDITIONS

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Executive Summary

The enclosed report summarizes the findings concerning existing construction conditions for the Cancer Institute building project at the Penn State Milton S. Hershey Medical Center in Hershey, Pennsylvania. Information is broken down into three sections: an abbreviated project schedule, building systems summary, and a project cost evaluation.

The Cancer Institute being constructed at PSHMC will be the new center for cancer research within the Penn State College of Medicine network. The facility features cutting-edge technology with its brachytherapy unit and linear accelerators, also known as a Gamma Knife, to provide individuals with the best possible methodologies for cancer treatment. It also houses numerous physician rooms, offices, research laboratories, and a unique "Healing Garden" designed to aid in the recovery process.

The purpose of this initial analysis is to lay the cornerstone off of which all further research will be based. By understanding the basic schedule and cost information, issues dealing with trade sequencing, construction methods, and value engineering may be identified and examined later on in the thesis process.

Schedule Summary

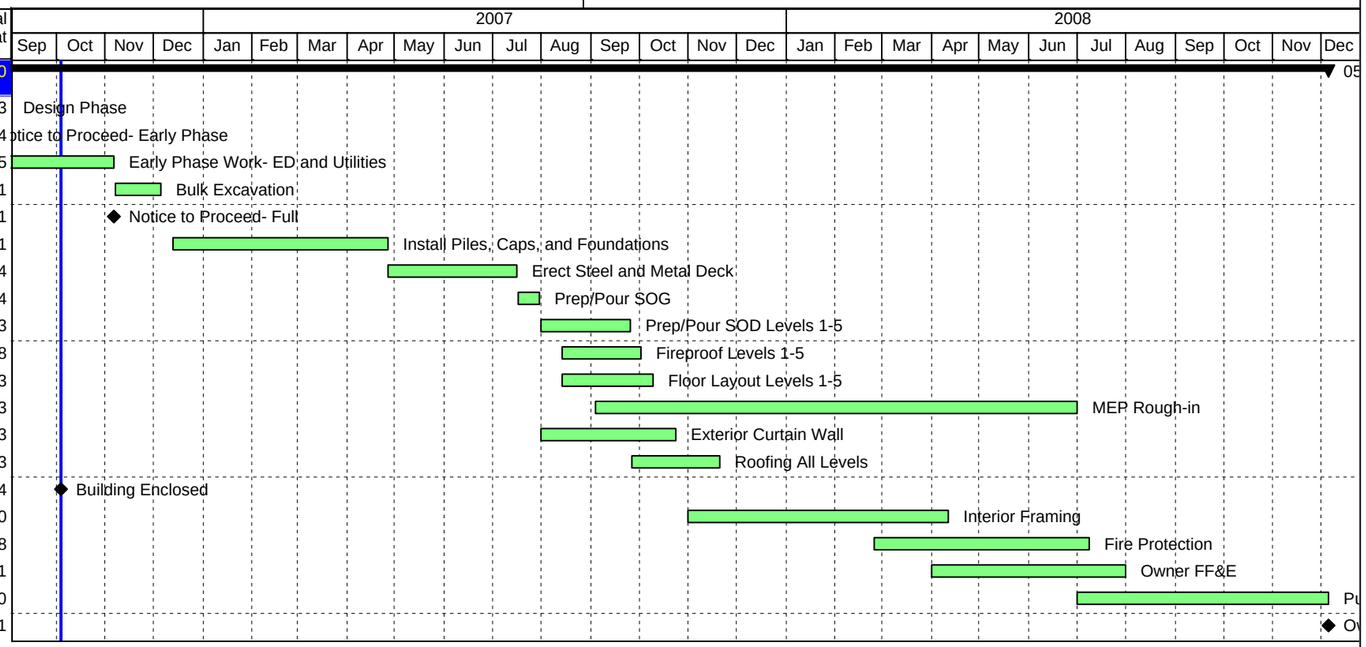
Sequencing Elements

- *Foundation*- After bulk excavation to sub-grade, a 2” mud matt of 2,000 psi to 2,500 psi concrete will be poured over the entire basement floor level, which will be pitched slightly to the perimeter for drainage purposes. The overall structural bearing is placed on load-bearing micropiles that are drilled into the ground approximately 90 feet, surrounded by a metal casing. The piles require an additional 20 feet of bond length in stable rock to resist uplift and shear forces. When the bond zone has been located, the casing is filled with grout to adhere to the threaded piles. Column piers and grade beams are formed and placed atop these micropiles. The slab-on-grade will be poured in sections. First, the 36” slab for the radiotherapy area is poured. At each brachytherapy or linear accelerator unit, the slab is stepped down to provide a shell for the base. After steel erection, the remainder of the 6” slab will be formed and poured.

- *Superstructure*- Steel and metal decking will be installed in bay sections, beginning at the North end of the building and completing one floor at a time. Shear studs for the composite metal deck will be installed prior to the placement of the metal deck, and will follow the sequence of the steel member erection. A mobile crane will be used to facilitate this sequence.

