Student Life Building

Technical Report 2

Northampton Community College

Tannersville, Pa

Kendall Slivka

Construction Management

Faculty Advisor; Dr Robert Leicht

Executive Summary

The Student Life Building of Northampton County Community College's new Monroe Campus officially broke ground in spring '12. The site was laid out in early May, erosion control was created and by the end of the month excavation had began. Throughout the summer the 72 acre site was being prepared for its 3 new buildings. Access roads and staging areas were created to bring in materials and equipment. Temporary facilities were also brought onto site for the project team. Utility poles and power finally arrived in late June. Construction of the building itself didn't begin until July 27 when the building pad was placed. Since the building pad has been placed, progress has been continuous. Currently, underground MEP is being roughed-in. The slab on grade and structural steel are scheduled to be completed by the New Year. Building finishes will begin with some stairs in late December, and interior partitions will begin placement in early February. The building will be completed and turned over to the owner on…

The final product could not come together so well without a thorough design phase. During the design phase multiple estimates were created to budget the College's funds and to ensure they could receive the most, and best building for their money. In order to understand the budget's created, a detailed structural systems estimate has been quantified to compare with the owner's existing one. The detailed estimate includes footings, slab on grade, structural steel and accessories. A general conditions estimate was also formed to understand the expenses of working onsite. The general conditions estimate includes estimated costs for temporary offices, and power, equipment, and the cost of the Construction Management staff.

Building Information Modeling and its uses are currently an area of much attention in the construction industry. Companies are putting large amounts of time and money into developing strong BIM departments to aid with marketing, coordination and the actual construction process. It may seem overwhelming to enter the world, but with a development and implementation plan, the process could go very smoothly. However, this is still the construction industry and there are events that happen every day onsite that haven't been or couldn't be planned. During the construction of the Student Life Building, there have been a few constructability challenges that have slowed progress. The challenges relate to site work and construction and involve multiple contractors. Communication between contractors is a necessity in order for a project as large as the new Monroe Campus to develop.

Table of Contents

Detailed Project Schedule

***A full version of the schedule is attached in Appendix A**

import.

The new Monroe Campus of Northampton Community College began its design phase in late 2011. Actual construction of the campus began in spring ‘12 when the site was prepared. A large amount of site work needed to be completed on the project. The work comprised of creating access roads in May 2012 and then preparing the grade for the buildings foundation in August Before excavation began, the sediment basins, staging areas and temporary facilities need to be created. Site work for the rest of the campus is ongoing; however the Student Life Building could begin pouring footings and slabs in July ‘12.

The shell of the building consists of the footings and slab, steel erections, and finally the exterior facades. The overall timeline for the shell is about a year -- June ’12-June’13. It will begin with building pad construction in July, move to foundations the next month, and then underground rough-ins of MEP systems will begin. This is an integral step in order for the future systems of the building to perform well. The milestone set for completion of the slab is January 2013, however by that time the structural steel should also be complete.

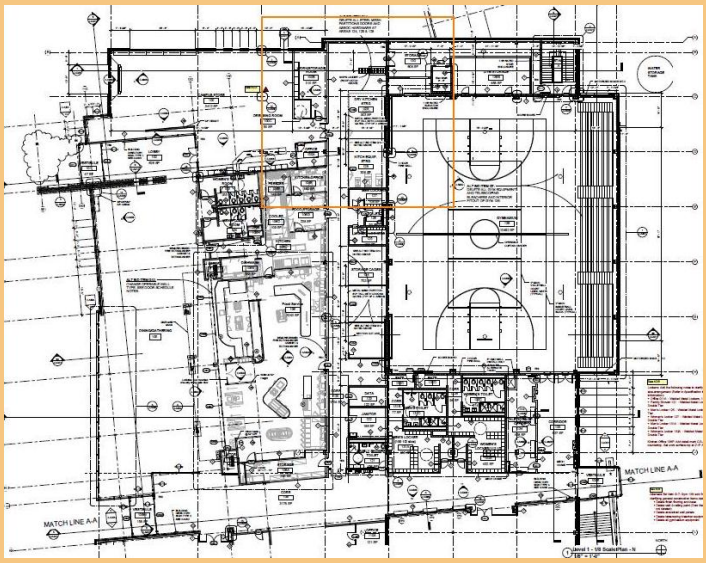
Some interior work, like forming metal stairs, can begin prior the slab milestone. However, interior wall partitions will not begin until February 2013. Interior MEP rough-in will occur almost simultaneously and once they have been inspected, drywall can be placed in late February. Finishes like painting and wall covering will not start until spring 2013 and will carry over into the summer. The milestone set for completion of interior walls finishes is November 11, 2013.

