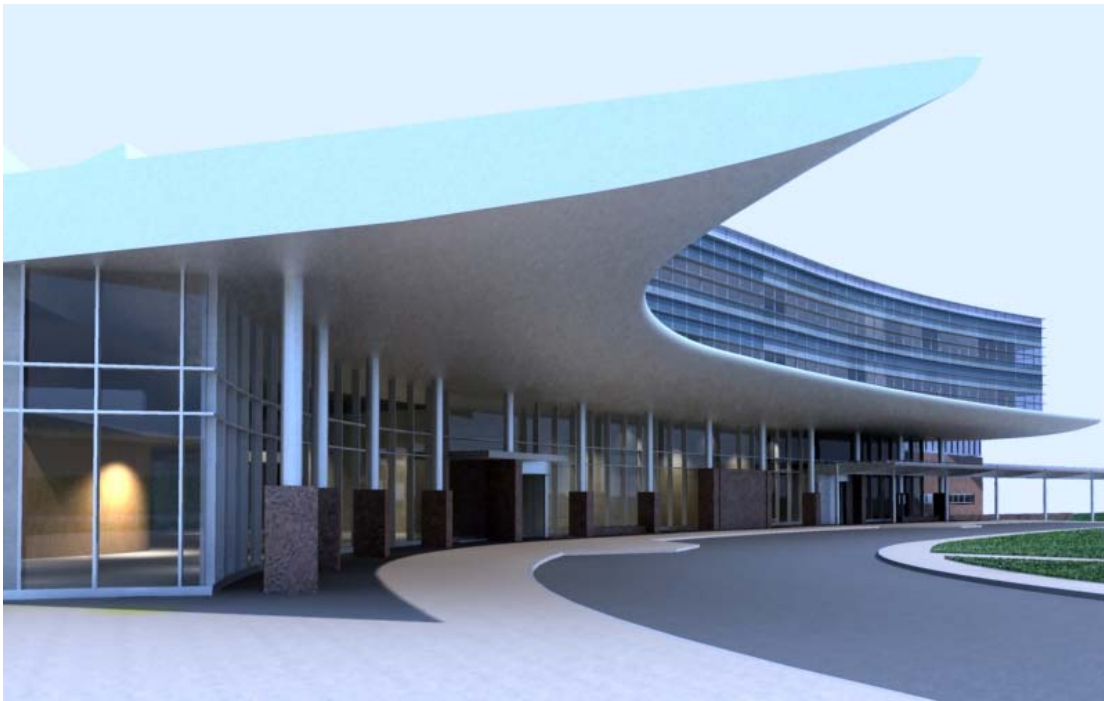


Chris Voros
Construction Management
Faculty Advisor: Dr. David Riley

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



Technical Assignment 2: Cost and Methods Analysis

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Executive Summary

Cost and Methods Analysis

The following report examines aspects of the Cancer Institute project that are critical to understanding how the project will be executed. Detailed analyses of the project schedule, site layout, and structural, curtainwall, and general conditions estimates provide a look into how PSHMC's plan came together. The findings of this report will be important later on in the research process as any proposed redesign, value engineering, or sequencing changes will impact these project elements.

The detailed project schedule is broken down into logical project phases, including design, early site work and renovation, structure, rough-ins, and finishes. These phases are then further sequenced to show the manner in which the facility will be constructed and how the trades will flow through the floors.

Detailed site plans are ordered to reflect the phasing schedule developed by PSHMC and Gilbane. The first plan shows the early phase of the project, which consists of site improvements and the emergency delivery renovation. The remaining two plans depict the structural phase of construction, which is of particular concern to PSHMC since full shutdowns will occur for every emergency helipad delivery.

Estimates for the structural and curtainwall systems, as well the general conditions, were developed so that comparisons can be made later to any adjusted costs associated with the redesign proposals. The mechanical estimate was produced using the Means Assemblies Estimating Manual, whereas the structural estimate utilizes a square foot method.

Detailed Project Schedule

The PSHMC Cancer Institute project has been broken down into two phases. The early phase, running from mid-August to early-November of 2006, consists of traffic and utility improvements, construction of a new helipad, and the renovation of the Emergency Delivery area. The second phase, consisting of the actual building construction, runs from November 2006 through December 2008. Some of the key milestone dates are listed below. Please see Appendix A for the complete detailed schedule.

Summary Schedule- Milestone Dates

Notice to Proceed- Early Phasing	August 15, 2006
Substantial Completion- Emergency Delivery	November 6, 2006
Notice to Proceed- Full	November 7, 2006
Piles, Foundations, and Underslab Utilities	February 2, 2007
Begin Superstructure	April 27, 2007
Top Out	August 19, 2007
Building Enclosed	November 20, 2007
Owner FF&E	April 1, 2008
Substantial Completion	December 5, 2008
Occupancy	December 8, 2008

Site Layout Planning

Since the Cancer Institute will have a significant impact on the day-to-day activities of the hospital, it was necessary to develop a phased site plan to minimize disruption and provide clear direction to the public when changes occurred. The project is broken down into three phases, with the bulk of construction occurring in the final phase. The following descriptions correlate to the plans contained in Appendix B.