- *Finishes*- Interior rough-ins and finishes will follow a typical sequence, beginning with piping, then mechanical, and lastly electrical and light fixture installation. Pipe and mechanical hangers are installed as the metal deck on the floor above is completed, avoiding the need to drill into the composite floor slabs.

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
PSHMC Cancer Institute...		757	757	0%	03-Jan-06	05-Dec-08	0
A1000	Design Phase	171	171	100%	03-Jan-06	31-Aug-06	393
A1010	Notice to Proceed- Early...	0	0	100%	15-Aug-06		564
A1020	Early Phase Work- ED a...	59	59	59.32%	15-Aug-06	06-Nov-06	505
A1030	Bulk Excavation	19	19	0%	07-Nov-06*	05-Dec-06	521
A1040	Notice to Proceed- Full	0	0	0%	06-Nov-06*		541
A1050	Install Piles, Caps, and ...	95	95	0%	13-Dec-06*	26-Apr-07	421
A1060	Erect Steel and Metal D...	57	57	0%	27-Apr-07*	16-Jul-07	364
A1070	Prep/Pour SOG	10	10	0%	17-Jul-07*	30-Jul-07	354
A1080	Prep/Pour SOD Levels 1-5	41	41	0%	31-Jul-07*	25-Sep-07	313
A1090	Fireproof Levels 1-5	36	36	0%	14-Aug-07*	02-Oct-07	308
A1100	Floor Layout Levels 1-5	41	41	0%	14-Aug-07*	09-Oct-07	303
A1110	MEP Rough-in	216	216	0%	04-Sep-07*	01-Jul-08	113
A1120	Exterior Curtain Wall	61	61	0%	31-Jul-07*	23-Oct-07	293
A1130	Roofing All Levels	40	40	0%	26-Sep-07*	20-Nov-07	273
A1140	Building Enclosed	0	0	0%		04-Oct-06	564
A1150	Interior Framing	118	118	0%	31-Oct-07*	11-Apr-08	170
A1160	Fire Protection	97	97	0%	25-Feb-08*	08-Jul-08	108
A1170	Owner FF&E	88	88	0%	01-Apr-08*	31-Jul-08	91
A1180	Punch-out	114	114	0%	01-Jul-08*	05-Dec-08	0
A1190	Owner Occupany	0	0	0%	05-Dec-08*		1



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

Summary Schedule

Building Systems Summary

Demoliton- The first phase of the project includes demolition of a hospital parking lot, the helipad, and a section of the Emergency Delivery area. The existing helipad and ED will be maintained until the new helipad and ED expansion are complete. The ED work demands usage of the Infection Control Risk Assessment plan to ensure that no demolition or construction debris contaminates the existing hospital, threatening patients in surgery and recovery. As the new helipad is being constructed nearby to the existing one, work stoppages will be ordered whenever an emergency delivery is sent to the hospital, typically carrying a 15 to 30 minute notice.