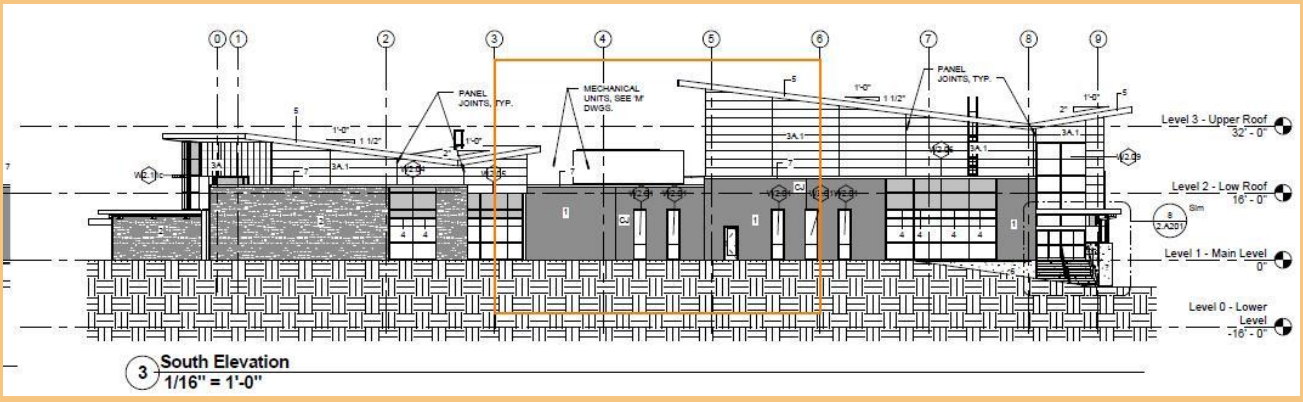
The building should be completed by late November 2013. This gives time for quality assurance inspections and for the systems to be tested. The certificate of occupancy will be obtained in January 2014 and Northampton Community College will have full use of their facilities.

Detailed Structural Systems Estimate

***full estimate and calculations are attached in Appendix B**

The superstructure of the Student Life Building was analyzed to create a detailed unit estimate. Instead of creating takeoffs for the entire building, a typical section was observed and the details of that section could then be scaled to relate to the entire building. The price estimated for the small section is about $99,600. Scaled to reflect the overall structure it would be about $996,500. This price however will varies from the actual superstructure cost that could be found by creating a full takeoff. The difference in prices occurred because the building has varying spaces and rooflines. These spaces are all framed differently and have unique roof heights and designs. For example the gymnasium has a much higher roof height at 41.5' than the campus store which has a roof height of only about 16'. In the areas where the roof height is extended, there are truss bracing systems in place. This allows for larger spans between columns. Finally, because the lower level only runs through the spine of the building, the first floor framing only exists there. The surrounding gym and cafeteria are on a slab on grade foundation.





The area chosen to represent a typical bay was partly under the low roof and partly under the high roofline of the gym. It was also had one area with the lower level foundation, framing, metal deck, floor slab, and roof framing, and then a second section with only the slab on grade and roof framing. The area chosen as a typical bay lies between column lines 3-6 and A-E. The overall floor area in the section is 6,968ft^2 and is called out in orange on the floor plan provided.

Estimate	Total Cost($)	Total Area(ft^2)
Typical Bay	99,635.41	6,968
Extrapolated Square Foot	996, 400	68,000

From the square foot extrapolation, other pricing quantities can be inferred. For example, the labor and material prices can be separated and scaled accordingly. Labor for the typical section is about $11,900. Scaling this amount to the overall building would make labor for the superstructure cost $. Materials, which were $84,500 in the section, would then be about $ overall. These amounts will vary from the actual price but the process could be a useful tool in the overall superstructure budget.

Estimate	**Total Area(ft^2)**	**Material Cost($)**	**Labor Cost($)**
Typical Bay	6,968	84,410.83	11,918.90
Overall Superstructure	68,000		

General Conditions Estimate

The general conditions of the Student Life Building are a large part of the general conditions of the entire campus. For example, the Construction Managers', and prime contractors' trailers have been placed and will remain in the same position until the third building is completed and handed over to the owner. The temporary utilities and equipment are also going to be used during the construction of each building. For the estimate below, only the construction period pertaining to the Student Life Building was considered. The amount, $2.6 million, reflects a percentage of the buildings overall cost, $18.5 million. The percentage of the total building cost is around 12% which is high for general conditions, but considering the permit values were included, the pricing is appropriate.

The Construction Manager's project team is comprised of a field coordinator, project manager and senior project manager. These terms weren't fully represented in the RSMeans data, so the field coordinator is equivalent to the field engineer and the superintendent is used as the senior project manager. The minimum rate was used for the senior project manager because he will be overseeing various jobs and will not be onsite daily.

Project Personnel		Unit	Quantity	Rate	Cost
01 31	**Proj. Mgmt and Coordination**				
01 31 13.20 0120	Field Engineer, Max	Week	83	1500	124500
01 31 13.20 0200	Project Manager, Average	Week	83	2150	178450
01 31 13.20 0240	Superintendent, Min	Week	83	1825	151475
01 31 13.20 0160	General Laborer(2)	Week	80	1425	114000
Total					$568,425

The estimates for temporary facilities, services, equipment and utilities were also calculated with the RSMeans data. The temporary facilities, i.e. trailers, were only considered as the CM's cost. The multiple prime contractors and sub-contractors will have trailers onsite at various times of construction. The total for having three trailers with air conditioning, and electricity for the duration of the project is approximately $25,000.