Early Phase- August 2006 through mid-November 2006

The first phase of construction consists of overtaking a portion of Lot 'D' to reconfigure the parking, add a new traffic route, and improve utilities. The majority of the construction is centered on the traffic rerouting, which includes a new drive through Lot 'D' and a reworking of the University Drive turning lane, or the "pork chop" as it is referred to by the project team. The displaced employees will be provided spaces above the parking garage project. The beginning of renovation work for the emergency delivery and canopy was set to begin in September, but has since been moved back considerably due to redesign issues.

Middle Phase- Mid-September 2006 through mid-November 2006

This phase consists of the helipad move and the opening of 50 new spaces reworked in the first phase. During construction of the new helipad, work stoppages will occur whenever an emergency requires landing on the existing drop-off space. Construction will also begin on 75 new spaces in Lot 'D'. The existing emergency delivery route will be maintained throughout the ED renovation process.

Building Phase- December 2006 to December 2008

Upon completion of the site improvements and ED renovation, Lot 'E' will be taken over to begin construction of the Cancer Institute. This is a critical step that will require weeks of notification by the project team to the hospital staff so that they may communicate the issue to students, patients, and visitors. The site plan found in Appendix B depicts the superstructure sequence of the building, where a crane pad will be set at the North elevation of the building. Due to the crane's proximity to the helipad, all work must be halted during emergency helicopter drop-offs. Communication is essential during steel sequencing, as there will be times when only a few minutes notice will be given prior to a drop-off.

Assemblies Estimate

The estimate for the glazed aluminum curtain wall system also includes the adjacent façade materials, such as the limestone cladding, granite walls, and EIFS. The level of detail involved in these connections has proven to be extensive and costly, so the system is currently undergoing a review by the designers. The hope is that the cost can be reduced without any loss to the aesthetics of the overall façade system. A summary estimate is provided below; for the full breakdown, consult Appendix C.

Summary- Curtain Wall, Cladding, and EIFS Systems Estimate (from Appendix C)

Glazed Aluminum Curtain Wall System	\$1,856,588.80
Dimensional Limestone Cladding	\$629,401.60
Granite Wall and Cladding	\$102,212.00
Exterior Insulation and Finish System (EIFS)	\$78,507.52
<i>Total, after adjustment factors</i>	\$3,782,778.99
<i>Actual Project Total</i>	\$5,720,000.00
<i>Difference- Estimate vs. Actual</i>	\$1,937,221.01

The discrepancy between the actual project total and the estimated value exists because the curtain wall system identified in RS Means could not be efficiently matched up to the proposed system. The key difference is in the aluminum mullion size and connection detail, which differs from conventional systems. Also, the assemblies estimate does not differentiate glazing types used because this aspect is not clarified on the drawings. The curtain wall system will use both tempered and fritted glass, the latter of which is considerably more expensive. RS Means does not specify the cost of fritted glass, so the cheaper tempered glass had to be assumed for the entire system.

Detailed Structural Estimate

The structural estimate uses a comprehensive analysis of the concrete foundations and elevated slabs, and a bay method for extrapolation of the steel framework. Due to the variance in the foundation over the footprint, a typical section could not be assumed. The

foundation take-off takes into account the critical elements of the linear accelerator and brachytherapy enclosures, but does not include foundations for the ED renovation, as this is currently being redesigned. For the elevated slabs, only floors three and four are approximately equal, and thus the remaining slabs needed to be examined as well.

For the superstructure, three bays were examined across the North-South span and extrapolated throughout the building. Composite metal decking was calculated through the elevated slab take-off, and shear studs were approximated for the three bay sections. A summary structural estimate is provided below.

Summary- Detailed Structural Estimate (from Appendix D)

Concrete- Foundations and Elevated Slabs	\$3,177,048.30
Metal Decking and Shear Studs	\$217,681.30
Structural Steel	\$1,622,641.60
Total Cost, Concrete and Steel Packages	\$5,017,371.20

The actual cost of the concrete and steel packages is \$10,150,000. It is evident that the estimating conventions used for the steel take-off do not accurately reflect the scope of work, considering that the steel package is over \$5 million itself. A bay system analysis is not sufficient; rather, a comprehensive analysis must be done for this system as well. The concrete take-off more closely matches the actual package estimate of \$4.5 million, with the discrepancy explained by the absence of the ED renovation work.

General Conditions Estimate

As Gilbane was hired on by PSHMC to handle a number of projects in their expansion plan, the team established a semi-permanent, on-campus trailer complex from which to base their operations. Because of this, a site conditions estimate and reimbursables estimate developed in the contract to forecast costs over the entire 41 months that Gilbane would be on site, through the completion of the Cancer Institute. The general conditions estimate herein reflects on this contract negotiation to accurately portray any one-time

fees, such as trailer mobilization and equipment costs. Though a 41-month schedule is used for these estimates, the staffing cost estimate shows costs over the duration of the Cancer Institute only, a 27-month schedule. This was done again to depict the manner in which the contract was negotiated for the project. It is important to note that the upcoming Children’s Hospital project will likely employ Gilbane as its construction manager, and consequently this project is not included in the contract negotiation for site conditions or reimbursables.