Structural Steel Frame- The superstructure utilizes steel bay construction with mostly moment frame connections. However, central to the structure and found at alternating column lines are three braced frame systems carried from the first to the fifth floor. Girder and beam sizes vary throughout the structure. Girder sizes typically range between a W18x26 and W27x84 on the first floor, to a W18x65 and W24x76 on the upper floors, all spanning lengths of 31 feet. Beam sizes throughout all floors are predominantly W16's and span from 26 to 29 feet. Columns, meanwhile, fall between a W14x43 and W14x90. Elevated floors are composite concrete slab on metal deck. To assemble the bay sections, one mobile crane will be used, which will run along the East façade of the building beginning at the North end.

Cast-in-Place Concrete- The foundation system uses pile caps and grade beams atop load-bearing foundation micropiles. Grade beams will be poured directly with no forming, though the pile caps will require stick-built forms for Ground floor concrete pours are critical to the project, as the radiotherapy equipment is found here. A 36" floor slab, depressed at locations for the linear accelerator and brachytherapy units, is coupled with 40" dividing walls and a 60" ceiling, both encased with lead bricks. Placement requires two successive pours and metal formwork to facilitate construction of this critical wall type. Elevated slabs will require the use of a concrete pump for placement.

Mechanical System- The ventilation system for this facility utilizes three central supply air handling units. AHU-C/A-1 is found on the ground floor and services the ground, first, and second floors, and averages 130,000 cubic feet per minute (cfm). The two remaining units, AHU-L-1 and AHU-L-2, are sized at 55,000 cfm, and both provide cooling and heating to the third and fourth floors. These units will provide air to approximately 400 constant volume or variable volume boxes located throughout the building.

Electrical System- Two high voltage loop circuits feed the entire PSHMC campus. The Cancer Institute will run on the Loop 'A' feed, delivering power on a 3 phase, 480Y / 270V circuit. Two emergency generators are located on the mechanical penthouse floor to prevent any interruption in patient treatment, clinical research, and other energy-dependent functions of the facility.

Masonry- The exterior wall system utilizes granite and limestone cladding in to compliment the curtain wall facade. Limestone veneer is found on the upper floors, with a standard brick size of 7'-9" x 1'-6". Granite masonry is kept to the first floor façade and used in conjunction with the limestone bricks are curtain wall storefront.

Curtain Wall- The wall system of the building is predominantly an aluminum curtain wall with glazing to match the nearby parking garage curtain wall, currently in early phases of construction. Though the design was developed by Payette Associates for both of these projects, connection details are dependent upon the selected manufacturer. Some difficulties can arise in this aspect since no standard construction method exists. For this reason, details for the curtain wall system are pending design verification with the parking garage project.

Support of Excavation- Dewatering specifications for the site require subsurface water to be kept two feet below the working sub-grade so that work can proceed in the dry. Structural fill, if needed, will be placed in lifts of no more than 8 inches at a time and then sufficiently proofrolled. Also required before the foundation slab is poured is a

minimum of 6 inches of compacted PennDOT 2A stone. Backfill using this stone will be used for the basement walls, but will not be installed until the floor slab is placed and cured. Sheeting and shoring will be used for excavated areas bordering the existing facilities, including the ED, so that no detrimental settlement occurs.

Project Cost Evaluation

Basic Overall Cost Information-

- Construction Cost (CC) = $82,000,000
    - Construction Cost / square foot (CC/sf) = $468 / sf
- Total Project Cost (TC) = $96,000,000
    - Total Project Cost / square foot (TC/sf) = $548 / sf

Buildings Systems Costs-

- Structural Cost = $11,520,000
    - Structural Cost / sf = $66 / sf
- Mechanical System Cost = $9,310,000
    - Mechanical Cost / sf = $53 / sf
- Electrical System Cost = $6,350,000
    - Electrical Cost / sf = $36 / sf
- Plumbing Cost = $4,870,000
    - Plumbing Cost / sf = $28 / sf
- Fire Protection Cost = $900,000
- Sitework Cost = $7,860,000
- Exterior Glass and Curtain Wall Cost = $5,720,000
- Masonry Cost = $90,000
- Conveying Systems Cost = $400,000
- Building Automation Cost = $1,960,000
- Lab Equipment = $850,000