Temporary Facilities & Services		Unit	Quantity	Unit Rate	Cost/Unit	Total Cost
01 52 13.20	*Office and Storage Space*					
01 52 13.20 0350	Office trailer. 32'X8' (rent) (3)	month	19	190	3610	10830
01 52 13.20 0700	air conditioning	month	19	46	874	2622
01 52 13.40	*Field Office Expense*					
01 52 13.40 0160	Lights/HVAC	month	19	152	2888	8664
01 52 13.40 0120	Office Supplies(2)	month	19	75	1425	2850
01 74 13.20 0020	Final Cleanup	job		0.30%	555,000	555,000
01 41 26	*Regulatory Requirments*					
01 41 26.50 0100	Permits, Most Cities	job		0.50%	925,000	925,000
Total					$1,488,797	$1,504,966

The final estimate that was compiled for the general conditions dealt with temporary utilities and equipment. The temporary heating was only considered for the CM's trailers and the temporary lighting should cover then square footage of the Student Life Building. The signage and temporary fencing quantities were taken from the information on the phasing drawings.

Temporary Utilities & Equipment		Unit	Quantity	Unit Rate	Duration	Cost
01 51 13	*Temporary Electricity*					
01 51 13.80 0350	Temporary Lighting	CSF Flr	700	38.38	19	510454
01 51 13.80 0100	Temporary Heating	CSF Flr	7.68	15.17	19	2213.6064
01 56 26	*Temporary Fencing*					
01 56 26.50 0100	Chain link, 6' high	L.F	6500	4.48		29120
01 58 13.50 0020	Project Signage	S.F	65	34		2210
Total						543997.61

BIM Use Evaluation

***Level 1 Process Map attached in Appendix C**

Building Information Modeling (BIM) has quickly come to the forefront of most discussions regarding the construction industry. It may seem intimidating to jump into, but companies at all levels can start implementing the various uses of BIM to assist with everything from marketing, to coordination, to the actual fabrication of materials. The most important part of moving into the 'BIM world' is having an implantation plan that your company can follow. It's necessary to understand which uses of the process are best suited to help your company succeed.

The Monroe Campus plan has not been a fully integrated BIM project. The companies and owner have chosen to go a more traditional construction route for various reasons. The owner does not have the need for a functioning maintenance model, and the contracting companies involved are smaller and do not have developing BIM departments.

The fact that models were not passed between contractors does not mean that that the clash detection process was ignored. The prime contractors, together with the construction managers worked together for months before construction began. They compared drawings and notes and even discussed coordination and scheduling issues as a team.

I feel that despite not feeling comfortable implementing BIM uses, the companies involved could definitely have benefitted from them. The owner felt it wasn't necessary to have a working model because maintenance staffing would need to be instructed on its uses, however providing training to the staff may prove to be a wise investment. The campus equipment and facilities could be monitored and controlled much more efficiently. The contractors involved could benefit even more from implementing BIM processes. Despite all coordination efforts, there have been issues on site. Even more of these issues could be avoided with the use of 4D modeling, or modeling in general.

The BIM use analysis below describes the different areas in which a company can use and benefit from the process. Instead of creating one based on the actual project's BIM use, I've created a plan to explain how they could have used BIM.

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
x	PROGRAMMING		DESIGN AUTHORING		SITE UTILIZATION PLANNING	X	BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS	x	DESIGN REVIEWS	x	CONSTRUCTION SYSTEM DESIGN	X	BUILDING SYSTEM ANALYSIS
		x	3D COORDINATION	x	3D COORDINATION	X	ASSET MANAGEMENT
		X	STRUCTURAL ANALYSIS		DIGITAL FABRICATION		SPACE MANAGEMENT / TRACKING
			LIGHTING ANALYSIS		3D CONTROL AND PLANNING		DISASTER PLANNING
		X	ENERGY ANALYSIS		RECORD MODELING		RECORD MODELING
			MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
			SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
x	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION	X	COST ESTIMATION		COST ESTIMATION		COST ESTIMATION
x	EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING	x	EXISTING CONDITIONS MODELING

Constructability Challenges

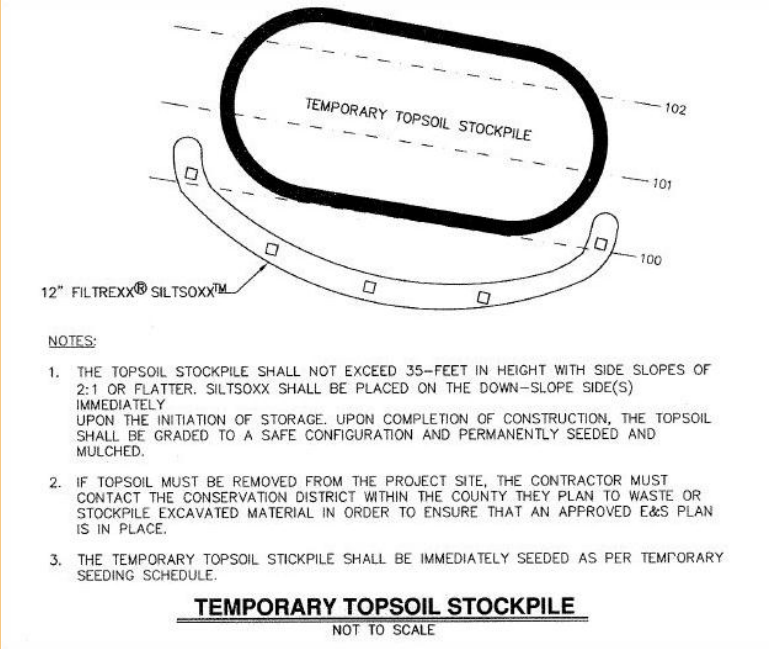
The construction of the Student Life Building, like most construction projects, has not gone as smoothly as planned. Owners spend an exuberant amount of time and money planning the design, site work and construction phases of a project, and Northampton Community College has been planning their new campus since they purchased the land in 2005. Despite the attention, there have been three major challenges to the site thus far. There have been problems with the watershed, a large foundation wall, and....