Summary- General Conditions Estimate (from Appendix E)

Staffing Cost	\$5,150,000
Site Conditions	\$2,079,578
Customary Reimbursables Fee	\$894,300
Total GC Cost	\$8,124,378
<i>Adjusted Total GC Cost, 27 Months</i>	<i>\$7,083,020</i>
<i>Percentage of Total Project Cost (\$82 MM)</i>	<i>8.64%</i>

The average general conditions cost around the industry today is about 10%. With the total Cancer Institute project cost at \$82 million, a GC cost of \$8.2 million would be expected, as shown above under “Total GC Cost.” However, when considering the fact that the Site Conditions and Customary Reimbursables are based on the 41-month schedule, the GC cost for the Cancer Institute project alone drops significantly.

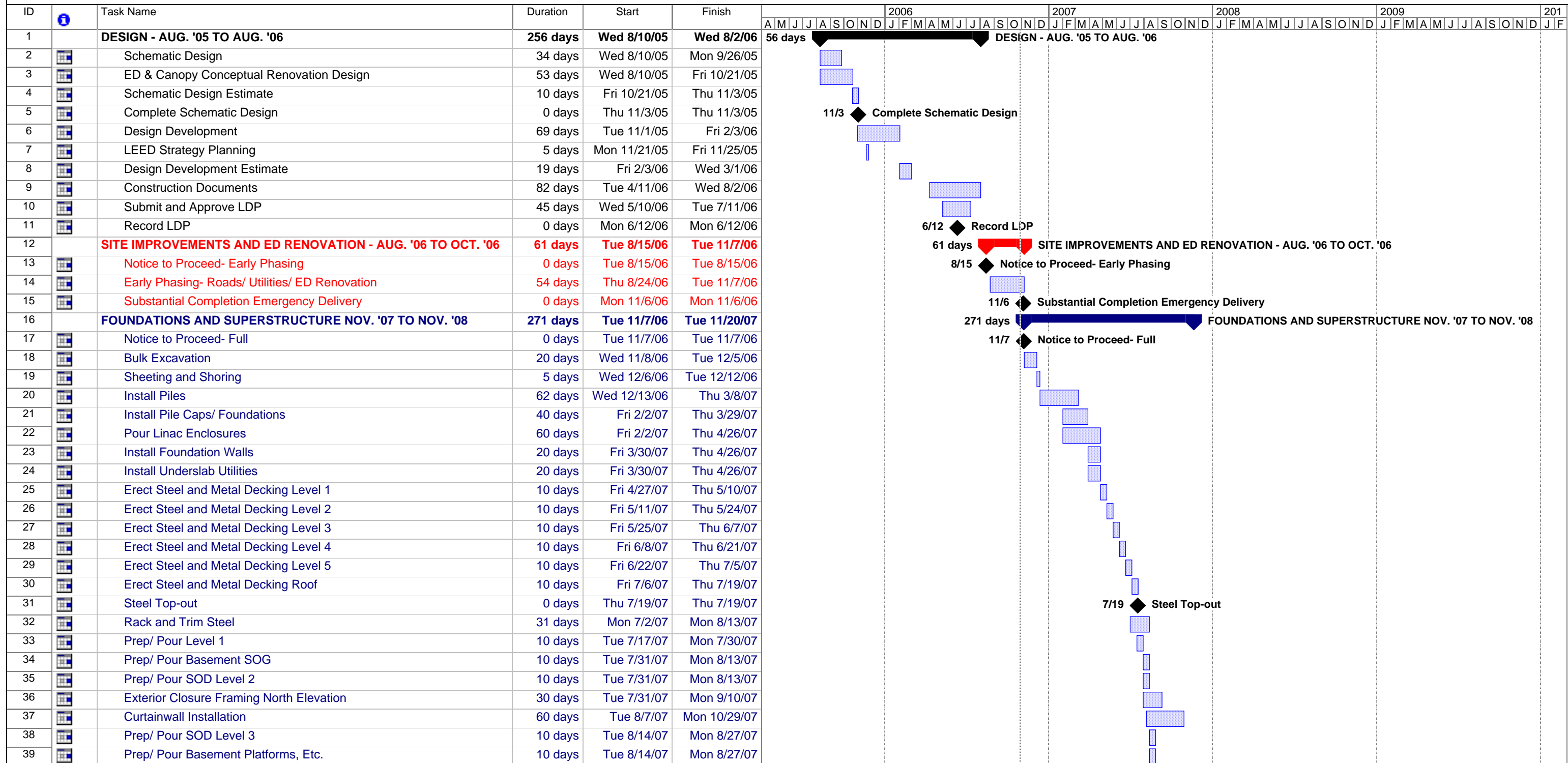
Assuming an equal distribution of these costs over each month, and a project schedule of 27 months, approximately 66% of the cost is appropriated to the Cancer Institute. Multiplying the GC cost by 0.66, the adjusted value totals just above \$7 million. Thus the new percentage of the project cost is 8.6%, just below industry standard. When considering the situation that Gilbane and PSHMC have with the semi-permanent trailer complex and expectations for future work, this is not surprising. Investments made early on in a project create benefits, and savings, in the long run.