D4Cost 2002 Estimate Comparison-

The following cost analysis was produced using D4 Cost Estimating software. Three projects were chosen that were similar in function, size, and cost to the Cancer Institute. These projects are then simulated for construction to the approximate location and time period that the Cancer Institute is being built, in an attempt to assess local cost conditions and inflation rates. The key points of the analysis are summarized in the table below. As many variables exist with such an assessment, the most important outcome is that of the Construction Cost per square foot (CC/sf). It is evident from the summation data that the Cancer Institute ranks much higher than the other three in terms of CC/sf. One key factor affecting this higher cost is the inclusion of site improvements, utilities, and the Emergency Delivery renovation and expansion, atop the modernized design program intrinsic to the project.

D4 Cost Comparison- Medical Facilities

	PSHMC Cancer Institute	**Duke Univ. Med. Research Building**	**Winship Cancer Institute**	**Slyvestra Cancer Center**
Building Usage	Medical	Medical	Medical	Medical
Location	Hershey, PA	Harrisburg, PA	Harrisburg, PA	Harrisburg, PA
Completion	Dec. 2008	Dec. 2008	Dec. 2008	Dec. 2008
# of Floors	5	5	7	4
Square Footage	175,000 sf	186,689 sf	260,000 sf	117,500 sf
Cost	$82,000,000.00	$60,093,710.00	$98,106,618.00	$30,295,250.00
CC/sf	$468.00	$322.00	$377.00	$258.00
Selected CSI Division Comparison				
02-Sitework	$6,940,000.00	$2,074,723.00	$7,215,414.00	$992,390.00
03-Concrete	$4,450,000.00	$9,127,327.00	$12,658,050.00	$4,903,345.00
04-Masonry	$1,340,000.00	$265,851.00	$1,251,872.00	$1,650,337.00
05-Metals	$6,820,000.00	$1,229,289.00	$2,812,950.00	$974,808.00
Structural Total	**$12,610,000.00**	**$10,622,467.00**	**$16,722,872.00**	**$7,528,490.00**
09-Finishes	$3,734,000.00	$3,464,981.00	$10,818,240.00	$3,448,361.00
11-Equipment	$850,000.00	$539,515.00	$1,026,572.00	$105,490.00
14-Conveying Systems	$400,000.00	$596,809.00	$1,915,217.00	$834,155.00

Note: Highlighted cells indicate figures that closely resemble the PSHMC Cancer Institute estimate for individual CSI divisions.

When the cost analyses are compared by CSI division, a lot can be inferred about the design and construction of the various projects. For example, when summing the cost of concrete, metals, and masonry, the Duke University building has an overall structural cost of $10,620,000 compared to $12,610,000 for the Cancer Institute. This would be expected, considering the two facilities are very close in square footage and height. Likewise, equipment costs for the Duke building and the Winship Cancer Institute are $540,000 and $1,100,000, respectively, compared to the PSHMC building equipment cost at $850,000.

However, when looking at site work costs, the PSHMC Cancer Institute most closely matches the largest facility of 260,000 square feet. This is due to the fact that, as stated above, significant roadway improvements are included in the Cancer Institute's estimate. Thus, one would expect a greater site work cost than the Duke building, even though they match in square footage. Another telling figure is that of the cost of finishes. The PSHMC Cancer Institute, Duke Research Building, and Sylvestra Cancer Center all come in at around $3.5 million, which, considering their relative square footages and building function is a reasonable outcome. It is evident from this analysis that the D4 software is a viable tool for schematic estimate evaluations. For full project cost breakdowns, please see Appendix A.