The first challenge was exposed very early in the sitework process. Because the site is considered a green field -- meaning there has not been previous construction -- Erosion and Sedimentation Plan Report needed to be created. Herbert, Rowland, and Grubic, a civil engineering firm, was commissioned to complete the report and their findings show that the site needs to distribute runoff between two separate watersheds. Considering the large site, this isn't extremely unusual; however a lot of planning and erosion control methods will need to be used.

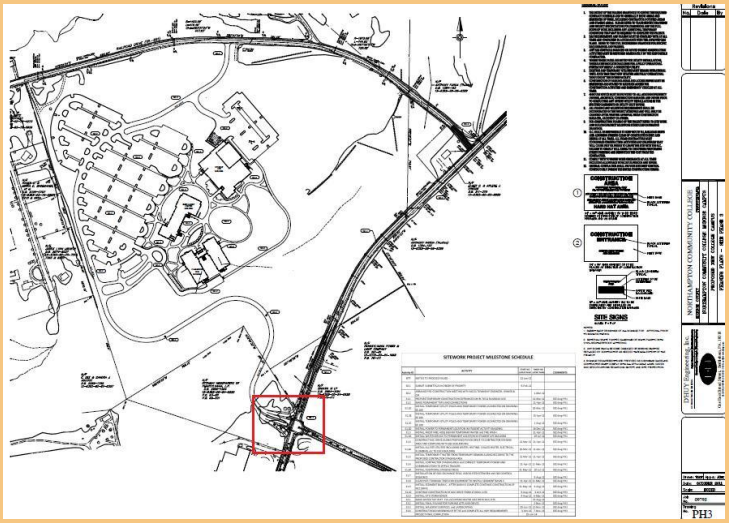
North (Railroad Ave) Drainage Area		
BMP	Area (acres)	%
Basin H-1	1.1442	3.79%
Basin H-2	2.4809	8.23%
Basin H-3	3.1198	10.35%
Basin H-4	2.3381	7.75%
Basin H-5	3.7120	12.31%
Basin I-1	9.7297	32.27%
Basin J-1	1.7808	5.91%
Basin J-2	4.1169	13.65%
Bypass	*1.7324*	*5.75%*
	30.1548	100.00%

South (SR0715) Drainage Area		
BMP	Area (acres)	%
Basin A-1	5.0564	21.80%
Basin A-2	11.0810	47.78%
Basin A-3	3.0940	13.34%
Basin A-4	1.8219	7.86%
Bypass	*2.1402*	*9.23%*
	23.1936	100.00%

In order to control erosion there will sediment basins, silt fences around all topsoil stockpiles and around the site in general. Also, the GC must monitor and remove any runoff that could possibly get into surrounding roadways. The most prominent aspect of the erosion control plan is the use of the sediment basins. Twelve basins will be created throughout the project. The basins will be distributed throughout the site, 8 in the northern section and 4 in the southern and their distribution areas can be seen in the tables from the Report. No ground can be broken before corresponding sediment basins are created and inspected. Different basins will be created in each phases of the project, and at the end of the project basins---- will become permanent retention ponds. The transformation to retention ponds includes adding gravel, vegetation, and permanent drainage lines.