Appendix A

Detailed Project Schedule

Penn State Milton S. Hershey Medical Center

Cancer Institute Project Detailed Construction Schedule



Project: PSHMC Cancer Institute
Date: 10/26/06

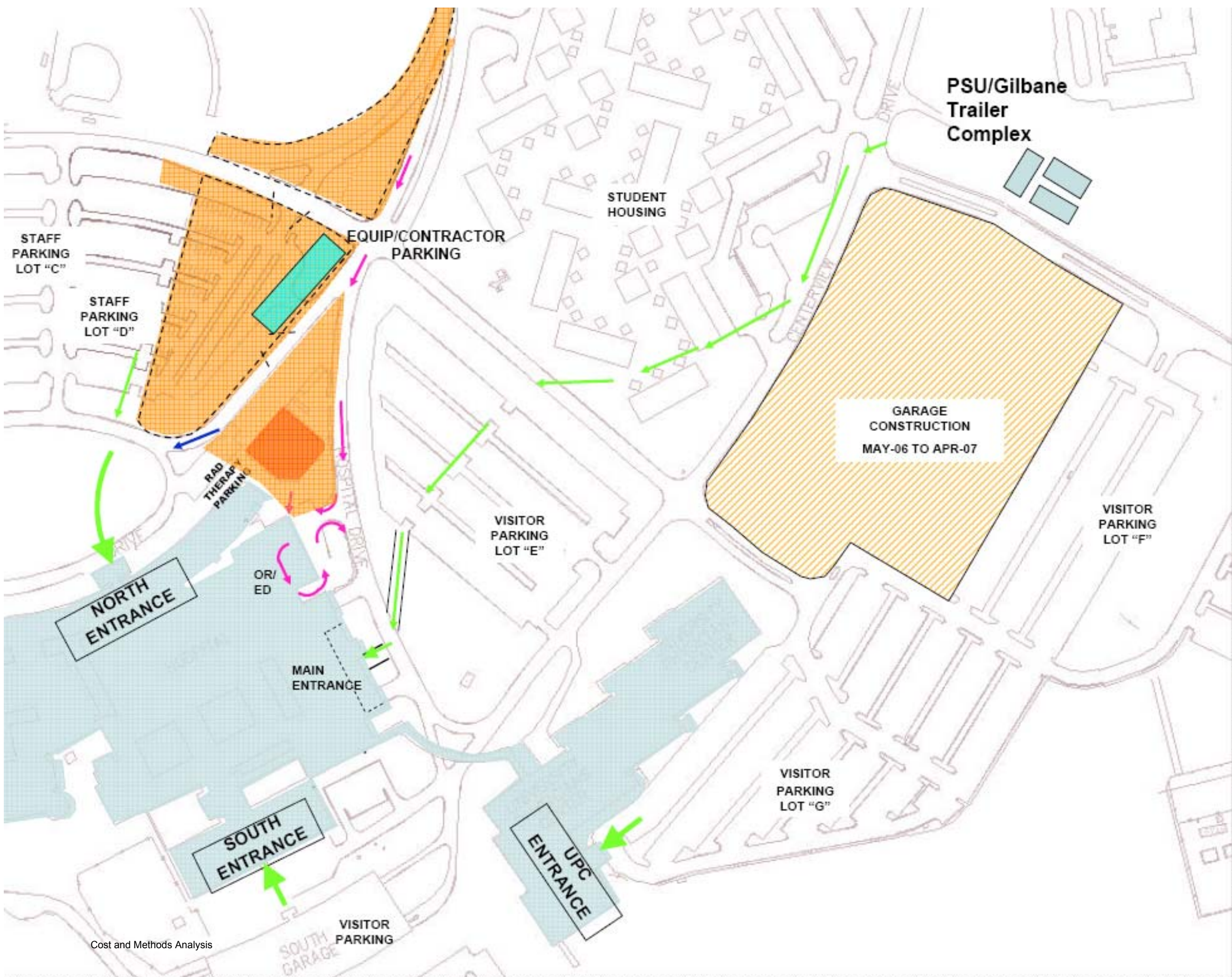
Task: [Blue Box] Milestone: [Black Diamond] Rolled Up Task: [Blue Box] Rolled Up Progress: [Black Arrow] External Tasks: [Grey Box] Group By Summary: [Black Arrow]

Progress: [Black Arrow] Summary: [Black Arrow] Rolled Up Milestone: [White Diamond] Split: [Dotted Line] Project Summary: [Grey Arrow] Deadline: [Green Arrow]

