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Construction Management Option

Technical Assignment 2
Cost and Methods Analysis

The Pennsylvania State University
Health and Counseling Services Building
University Park, Pennsylvania

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Appendix

Executive Summary

Technical Assignment 2, Cost and Methods Analysis, is a detailed analysis of Health and Counseling Services related to project execution. Information gathered in this analysis will be used in future research involving scheduling, cost savings, and site planning. Information for this assignment was gathered through actual project information, estimating software, and extrapolations of information obtained from industry contacts. This report includes a detailed project schedule, critical phase site layout plan, assemblies estimate of the exterior envelope, detailed structural estimate, and a general conditions estimate of the Health and Counseling Services Building.

The detailed schedule shows all major portions of the project broken down into specific trades or grouping of trades where possible. The critical phase of construction chosen for the site layout planning is the steel erection sequence, specifically the location of the mobile crane. Health Services has a glass curtain wall, brick veneer cavity wall, and metal panels encompassing the majority of the exterior envelope. An assemblies estimate of these systems is estimated from the drawings. Two bays of the building were chosen as a representation of typical construction throughout all floors of the building and were extrapolated to give the entire structural systems cost. Finally, a general conditions estimate is included to show how changes to the schedule can affect the final project cost.

Site Layout Planning

The steel erection phase of construction was chosen to show the limited locations for the crane to be located on the site, potential locations for congestion of vehicular traffic, and where miscellaneous construction facilities will be located. A detailed look at the steel erection site plan can be viewed in Appendix A.

Sit e Trailer

The most important part of the site layout is the location of Whiting-Turner's job site trailer. Penn State has given the construction manager permission to utilize a section of one of the tennis courts below the roller hockey rinks to the South. Due to this condition, there is more room for staging areas and construction traffic within the original site boundaries.

Traffic Flow

Traffic flow during the erection phase will be critical for the crane and delivery trucks to move without impeding one another. There is only one access point for construction traffic on the East side of the site off of Bigler road. Bigler road is congested on a daily basis with the high amount of student and faculty traffic. Also, CATA, the center county public transit system, uses this road as a main route to College Avenue. The ability to turn truck around within the site will be critical to keep congestion to a minimum and to keep the client pleased.

Crane Locations

The crane locations are based on a 100-foot radius of the boom. Actual crane size and loading details are not available for comparison. With a 100 foot radius it was determined that at a minimum 3 locations are needed to construct the steel frame. The most difficult of these locations is on the North side of the lot. At this location, there is minimal space due to the neighboring Bank of America Career Center and the sidewalks that will still be in use of pedestrians. Proper precautions will need to be put into place to protect anyone that could potentially be injured. This can be accomplished by having good communication between the ground crew and operator. At any time the crane's swing would go over the boundaries of the lot, extra care must be taken to make sure that

pedestrians are stopped, especially around the traffic heavy Bank of America Career Center.

Dumpsters

Dumpster locations are also a critical portion of the site layout. During the steel erection phase, they will be moved away from the building to allow the structure to be constructed. During the interior construction phase they will become more critical due to the LEED requirements on the project. Separate dumpsters for different materials will begin to be a problem due to space limitations on the site. To alleviate this potential problem, the construction manager will have to update their schedule regularly and know what materials will be discarded daily so that they have the right number of dumpsters and pulls scheduled.

Detailed Project Schedule

Health and Counseling Services will be constructed October 1, 2006 through May 31, 2008. The schedule focuses on the construction phases of the project and does not include the design.

Key Milestones

Steel construction starts on January 8, 2007. This date is a potential problem for the schedule due to the timing and delivery of the mill order. Penn State's, Chad Spackman, will be monitoring this date closely to judge the remainder of the schedule. If typical sized steel is used instead of what is shown in the drawings, this date would become less critical.

The building is scheduled to be watertight on August 31, 2007 after 11 months of construction. Completing this milestone is important due to the critical path, but also to avoid the upcoming fall and winter seasons that usually have bad weather.

Construction phases are organized by the following sequences

- Foundation and Superstructure
- Partition Layout
- Exterior Skin

- Mechanical and Plumbing Rough- In
- Doors Frames and Hardware
- Electrical Rough- In
- Elevators
- Finish Phases

While the limitations of the assignment did not allow for the full 400 line item schedule to be displayed, a condensed version shows all major activities and their durations over the course of the project. Durations were obtained from Whiting-Turner through Penn State's Office of Physical Plant. Microsoft Project software was used to construct the schedule. The schedule can be viewed in Appendix B.