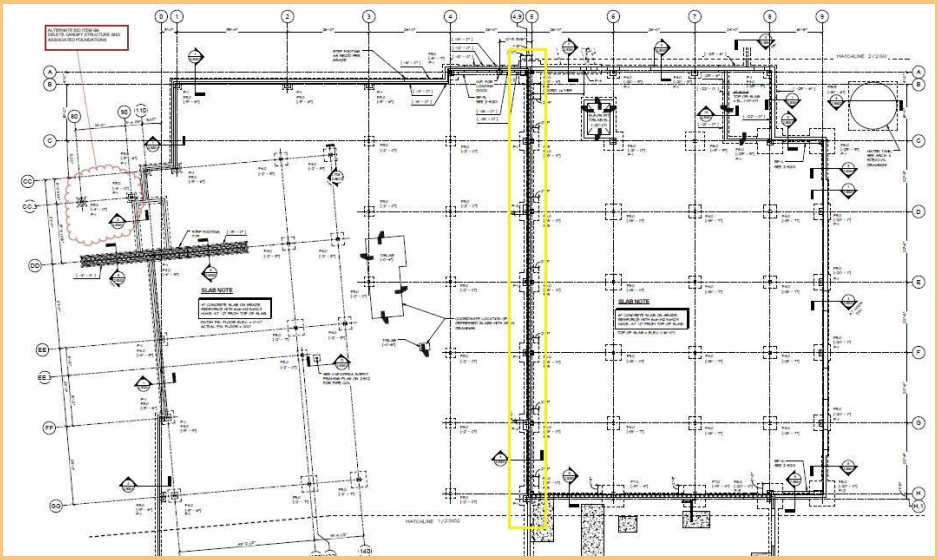


The process may not seem like it would cause constructability issues, however the basin placement created stress on the existing runoff piping. The existing piping on the corner of NCC road and SR 0715 does not have a diameter large enough for the amount of runoff it could potentially see. This basin will become a permanent retention pond and the pipe must be replaced. However, the positioning of the pipe caused challenges to the schedule and overall cost of the project. The ownership of the pipe needed to be transferred from the county to Northampton Community College. Once NCC obtained ownership of the pipe, they needed to convince PennDot that tearing up

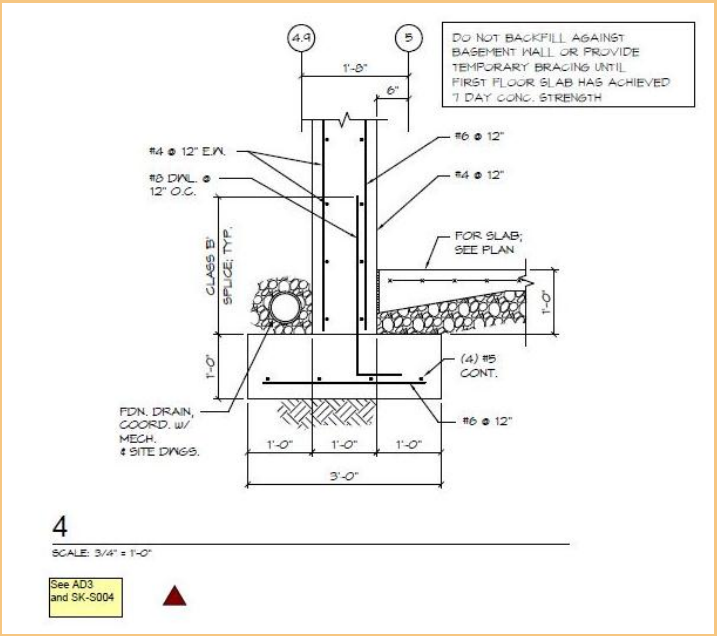


their road was necessary. This permit and ownership process was extremely elongated as a result, the overall schedule was delayed and sitework costs were expanded.

The second challenge that the project team experienced occurred after sitework and construction were well underway. There is a large foundation wall on line 5 of the foundation. It can be seen in the drawings on page 2S101, and 2S102. There is also a section detail that can be seen from 2.S301. The section detail shows that there were changes to the design in the addendum; however that changed only the thickness of the wall and the current problem is related to coordination.



The area was first excavated and the 18’ wall was then cast in place. The area cannot be backfilled until all work around the wall is complete, and this is what had been agreed upon in the preconstruction meetings. The process agreed upon was to pour the wall, erect the steel and metal decking, and then have the wall be backfilled. However, due to the positioning of the wall, numerous sanitary lines run toward it and these lines need to be placed as soon as possible.



The plumbing contractor had agreed to the phasing plan but now that he faces working under the GC and steel subcontractors, he is arguing that it’s become a safety and coordination issue. It is a safety issue because although the metal deck will be placed, there is a possibility of objects falling

into his workspace. The coordination comes into play with the multiple prime contractors. While the PC is placing his pipe work, the GC needs to oversee both the steel erection and concrete pours. There are remaining column footings that need to be poured – one located on line 4 of the drawings. Not only will a crane need to be in the area to erect the steel but a concrete truck will need access to line 4's column footing. Discussions on this coordination have delayed the process of installing the sanitary lines.