Appendix B







Phased Site Plans

August 2006 through mid-November 2006

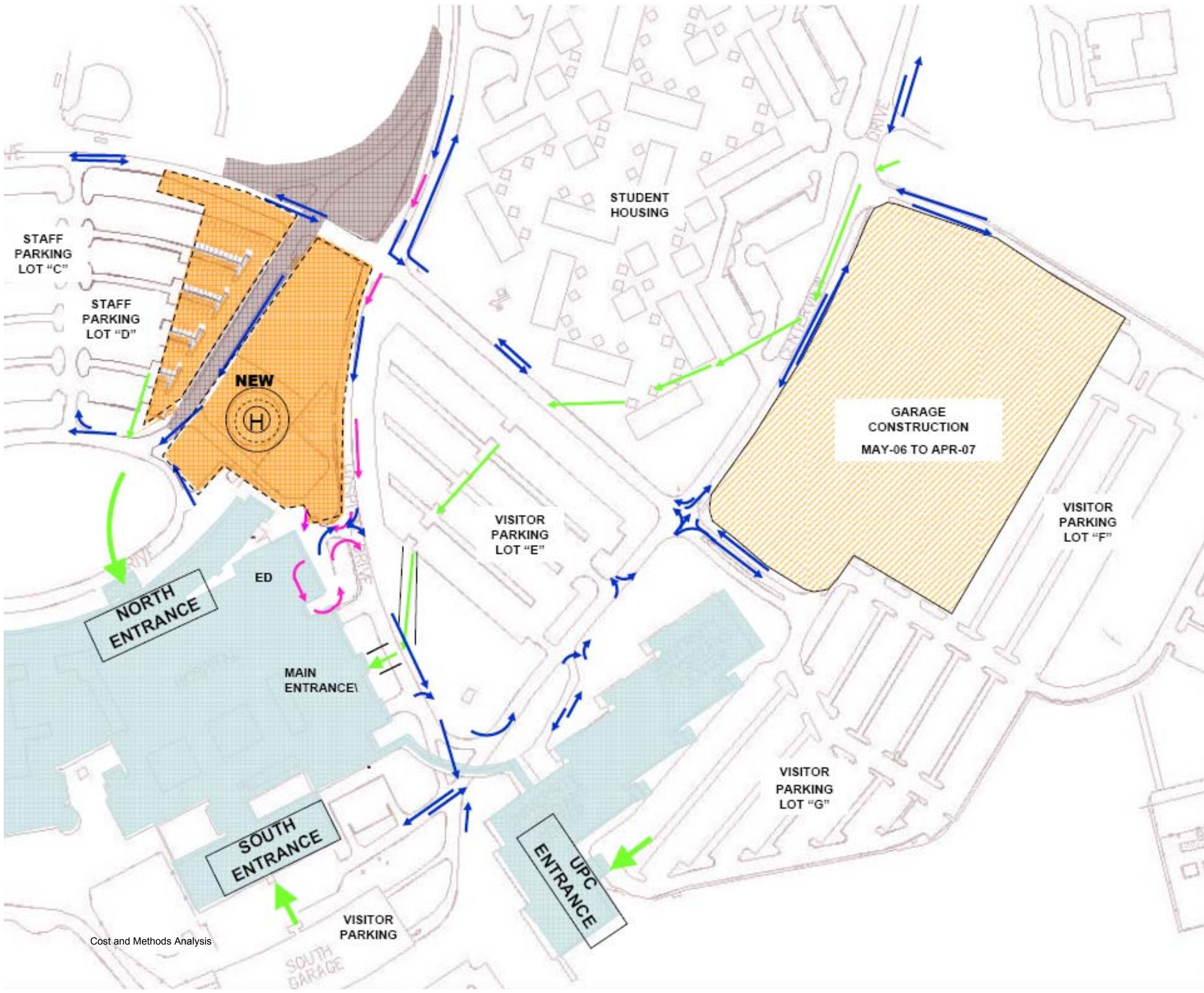


Scope of Work:

- ED Canopy and Entry
- Helipad Relocation
- University Drive Turn Lane Relocation
- Reconfiguration of Lot D







-  Area of Construction
-  Completed Construction
-  Ambulance / Helipad Traffic
-  Student/Pedestrian Traffic
-  Vehicular Traffic
-  Site Fence