Assemblies Estimate

The assemblies estimate focuses on the exterior envelope of the building. After reviewing the drawings, the envelope consists of glass curtain walls, brick face insulated cavity walls, and metal panels. The envelope estimate was approximately $800,000.00, which is 4.5% of the $18,000,000.00 price of construction. A summary of this estimate is shown in Figure 1.

Exterior Envelope Summary

Item	Amount
Brick Face Cavity Wall	$348,976.88
Metal Siding Panels	$24,254.58
Metal Siding Support	$17,368.56
Curtain Wall System	$427,343.50
Total	**$817,943.52**

Figure 1. Summary of Exterior Envelope

Costworks 2005 software was used for all data shown within the estimate. At this time, a comparison cannot be made between this estimate and the contracted price due to incomplete bids. Bids for the masonry and curtain wall system were received on October

23, 2006 and are under review and subject to approval through Physical Plant. The complete assemblies estimate is in Appendix C.

Detailed Structural Estimate

Bay D-E, 1-2 and 2-3 were chosen as the basis of the structural system estimate by the aforementioned column lines. As the two most typical bays in the structure, they were extrapolated throughout the building to create a complete estimate. Bay D-E, 1-2 is 28'X29' with a total square footage of 812 square feet. Bay D-E, 2-3 is 29'X15' with a total square footage of 415 square feet. Situations where one of the bays did not fit exactly were evaluated and assumed to be of the closest size to an estimated bay.

This detailed analysis includes concrete, concrete placement, rebar, anchor bolts, welded wire fabric, structural steel, and galvanized deck. The final estimate was $2,150,048.69. Comparing the total cost of the structural estimate to the total project cost shows that the structural package is 11.8% of the total project cost. A summary breakdown is shown in Figure 2.

Structural Summary

Item	Amount
Concrete	$122,668.08
Concrete Accessories	$18593.79
Concrete Formwork	$68,874.80
Structural Steel	$1,830,992.75
Structural Steel Accessories	$6,536.00
Sub-Total	**$2,047,665.42**
Markup	**$102,383.27**
Total	**$2,150,048.69**

Figure 2. Detailed Structural Estimate Summary

The actual cost of the structural steel for Health and Counseling Services is $1,703,220.00. Comparing this to the estimated price of $1,837,528.75, it can be seen that the 2 Bays chosen as a representation of the structure were appropriate. A more detailed analysis of the structural system is in Appendix D.

General Conditions Estimate

A general conditions estimate was developed through the use of Costworks 2005 estimating software and Whiting-Turner supplied numbers. The general conditions estimate is approximately $2,379,000.00. A comparison cannot be made between this estimate and the actual general conditions due to the confidentiality required of Whiting-Turner. Future research will be able to reference this estimate for potential cost impacts due to schedule delays or accelerations.

LEED Rating

Since the structure will be LEED rated, extra line items were required inside the general conditions. The amount of dumpsters that will be required for recycling will be much higher than a traditionally built structure therefore this increased price has been added. Other LEED items include an erosion control plan, indoor air quality plan, silt fencing, and a LEED consultant as part of the general conditions.

Project Staffing

Project staffing includes a senior project manager working, project manager, assistant project manager, project engineer, MEP engineer, superintendent, field carpenter, and clerical assistant. The duration that each will spend on Health Services is available in the Appendix attached estimate. The detailed general conditions estimate is available in Appendix E.

Appendix

Appendix A

Detailed Project Schedule

Appendix B

Site Layout Planning

Appendix C

Assemblies Estimate

The Pennsylvania State University

Health and Counseling Services Building

Exterior Envelope Assemblies Estimate

CSI #	Description	Unit	Price/S.F.	Quantity	Total
B2010 135 5140	Brick Face Cavity Wall-Insulated Backup, Standard, 8" Block Backup	S.F.	20.85	16737.5	$348,976.88
B2010 146 3450	Metal Siding Panels, 20 Gauge, Galvanized, Colored	S.F.	5.53	4386	$24,254.58
B2010 154 5000	Metal Siding Support, Wind Load 20 psf, Column Spacing 30'	S.F.	3.96	4386	$17,368.56
B2020 220 2500	Curtain Wall System, 1/2" Thick, Tinted	S.F.	32.35	13210	$427,343.50
				Total	**$817,943.52**