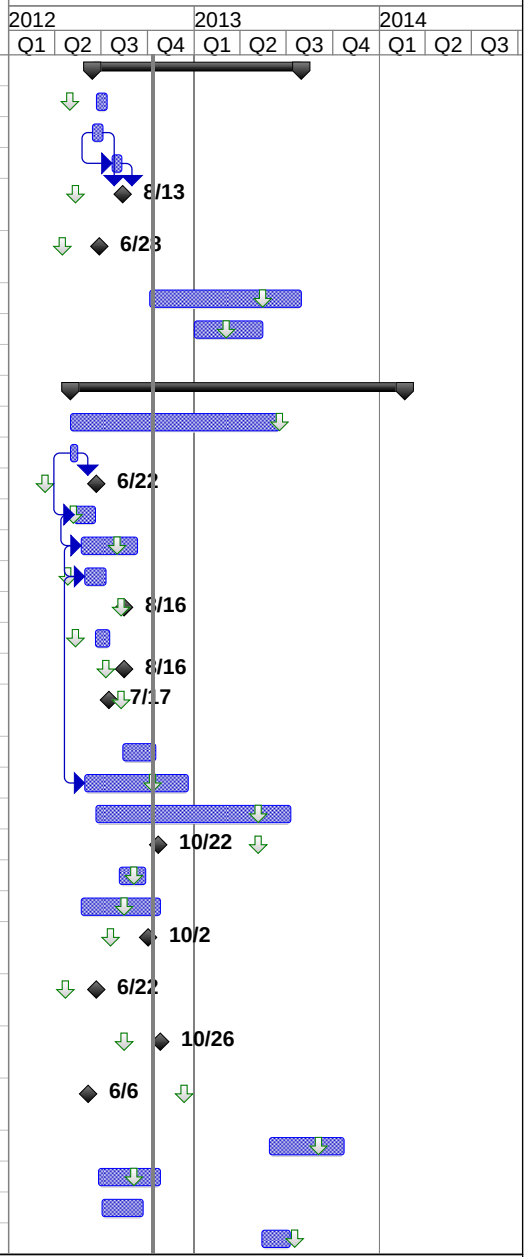
Final decisions on the process have not currently been made, but each subcontractor has posed their side. The general contractor wants to proceed with steel erection because the equipment is already on site – keeping a crane etc. onsite and idle would be costly. Also, the GC wants to continue to pour the remaining footings so that the columns on top of them can be placed sooner. The plumbing contractor is adamant about not wanting to work in such confined spaces and does not want to put the safety of his workers at any risk. It seems the best solution for this issue is to continue with the process approved during preconstruction meetings. It should also be made clear that in the future it is the contractors' responsibility to understand what scope of work and scheduling they are agreeing to.

Because the site is in the early phases of construction, there hasn't been another constructability challenge as large as the two described. The only other challenges had been to continuously keep workers on schedule. The campus is an extremely large scope of work that needs to be completed in a relatively short time period. All parties involved must be constantly communicating and being productive.