Appendix A
D4 Cost Analysis Reports

Estimates of Probable Cost

Estimate of Probable Cost

Cancer Institute Comparison- Sylves - Dec 2008 - PA - Harrisburg

Prepared By:		Prepared For:	
	,		,
	Fax:		**Fax:**
Building Sq. Size:	**117500**	Site Sq. Size:	**84075**
Bid Date:		Building use:	
No. of floors:	**4**	Foundation:	
No. of buildings:		Exterior Walls:	
Project Height:		Interior Walls:	
1st Floor Height:		Roof Type:	
1st Floor Size:		Floor Type:	
		Project Type:	

Division		Percent	Sq. Cost	Amount
00	**Bidding Requirements**	**0.00**	**0.00**	**0**
	Bidding Requirements	0.00	0.00	0
01	**General Requirements**	**9.18**	**23.68**	**2,781,818**
	General Requirements	9.18	23.68	2,781,818
02	**Site Work**	**3.28**	**8.45**	**992,390**
	Site Work	3.28	8.45	992,390
03	**Concrete**	**16.19**	**41.73**	**4,903,345**
	Concrete	16.19	41.73	4,903,345
04	**Masonry**	**5.45**	**14.05**	**1,650,337**
	Masonry	5.45	14.05	1,650,337
05	**Metals**	**3.22**	**8.30**	**974,808**
	Metals	3.22	8.30	974,808
06	**Wood & Plastics**	**5.82**	**15.01**	**1,764,032**
	Wood & Plastics	5.82	15.01	1,764,032
07	**Thermal & Moisture Protection**	**1.39**	**3.57**	**420,008**
	Thermal & Moisture Protection	1.39	3.57	420,008
08	**Doors & Windows**	**5.04**	**12.98**	**1,525,702**
	Doors & Windows	5.04	12.98	1,525,702
09	**Finishes**	**11.38**	**29.35**	**3,448,361**
	Finishes	11.38	29.35	3,448,361
10	**Specialties**	**0.77**	**1.98**	**232,469**
	Specialties	0.77	1.98	232,469
11	**Equipment**	**0.35**	**0.90**	**105,490**
	Equipment	0.35	0.90	105,490
12	**Furnishings**	**0.35**	**0.90**	**105,490**
	Furnishings	0.35	0.90	105,490
13	**Special Construction**	**0.52**	**1.33**	**156,282**
	Special Construction	0.52	1.33	156,282
14	**Conveying Systems**	**2.75**	**7.10**	**834,155**
	Conveying Systems	2.75	7.10	834,155
15	**Mechanical**	**21.74**	**56.06**	**6,587,283**
	Mechanical	21.74	56.06	6,587,283
16	**Electrical**	**12.59**	**32.45**	**3,813,279**
	Electrical	12.59	32.45	3,813,279
Total Building Costs		**100.00**	**257.83**	**30,295,250**

Total Site Costs	**100.00**	**0.00**	**0**
Total Project Costs	**--**	**--**	**30,295,250**

Estimate of Probable Cost

Cancer Institute Comparison- Duke U - Dec 2008 - PA - Harrisburg

Prepared By:		Prepared For:	
	,		,
	Fax:		**Fax:**
Building Sq. Size:	**186669**	Site Sq. Size:	**95832**
Bid Date:		Building use:	
No. of floors:	**5**	Foundation:	
No. of buildings:		Exterior Walls:	
Project Height:		Interior Walls:	
1st Floor Height:		Roof Type:	
1st Floor Size:		Floor Type:	
		Project Type:	