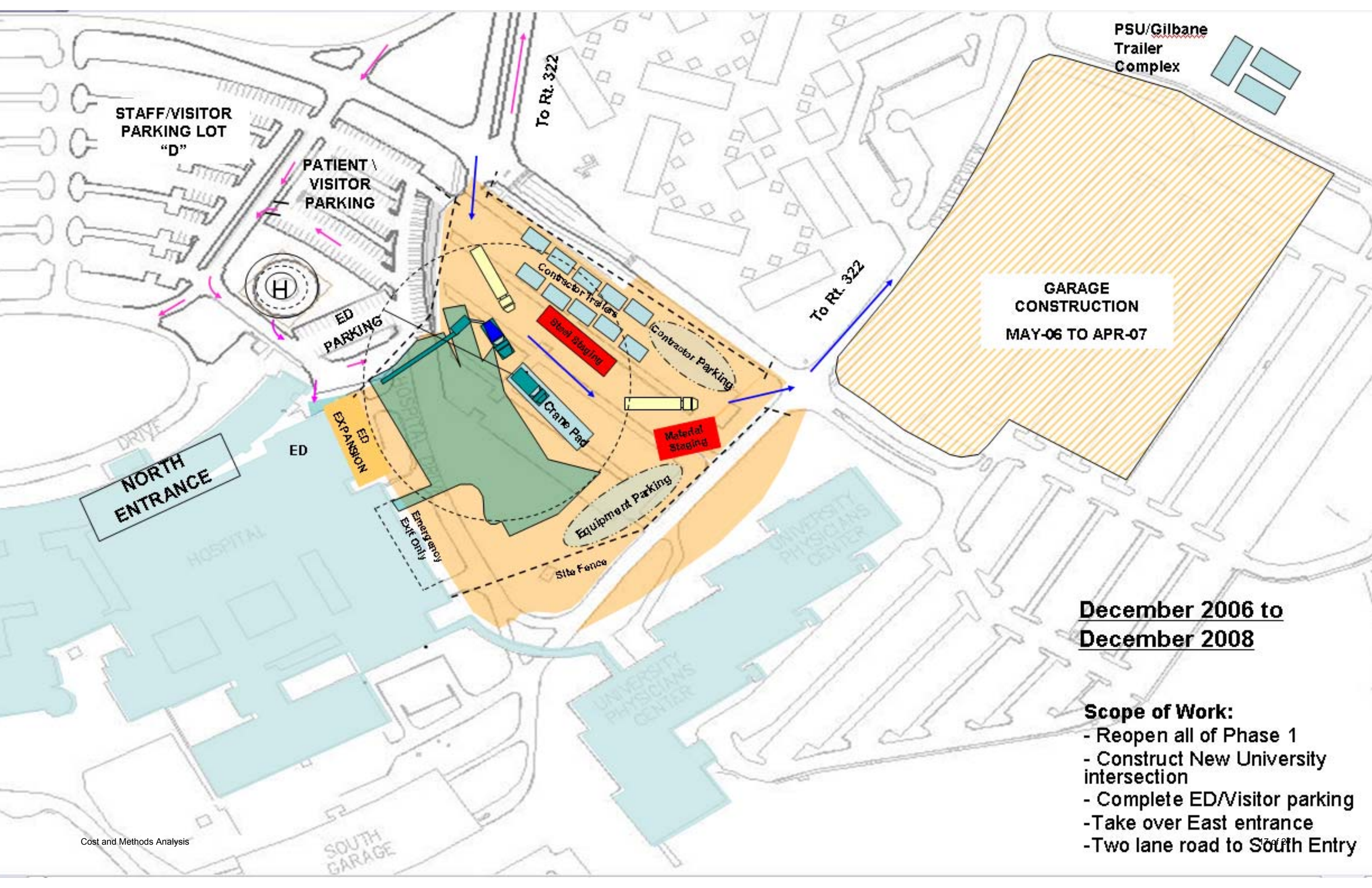
Mid-September through mid-November 2006



Scope of Work:

- Open up Phase 1 (50 spaces back)
- New road to Lot D for parking
- Maintain existing ED roadway
- Maintain existing PT drop-off
- Construct new helipad/ maintain existing
- Construct 75 new parking spaces
- Use existing helipad until new one is constructed; one helipad is open at all times

-  Area of Construction
-  Completed Construction
-  Ambulance / Helipad Traffic
-  Student/Pedestrian Traffic
-  Vehicular Traffic
-  Site Fence



STAFF/VISITOR
PARKING LOT
"D"

PATIENT
VISITOR
PARKING

ED
PARKING

ED
EXPANSION

NORTH
ENTRANCE

ED

Emergency
Exit Only

Equipment
Parking

Site Fence

Contractor Trailers

Steel Staging

Crane Pad

Material
Staging

Contractor
Parking

To Rt. 322

To Rt. 322

PSU/Gilbane
Trailer
Complex

GARAGE
CONSTRUCTION
MAY-06 TO APR-07

**December 2006 to
December 2008**

- Scope of Work:**
- Reopen all of Phase 1
 - Construct New University intersection
 - Complete ED/Visitor parking
 - Take over East entrance
 - Two lane road to South Entry

Appendix C

Assemblies Estimate

ASSEMBLIES ESTIMATE

Glazed Aluminum Curtain Wall, Stone Cladding, and EIFS Façade Systems

Utilizing RS Means Assemblies Cost Data 2001

Glazed Aluminum Curtain Wall and Ribbon Wall, 9/16" insulated glass

A4.7-582-1750: Alum flush tube frame, for insulating glass, 2"x4-1/2", one intermediate horizontal

A4.7-584-2450: Glazing panel, plate glass, 1/2" thick, tempered

	Quantity	Unit	Mat. Cost	Instl. Cost	Total Unit Cost	Total Cost
North Elevation	3856	sf	32.7	23.1	60.8	\$234,444.80
East Elevation	10832	sf	32.7	23.1	60.8	\$658,585.60
West Elevation	8496	sf	32.7	23.1	60.8	\$516,556.80
ED- East Elevation	2980	sf	32.7	23.1	60.8	\$181,184.00
South Elevation	4372	sf	32.7	23.1	60.8	\$265,817.60
Total	30536	sf				\$1,856,588.80

Dimensional Limestone Cladding (7'-0" x 1'-6" x 0'-4" modular brick)

A4.1-242-5450: 4" Thick, Smooth finish, metal stud backup, 8' high, 16" O.C.

	Quantity	Unit	Mat. Cost	Instl. Cost	Total Unit Cost	Total Cost
North Elevation	4792	sf	20	10.4	30.4	\$145,676.80
East Elevation	2552	sf	20	10.4	30.4	\$77,580.80
West Elevation	8880	sf	20	10.4	30.4	\$269,952.00
ED- East Elevation	880	sf	20	10.4	30.4	\$26,752.00
South Elevation	3600	sf	20	10.4	30.4	\$109,440.00
Total	20704	sf				\$629,401.60

Dimensional Granite Cladding (varied modular size)

A4.1-242-7000: 4" Thick, metal stud backup, 8' high, 16" O.C.