Appendix D

Detailed Structural Systems Estimate

The Pennsylvania State University

Health and Counseling Services Building

Detailed Structural Estimate

1st Floor/ Foundation Concrete

CSI #	Description	Quantity	Unit	Cost	Total
033100-200	S.O.G. Concrete- 3000 psi, 5 inch	197.33	C.Y.	$89.00	$17,562.37
033100-200	Grade Beams	150.36	C.Y.	$89.00	$13,382.04
033100-200	Pile Caps	156.02	C.Y.	$89.00	$767.34
033100-200	Piers	29.03	C.Y.	$89.00	$2,583.67
				Total:	**$34,295.42**

Elevated Slab Concrete

CSI #	Description	Quantity	Unit	Cost	Total
033100-200	2nd Floor Elevated Slabs	128.32	C.Y.	$89.00	$11,420.48
033100-200	3rd Floor Elevated Slabs	123.96	C.Y.	$89.00	$11,032.44
033100-200	4th Floor Elevated Slabs	123.96	C.Y.	$89.00	$11,032.44
033100-200	5th Floor Elevated Slabs	123.96	C.Y.	$89.00	$11,032.44
033100-200	Main Roof\Penthouse	98.23	C.Y.	$89.00	$8,742.47
				Total:	**$53,260.27**

Placing Concrete- Pumped

CSI #	Description	Quantity	Unit	Cost	Total
033100-700	Grade Beams	150.36	C.Y.	$77.40	$11,637.86
033100-700	S.O.G.	197.33	C.Y.	$24.00	$4,735.92
033100-	Piers	29.03	C.Y.	$28.50	$827.36

700					
033100-700	Pile Caps	156.02	C.Y.	$28.50	$4,446.57
033100-700	Elevated Slab- 2nd Floor	128.32	C.Y.	$22.50	$2,887.20
033100-700	Elevated Slab- 3rd Floor	123.96	C.Y.	$22.50	$2,789.10
033100-700	Elevated Slab- 4th Floor	123.96	C.Y.	$22.50	$2,789.10
033100-700	Elevated Slab- 5th Floor	123.96	C.Y.	$22.50	$2,789.10
033100-700	Elevated Slab- Main Roof/ Penthouse	98.23	C.Y.	$22.50	$2,210.18
				Total:	**$35,112.39**

Concrete Formwork

CSI #	Description	Quantity	Unit	Cost	Total
033100-435	Grade Beam Forms	11520	S.F.C.A.	4.69	$54,028.80
033100-655	Edge Forms	4000	S.F.C.A.	2.98	$11,920.00
033100-655	Curb Forms	380	S.F.C.A.	7.7	$2,926.00
				Total:	**$68,874.80**

Concrete Accessories

CSI #	Description	Quantity	Unit	Cost	Total
03210-600	Grade Beam Reinforcement	4.26	Tons	$2,025.00	$1,437.75
03210-600	Pier Reinforcement	2.7	Tons	$2,500.00	$6,750.00
03210-600	Pile Cap Reinforcement	2.2	Tons	$2,500.00	$5,500.00
03210-600	Pile Cap Reinforcement	0.5	Tons	$2,500.00	$1,250.00
03220-200	6X6-W2.1X2.1 WWF- S.O.G.	12789	C.S.F.	$60.00	$767.34
03220-200	6X6-W1.4X1.4 WWF- 2nd Floor	12789	C.S.F.	$49.50	$633.06
03220-200	6X6-W1.4X1.4 WWF- 3rd Floor	12354	C.S.F.	$49.50	$611.52
03220-200	6X6-W1.4X1.4 WWF- 4th Floor	12354	C.S.F.	$49.50	$611.52
03220-200	6X6-W1.4X1.4 WWF- 5th Floor	12354	C.S.F.	$49.50	$611.52
03220-200	6X6-W1.4X1.4 WWF- Main Roof/ Pent.	7018	C.S.F.	$49.50	$421.08
				Total:	**$18,593.79**

Structural Steel Accessories

CSI #	Description	Quantity	Unit	Cost	Total
05090-080	3/4 " Diameter ,8" Long	304	Ea.	$21.50	$6,536.00
				Total:	**$6,536.00**

Structural Steel Members- 1st Floor

CSI #	Description	Quantity	Unit	Cost	Total
05120-640	W14X99	240	L.F.	$94.50	$22,680.00
05120-640	W14X82	240	L.F.	$94.50	$22,680.00
05120-640	W14X159	1536	L.F.	$123.00	$188,928.00
05120-640	W14X48	224	L.F.	$79.00	$17,696.00
				Total:	**$251,984.00**