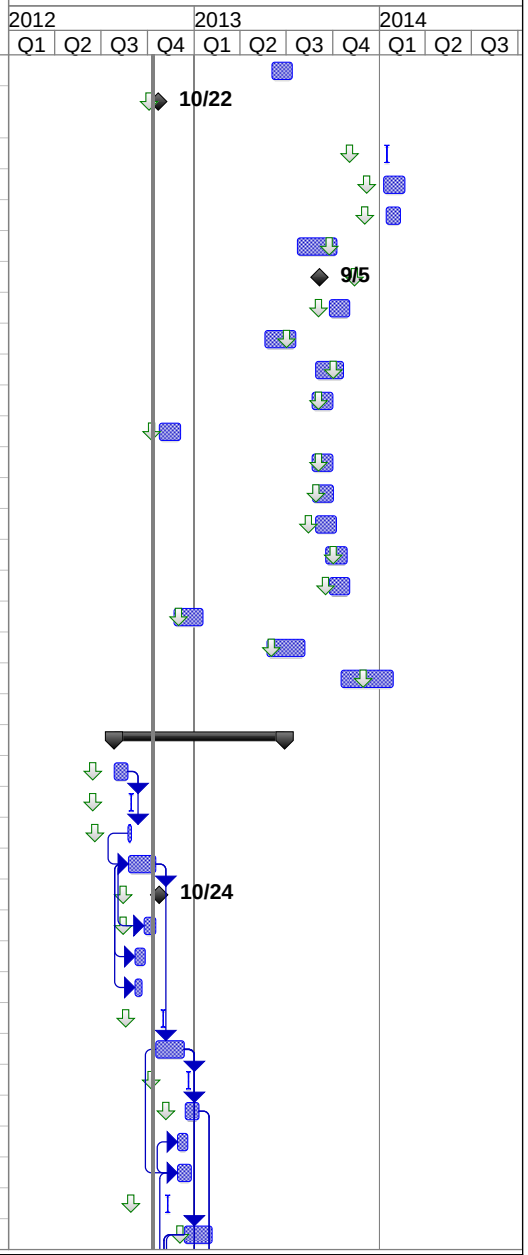
Appendix A

NORTHAMPTON COMMUNITY COLLEGE

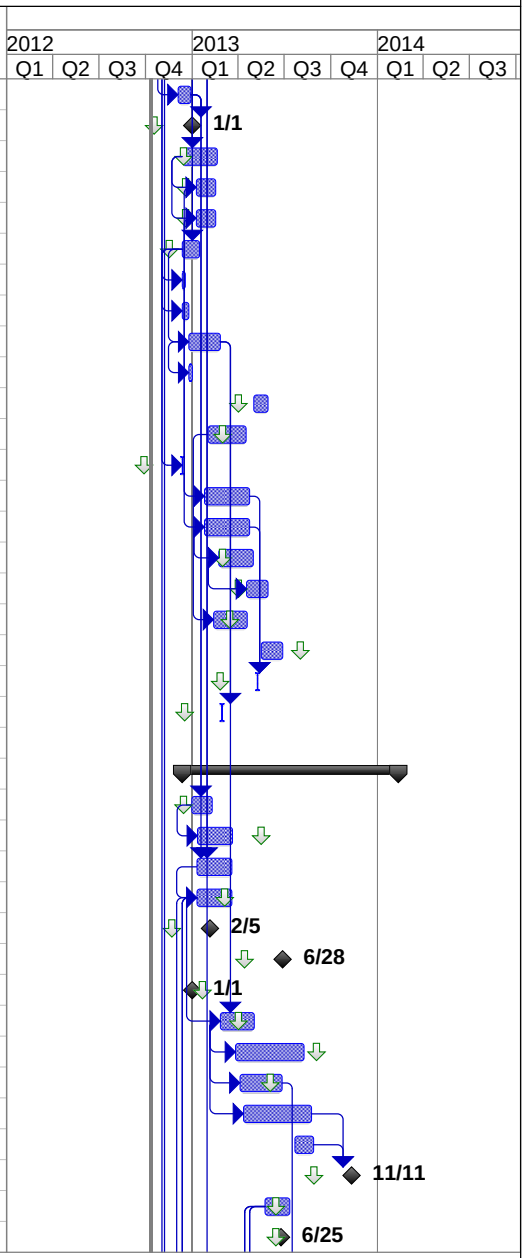
ID	Task Name	Duration	Original Baseline Start	Original Baseline Finish
1	**TEMPORARY CONSTRUCTION**	**301 days**	**Thu 5/31/12**	**Mon 7/30/12**
2	temporary fence	15 days	Fri 6/22/12	Thu 7/12/12
3	mobilize job trailers	15 days	Thu 6/14/12	Wed 7/4/12
4	EC. temporary electric to job tailers	15 days	Mon 7/23/12	Fri 8/10/12
5	**MILESTONE INSTALL CONTRACTOR STAGING AREA & CONNECT POWER TO OFFICE TRAILERS**	1 day	Mon 8/13/12	Mon 8/13/12
6	**MILESTONE INSTALL TEMP UTILITY POLES & TEMP POWER AS SHOWN ON OE.100**	1 day	Thu 6/28/12	Thu 6/28/12
7	EC temporay electric and lighting in buildings	218 days	Mon 10/15/12	Tue 7/30/13
8	**MILESTONE PROVIDE TEMPORARY HEAT**	99 days	Tue 1/1/13	Wed 5/15/13
9				
10	**SITE WORK**	**484 days**	**Wed 5/2/12**	**Wed 2/19/14**
11	site layout	300 days	Wed 5/2/12	Sun 6/17/12
12	install rock construction entrance	10 days	Wed 5/2/12	Tue 5/15/12
13	**PREPARE CONSTRUCTION ENTRANCES ON RT 715 & RR AVE**	1 day	Fri 6/22/12	Fri 6/22/12
14	erosion controls	30 days	Wed 5/9/12	Fri 6/1/12
15	site clearing and strip topsoil	80 days	Wed 5/23/12	Mon 9/10/12
16	temporary basins A&B and swales	30 days	Wed 5/30/12	Tue 7/10/12
17	**MILESTONE INSTALL SEDIMENT BASIN C.**	51 days	Thu 8/16/12	Mon 10/22/12
18	Install paving binder access roads and staging areas	20 days	Wed 6/20/12	Tue 7/17/12
19	**MILESTONE INSTALL ADDITIONAL STAGING AREAS**	29 days	Thu 8/16/12	Sat 9/22/12
20	**MILESTONE INSTALL GEO-EXCHANGE FIELD, ASSOCIATED SITEWORK & E&S CONTROLS**	105 days	Tue 7/17/12	Sun 12/5/21
21	Electrical Ductbank	50 days	Mon 8/13/12	Tue 10/16/12
22	excavation cut/fill	150 days	Wed 5/30/12	Wed 12/19/12
23	storm sewer	280 days	Thu 6/21/12	Mon 7/9/12
24	**MILESTONE INSTALL STORM SEWER**	193 days	Mon 10/22/12	Fri 7/12/13
25	sanitary sewer	40 days	Mon 8/6/12	Wed 9/26/12
26	water system	115 days	Wed 5/23/12	Thu 10/25/12
27	**MILESTONE WATER SERVICE TO PERMANENT LOCATION IN STUDENT LIFE BUILDING**	1 day	Tue 10/2/12	Tue 10/2/12
28	**MILESTONE INSTALL TEMPORARY WATER TO CONTRACTOR STAGING AREA**	1 day	Fri 6/22/12	Fri 6/22/12
29	**MILESTONE MAKE WATER TAP IN RT715 AND EXTEND WATER LINE ONTO NCC SITE**	1 day	Fri 10/26/12	Fri 10/26/12
30	**INSTALL ALL SITE UTILITIES INCLUDING WATER, HEATING. CHILLED WATER, ELECTRICAL TO BUILDINGS**	189 days	Wed 6/6/12	Tue 2/19/13
31	Site grading and excavation	109 days	Wed 5/29/13	Tue 10/22/13
32	concrete curb 2012	91 days	Tue 6/26/12	Thu 10/25/12
33	EC site lighting	60 days	Tue 7/3/12	Tue 7/3/12
34	concrete curb 2013	40 days	Tue 5/14/13	Mon 7/8/13