Division		Percent	Sq. Cost	Amount
00	**Bidding Requirements**	**4.01**	**12.90**	**2,408,936**
	Bidding Requirements	4.01	12.90	2,408,936
01	**General Requirements**	**3.90**	**12.57**	**2,346,226**
	General Requirements	3.90	12.57	2,346,226
02	**Site Work**	**3.45**	**11.11**	**2,074,723**
	Site Work	3.45	11.11	2,074,723
03	**Concrete**	**15.19**	**48.90**	**9,127,327**
	Concrete	15.19	48.90	9,127,327
04	**Masonry**	**0.44**	**1.42**	**265,851**
	Masonry	0.44	1.42	265,851
05	**Metals**	**2.05**	**6.59**	**1,229,289**
	Metals	2.05	6.59	1,229,289
06	**Wood & Plastics**	**7.69**	**24.76**	**4,621,095**
	Wood & Plastics	7.69	24.76	4,621,095
07	**Thermal & Moisture Protection**	**3.60**	**11.59**	**2,163,759**
	Thermal & Moisture Protection	3.60	11.59	2,163,759
08	**Doors & Windows**	**2.54**	**8.18**	**1,527,860**
	Doors & Windows	2.54	8.18	1,527,860
09	**Finishes**	**5.77**	**18.56**	**3,464,981**
	Finishes	5.77	18.56	3,464,981
10	**Specialties**	**0.10**	**0.33**	**61,730**
	Specialties	0.10	0.33	61,730
11	**Equipment**	**0.90**	**2.89**	**539,515**
	Equipment	0.90	2.89	539,515
13	**Special Construction**	**1.76**	**5.67**	**1,057,707**
	Special Construction	1.76	5.67	1,057,707
14	**Conveying Systems**	**0.99**	**3.20**	**596,809**
	Conveying Systems	0.99	3.20	596,809
15	**Mechanical**	**36.19**	**116.52**	**21,750,031**
	Mechanical	36.19	116.52	21,750,031
16	**Electrical**	**11.41**	**36.74**	**6,857,872**
	Electrical	11.41	36.74	6,857,872
Total Building Costs		**100.00**	**321.93**	**60,093,710**
Total Site Costs		**100.00**	**0.00**	**0**

Total Project Costs	**--**	**--**	**60,093,710**

Estimate of Probable Cost

CI Comparison- Winship CI - Dec 2008 - PA - Harrisburg

Prepared By:		Prepared For:	
	,		,
	Fax:		**Fax:**
Building Sq. Size:	**260000**	Site Sq. Size:	**87120**
Bid Date:		Building use:	
No. of floors:	**7**	Foundation:	
No. of buildings:		Exterior Walls:	
Project Height:		Interior Walls:	
1st Floor Height:		Roof Type:	
1st Floor Size:		Floor Type:	
		Project Type:	

Division		Percent	Sq. Cost	Amount
01	**General Requirements**	**13.82**	**52.14**	**13,557,550**
	General Requirements	13.82	52.14	13,557,550
02	**Site Work**	**7.35**	**27.75**	**7,215,414**
	Site Work	7.35	27.75	7,215,414
03	**Concrete**	**12.90**	**48.68**	**12,658,050**
	Concrete	12.90	48.68	12,658,050
04	**Masonry**	**1.28**	**4.81**	**1,251,872**
	Masonry	1.28	4.81	1,251,872
05	**Metals**	**2.87**	**10.82**	**2,812,950**
	Metals	2.87	10.82	2,812,950
06	**Wood & Plastics**	**2.71**	**10.23**	**2,659,265**
	Wood & Plastics	2.71	10.23	2,659,265
07	**Thermal & Moisture Protection**	**2.76**	**10.40**	**2,702,998**
	Thermal & Moisture Protection	2.76	10.40	2,702,998
08	**Doors & Windows**	**3.64**	**13.75**	**3,574,952**
	Doors & Windows	3.64	13.75	3,574,952
09	**Finishes**	**11.03**	**41.61**	**10,818,240**
	Finishes	11.03	41.61	10,818,240
10	**Specialties**	**0.82**	**3.08**	**801,496**
	Specialties	0.82	3.08	801,496
11	**Equipment**	**1.05**	**3.95**	**1,026,572**
	Equipment	1.05	3.95	1,026,572
12	**Furnishings**	**3.59**	**13.56**	**3,525,336**
	Furnishings	3.59	13.56	3,525,336
13	**Special Construction**	**0.97**	**3.66**	**950,387**
	Special Construction	0.97	3.66	950,387
14	**Conveying Systems**	**1.95**	**7.37**	**1,915,217**
	Conveying Systems	1.95	7.37	1,915,217
15	**Mechanical**	**20.20**	**76.21**	**19,815,695**
	Mechanical	20.20	76.21	19,815,695
16	**Electrical**	**13.07**	**49.31**	**12,820,622**
	Electrical	13.07	49.31	12,820,622
Total Building Costs		**100.00**	**377.33**	**98,106,618**
Total Site Costs		**100.00**	**0.00**	**0**

Total Project Costs	**--**	**--**	**98,106,618**