Structural Steel Members- 2nd Floor

CSI #	Description	Quantity	Unit	Cost	Total
05120-640	W18X40	453	L.F.	$46.50	$21,064.50
05120-640	W16X26	1555	L.F.	$31.00	$48,205.00
05120-640	W24X76	551	L.F.	$80.00	$44,080.00
05120-640	W21X57	336	L.F.	$67.00	$22,512.00
05120-640	W21X44	336	L.F.	$49.50	$16,632.00
05120-640	W12X14	168	L.F.	$20.00	$3,360.00
				Total:	**$155,853.50**

Structural Steel Members- 3rd Floor

CSI #	Description	Quantity	Unit	Cost	Total
05120-640	W27X84	348	L.F.	$87.50	$30,450.00
05120-640	W16X26	1392	L.F.	$31.00	$43,152.00
05120-640	W24X68	348	L.F.	$72.50	$25,230.00
05120-640	W21X44	672	L.F.	$49.50	$33,264.00
05120-640	W12X14	168	L.F.	$20.00	$3,360.00
05120-640	W14X53	288	L.F.	$48.50	$13,968.00
05120-640	W14X90	288	L.F.	$94.50	$27,216.00
05120-640	W18X35	90	L.F.	$41.50	$3,735.00
05120-640	W24X76	174	L.F.	$80.00	$13,920.00
				Total:	**$194,295.00**

Structural Steel Members-4th Floor

CSI #	Description	Quantity	Unit	Cost	Total
05120-640	W27X84	348	L.F.	$87.50	$30,450.00
05120-640	W16X26	1392	L.F.	$31.00	$43,152.00
05120-640	W24X68	348	L.F.	$72.50	$25,230.00
05120-640	W21X44	672	L.F.	$49.50	$33,264.00

05120-640	W12X14	168	L.F.	$20.00	$3,360.00
05120-640	W14X53	288	L.F.	$48.50	$13,968.00
05120-640	W14X90	288	L.F.	$94.50	$27,216.00
05120-640	W14X145	624	L.F.	$123.00	$76,752.00
05120-640	W14X109	660	L.F.	$123.00	$81,180.00
05120-640	W18X35	90	L.F.	$41.50	$3,735.00
05120-640	W24X76	174	L.F.	$80.00	$13,920.00
05120-640	W14X43	228	L.F.	$48.50	$11,058.00
05120-640	W14X48	228	L.F.	$48.50	$11,058.00
				Total:	**$374,343.00**

Structural Steel Members- 5th Floor

CSI #	Description	Quantity	Unit	Cost	Total
05120-640	W24X62	348	L.F.	$66.50	$23,142.00
05120-640	W16X36	696	L.F.	$45.50	$31,668.00
05120-640	W24X55	348	L.F.	$59.50	$20,706.00
05120-640	W21X62	522	L.F.	$67.00	$34,974.00
05120-640	W24X76	672	L.F.	$80.00	$53,760.00
05120-640	W12X14	1687	L.F.	$20.00	$3,360.00
05120-640	W16X26	438	L.F.	$31.00	$13,578.00
05120-640	W18X35	90	L.F.	$41.50	$3,735.00
				Total:	**$184,923.00**

Structural Steel Members- Main Roof/ Penthouse

CSI #	Description	Quantity	Unit	Cost	Total
05120-640	W24X76	319	L.F.	$80.00	$25,520.00
05120-640	W18X35	638	L.F.	$41.50	$26,477.00
05120-640	W12X14	385	L.F.	$20.00	$7,700.00
05120-640	W18X50	319	L.F.	$56.50	$18,023.50
05120-640	W18X40	319	L.F.	$46.50	$14,833.50
05120-640	W24X84	165	L.F.	$88.00	$14,520.00
05120-640	W27X84	165	L.F.	$87.50	$14,437.50
				Total:	**$121,511.50**

Structural Steel Members- Penthouse Roof

CSI #	Description	Quantity	Unit	Cost	Total
05120-640	W14X22	319	L.F.	$31.00	$9,889.00
05120-640	W8X24	175	L.F.	$33.50	$5,862.50
				Total:	**$15,751.50**

Structural Steel- Galvanized Deck

CSI #	Description	Quantity	Unit	Cost	Total
053100-300	2nd Floor- 2" Deep, 20 Gauge	12789	S.F.	$8.25	$105,509.25
053100-300	3rd Floor- 2" Deep, 20 Gauge	12354	S.F.	$8.25	$101,920.50
053100-300	4th Floor- 2" Deep, 20 Gauge	12354	S.F.	$8.25	$101,920.50
053100-300	5th Floor- 2" Deep, 20 Gauge	12354	S.F.	$8.25	$101,920.50
053100-300	Main Roof/Pent.-3" Deep, 20 Gauge	7018	S.F.	$9.00	$63,162.00
053100-300	Pemt. Roof- 1 1/2", 20 Gauge	7018	S.F.	$8.25	$57,898.50
		Total:			**$532,331.25**
		Subtotal:			**$2,047,665.42**
		Markup (5%):			**$102,383.27**
		Total:			**$2,150,048.69**