	Quantity	Unit	Mat. Cost	Instl. Cost	Total Unit Cost	Total Cost
North Elevation	416	sf	30.5	20	50.5	\$21,008.00
East Elevation	1592	sf	30.5	20	50.5	\$80,396.00
West Elevation	16	sf	30.5	20	50.5	\$808.00
ED- East Elevation	0	sf	30.5	20	50.5	\$0.00
South Elevation	0	sf	30.5	20	50.5	\$0.00
Total	2024	sf				\$102,212.00

Exterior Insulation and Finish System

A4.5-110-5230: Cement board sheathing, 6" metal studs, 16" O.C., 2" EPS

	Quantity	Unit	Mat. Cost	Instl. Cost	Total Unit Cost	Total Cost
North Elevation	0	sf	4.63	8.85	13.48	\$0.00
East Elevation	2624	sf	4.63	8.85	13.48	\$35,371.52
West Elevation	0	sf	4.63	8.85	13.48	\$0.00
ED- East Elevation	0	sf	4.63	8.85	13.48	\$0.00
South Elevation	3200	sf	4.63	8.85	13.48	\$43,136.00
Total	5824	sf				\$78,507.52

Total, Curtain Wall, Stone Cladding, and EIFS Systems \$2,666,709.92

Adjustment, 5 years @6% inflation = 1.06 multiplier 1.42

Adjusted Total \$3,782,778.99

Actual Project Total \$5,720,000.00

Difference, Actual vs. Estimated \$1,937,221.01

Appendix D

Detailed Structural Estimate

Detailed Structural Estimate

CSI Division	Location	Qty. (CY)	Cost/ unit			Total, Including O&P	Total Cost
			Mat.	Labor	Equip.		
Concrete Placement- Form, Reinforce, & Place							
03310-240-4700	Level G, Slab on grade	1258.3	98.00	32.00	0.26	\$159.00	\$200,069.70
03310-240-3960	Footings	187.4	108.00	61.00	0.39	\$214.00	\$40,103.60
03310-240-4500	Walls	1273.6	143.00	139.00	14.90	\$390.00	\$496,704.00
None Available	Linac/Brachy Vaults	1603.3				\$1,000.00	\$1,603,300.00
03310-240-1950	Level 1	442.9	232.00	140.00	14.30	\$490.00	\$217,021.00
	Level 2	385.9	232.00	140.00	14.30	\$490.00	\$189,091.00
	Level 3	364.5	232.00	140.00	14.30	\$490.00	\$178,605.00
	Level 4	364.5	232.00	140.00	14.30	\$490.00	\$178,605.00
	Roof slab	150.1	232.00	140.00	14.30	\$490.00	\$73,549.00
Total, Concrete Placement							\$3,177,048.30

CSI Division	Location	Qty. (CY)	Cost/ unit			Total, Including O&P	Total Cost
			Mat.	Labor	Equip.		
Composite Metal Deck- 20 gage, 2" thick							
05310-300-2200	Level 1	31459.2	1.14	0.25	0.02	\$1.72	\$54,109.82
	Level 2	27419.2	1.14	0.25	0.02	\$1.72	\$47,161.02
	Level 3	25898.7	1.14	0.25	0.02	\$1.72	\$44,545.76
	Level 4	25898.7	1.14	0.25	0.02	\$1.72	\$44,545.76
	Roof Slab	10665	1.14	0.25	0.02	\$1.72	\$18,343.80
05090-840-0900	Shear Studs, typical	4136	0.56	0.69	0.28	\$2.17	\$8,975.12
Total, Composite Metal Deck							\$217,681.30

CSI Division	Location	Qty. (LF)	Cost/ unit			Total, Including O&P	Total Cost
			Mat.	Labor	Equip.		
Structural Steel							
05120-640-2700	Bay 1, W16x26	9512	25.00	2.07	1.33	\$32.50	\$309,140.00
05120-640-3120	W16,45	5084	48.00	2.59	1.66	\$59.50	\$302,498.00
05120-640-3300	Bay 2, W18x35	5368	33.50	3.13	1.46	\$44.00	\$236,192.00
05120-640-0300	W8x10	1848	9.65	3.45	2.21	\$18.95	\$35,019.60
05120-640-5500	W24x76	1364	73.00	2.70	1.27	\$86.50	\$117,986.00
05120-640-1900	Bay 3, W14x22	5304	25.00	2.09	1.34	\$32.50	\$172,380.00
05120-640-3120	W16x45	2108	48.00	2.59	1.66	\$59.50	\$125,426.00
None Available	Col. Lines 2 to 5, W14x193	2880				\$75.00	\$216,000.00
None Available	Col. Lines 1 & 6, W14x370	1440				\$75.00	\$108,000.00
Total, Structural Steel							\$1,622,641.60