Assumptions/ Qualifications:

1. All material, labor, and equipment costs are taken from Costworks, Copyright 2005
2. 8 Hour Day/ 40 Hour Work Week
3. Union Wages will be used on this project
4. If the size of structural member is not available the closest size was assumed to be of comparable price in Costworks
5. Bay D-E, 1-2 and Bay D-E, 2-3 are assumed to be typical and are the basis of the overall estimate by extrapolation
6. A 6 foot depth was used as the average depth of each pier

Appendix E

General Conditions Estimate

The Pennsylvania State University

Health and Counseling Services Building

General Conditions Estimate

DESCRIPTION	UNIT	QUANTITY	UNIT COST	AMOUNT
Small Tools & Equipment	LS	1		$50,000.00
Misc. Supplies	MO	16	$150.00	$2,400.00
Computer equipment	MO	16	$250.00	$4,000.00
Office Equipment/Fax/Copier	LS	1		$10,000.00
Service & Supplies	MO	16	$150.00	$2,400.00
Network Equipment	LS	1		$1,000.00
Network Service	MO	16	$150.00	$2,400.00
Drawings & Specifications	MO	16	$200.00	$3,200.00
Postage & Shipping	MO	16	$150.00	$2,400.00
Misc. Yard Charges	LS	1		$15,000.00
Sanitary Facilities	MO	16	$100.00	$3,200.00
Drinking Water	MO	16	$100.00	$1,600.00
Radios (two-way)	MO	16	$100.00	$1,600.00
Progress Photos	MO	16	$1,553.00	$24,484.00
Field Office Set Up, In & Out	LS	1		$2,000.00
Field Offices				
W/T	MO	16	$1,200.00	$19,200.00
PSU	MO	16	$1,200.00	$19,200.00
Storage Trailers	MO	16	$82.00	$1,312.00
Telephone Service and Equipment	LS	1		$5,000.00
Telephone Charges	MO	16	$250.00	$4,000.00
Temporary Electric service	LS	1		$263,500.00
Miscellaneous Travel	MO	16	$5,000.00	$80,000.00
Layout/Survey(Bldg.)	LS	1		$100,000.00
Temporary Fencing	LF	700	$5.00	$3,500.00
Fencing Relocations	LS	1		$1,500.00
Gates	EA	2	$400.00	$800.00
Silt Fence				
Super Silt	LF	350	$10.00	$3,500.00
Normal	LF	350	$7.00	$2,450.00
Indoor Air Quality Control	LS	1		$100,000.00
Erosion Control Plan	LS	1		$50,000.00
Wash Racks	EA	2	$200.00	$400.00

Project Signs	EA	3	$50.00	$150.00
Site Maintenance	MO	16	$2,000.00	$32,000.00
Safety / Temp. Partitions	ALL	18	$250.00	$4,500.00
Start-Up / Commissioning	LS	0.75%		$135,750.00
Misc Trucking/Equipment	LS	1		$15,000.00
Dumpsters	MO	16	$8,000.00	$128,000.00
Trash chutes	MO	12	$600.00	$7,200.00
Daily Clean-Up	MO	16	$2,185.00	$34,960.00
Final Clean-up	SF	66,000	$1.72	$108,600.00
Cold Weather Protection	MO	5	$20,261.00	$101,305.00
Temp Heat in Building	MO	5	$19,000.00	$95,000.00
Snow Removal	LS	1		$5,000.00
Equipment Rental	LS	0		$30,000.00
Field Carpenter	MO	16	$4,800.00	$76,800.00
Senior Project Manager	WK	16	$2,700.00	$43,200.00
Project Manager	WK	64	$2,375.00	$152,000.00
Assistant Project Manager	WK	64	$2,100.00	$134,400.00
Project Engineer	WK	64	$1,675.00	$107,200.00
MEP Engineer	WK	32	$1,675.00	$53,600.00
Superintendent	WK	64	$2,175.00	$139,200.00
LEED Consultant	LS	1		$20,000.00
Clerical	WK	64	$470.00	$30,080.00
Liability Insurance (NON OCIP)	LS	0.80%		$144,800.00
GENERAL CONDITIONS TOTAL:				**$2,378,791.00**