Total, Steel and Concrete Packages \$5,017,371.20

Appendix E

General Conditions Estimate

General Conditions Estimate- PSHMC Cancer Institute

Site Conditions				
Item	Quantity	Unit	Cost	Total
Subsistence	126	months	2,800	\$352,800.00
Temporary Toilets	500	months	160	\$80,000.00
Temporary Fencing	1	allowance	40,000	\$40,000.00
Project signs	1	est	5,000	\$5,000.00
Safety (material/ incentives)	1	LS	20,000	\$20,000.00
Progress Photos	41	months	1,000	\$41,000.00
Survey	65	days	2,000	\$130,000.00
Ceremonies				by Owner
Testing	1	LS	50,000	\$50,000.00
Dumpster	500	pulls	700	\$350,000.00
Interim clean-up	1	allowance	300,000	\$300,000.00
Final clean-up	1	allowance	50,000	\$50,000.00
Clean glass	1	allowance	15,000	\$15,000.00
General weather protection	1	LS	100,000	\$100,000.00
Snow removal				by Trades
Small tools/ supplies/ fire extinguisher	1	est	10,000	\$10,000.00
Staff gear/ OSHA	1	est	30,000	\$30,000.00
General/ Excess insurance				
on Gilbane cost only	10000	per thousand	5.95	\$59,500.00
Derry Township taxes (on CM staff)	1	allowance	40,000	\$40,000.00
Auto- job travel	335	trips	400	\$134,000.00
Air- job travel	62	trips	424	\$26,288.00
Vehicles (with fuel/ maintenance)				
Project Executive	39	months	1,090	\$42,510.00
Project Superintendent	20	months	1,090	\$21,800.00
Project Superintendent	27	months	1,090	\$29,430.00
Project Engineer	21	months	1,090	\$22,890.00
Assistant Site Manager	4	months	1,090	\$4,360.00
Bid Documents printing allowance	1	allow	75,000	\$75,000.00
Blueprinting shop drawing allowance	1	LS	50,000	\$50,000.00
Record Document printing				In bluprinting
Total				\$2,079,578.00
Note: Temporary utilities are covered by the owner. There are no subtier costs to Gilbane.				

Customary Reimbursables Fee				
Item	Quantity	Unit	Cost	Total
Partnering Sessions	9	est	5,000	\$45,000.00
Cell Phones (10)	41	months	2,000	\$82,000.00
Field Office- setup, demobilize	1	est	40,000	\$40,000.00
Rental	41	months	4,000	\$164,000.00
Sanitary Connection	1	est	10,000	\$10,000.00
Electrical Connection	1	est	10,000	\$10,000.00
Furniture	16	stations	1,500	\$24,000.00
Janitorial	41	months	500	\$20,500.00
Stationary/ Supplies	41	months	1,500	\$61,500.00
Postage/ Overnight delivery	41	months	1,500	\$61,500.00
Fax Machine	2	each	400	\$800.00
Supplies/ Monthly usage	41	months	200	\$8,200.00
Telephones	20	stations	1,000	\$20,000.00
Monthly usage	41	months	2,000	\$82,000.00
Radios	10	each	800	\$8,000.00
Monthly usage				in telephone
Digital Camera	1	each	800	\$800.00
Laptop Computer	6	each	3,000	\$18,000.00
Desktop Computer	6	each	3,000	\$18,000.00
Internet Service	1	each	20,000	\$20,000.00
Printer	3	each	1,750	\$5,250.00
Primavera Software	1	each	7,000	\$7,000.00
Prolog Manager	3	each	300	\$900.00
License	41	months	300	\$12,300.00
T1 Line monthly usage	41	months	650	\$26,650.00
Water	41	months	400	\$16,400.00
Temporary Secretary	8	weeks	1,000	\$8,000.00
First Aid	1	LS	5,000	\$5,000.00
Copier Lease	41	months	1,500	\$61,500.00
Record Storage	200	est	80	\$16,000.00
Petty Cash/ Meeting	41	months	1,000	\$41,000.00
Total				\$894,300.00

Gilbane Building Company- On-site Staff			
	Hours by Position	Total Hours	Cost
Project Executive	6,435		
Senior Project Manager	7,095		
Senior Project Engineer	7,095		
Project Engineer	5,115		
Field Engineer	3,300		
Office Engineer, Site Wide	4,960		
General Superintendent	4,455		
MEP Superintendent	3,465		
Superintendent	3,465		
Administrative Assistant	6,600		
Accountant	6,600		
Interns	1,980		
Subtotal		60,565	\$5,150,000.00

The Staffing compensation is based on actual hours worked, multiplied by hourly billing rates. The hourly billing rates are equal to base compensation of the individual multiplied by 1.97. Gilbane organizes their staffing cost breakdown in this manner to allow for any training required on the job.

Staffing Cost	\$5,150,000
Site Conditions	\$2,079,578
Customary Reimbursables Fee	\$894,300
Total GC Cost	\$8,124,378
Adjusted Total GC Cost, 27 Months	\$7,083,020
Percentage of Total Project Cost (\$82 MM)	8.64%

Note: Adjusted GC cost determined by the following formula-

$$\begin{aligned} \text{Adjusted Total GC Cost} &= \text{Total GC Cost} * (27 \text{ mo.} / 41 \text{ mo.}) \\ &= 8,124,378 * (0.66) = \$7,083,020 \end{aligned}$$