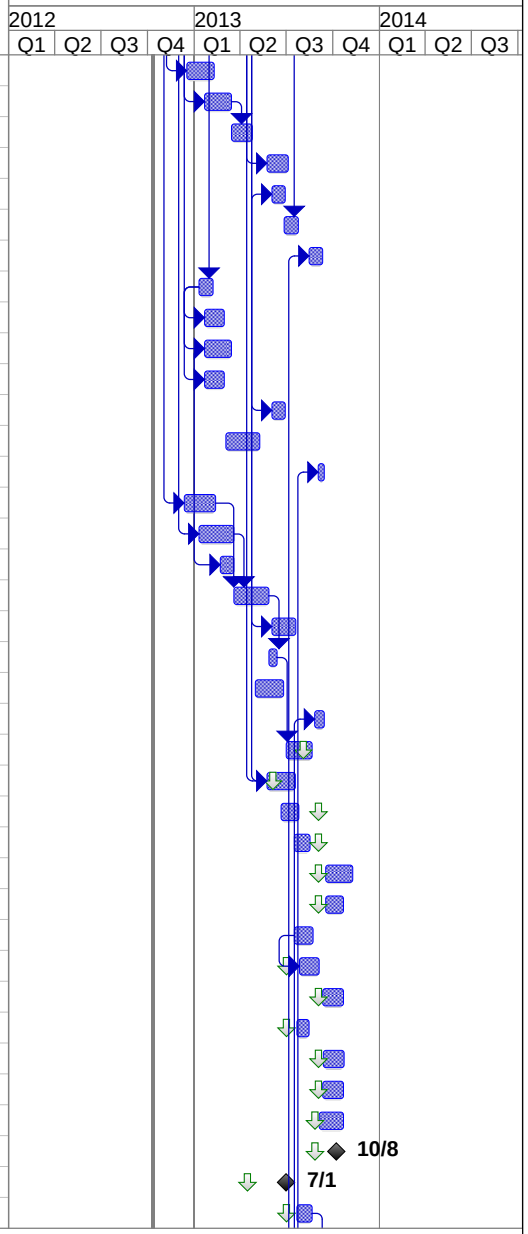
ID	Task Name	Duration	Original Baseline Start	Original Baseline Finish
35	EC site lighting	30 days	Mon 6/3/13	Mon 6/3/13
36	**MILESTONE CONTINUE CONSTRUCTION OF NCC DRIVE FROM 27+00 TO 1+50**	40 days	Mon 10/22/12	Fri 12/14/12
37	**MILESTONE INSTALL FINAL PAVING FOR PARKING LOTS AND DRIVES**	1 day	Wed 1/15/14	Wed 1/15/14
38	site linestriping & signage	30 days	Thu 1/9/14	Wed 2/19/14
39	concrete bumper blocks	20 days	Tue 1/14/14	Mon 2/10/14
40	concrete sidewalks & ramps	60 days	Tue 7/23/13	Tue 10/8/13
41	**MILESTONE INSTALL WALKWAY SURFACES & LANDSCAPING**	1 day	Thu 9/5/13	Thu 9/5/13
42	unit pavers	30 days	Tue 9/24/13	Sat 11/2/13
43	exterior masonry seat walls and site walls	45 days	Mon 5/20/13	Fri 7/19/13
44	exterior site railings	40 days	Wed 8/28/13	Mon 10/21/13
45	timber guide rail	30 days	Wed 8/21/13	Wed 8/21/13
46	segmented retaining wall	30 days	Wed 10/24/12	Tue 12/4/12
47	site benches	30 days	Wed 8/21/13	Mon 9/30/13
48	bus shelters	30 days	Thu 8/22/13	Tue 10/1/13
49	flagpoles	30 days	Wed 8/28/13	Mon 10/7/13
50	parking control equipment	30 days	Tue 9/17/13	Mon 10/28/13
51	relocate available boulders	30 days	Tue 9/24/13	Sat 11/2/13
52	Landscaping trees and shrubs fall 2012	42 days	Thu 11/22/12	Thu 1/17/13
53	landscaping trees and shrubs spring 2013	55 days	Fri 5/24/13	Tue 8/6/13
54	landscaping trees and shrubs fall 2013	76 days	Thu 10/17/13	Mon 1/27/14
55				
56	**BUILDING SHELL CONSTRUCTION**	**246 days**	**Fri 7/27/12**	**Thu 6/27/13**
57	construct the building pad	20 days	Fri 7/27/12	Wed 8/22/12
58	**B.2 MILESTONE COMPLETE SUB GRADE FOR BUILDING PAD**	1 day	Wed 8/29/12	Tue 8/28/12
59	layout for foundations	5 days	Thu 8/23/12	Wed 8/29/12
60	footing excavation and concrete foundations	40 days	Fri 8/24/12	Tue 10/16/12
61	**B.3 MILESTONE COMPLETE CONCRETE FOUNDATIONS**	1 day	Wed 10/24/12	Wed 10/24/12
62	waterproofing	18 days	Mon 9/24/12	Tue 10/16/12
63	PC underground sanitary/storm rough-in	15 days	Thu 9/6/12	Tue 9/25/12
64	EC deep underground rough in	10 days	Thu 9/6/12	Wed 9/19/12
65	**B.4 MILESTONE COMPLETE MECH & PC UNDERGROUND ROUGH IN**	1 day	Wed 10/31/12	Wed 10/31/12
66	erect structural steel and deck	40 days	Wed 10/17/12	Tue 12/11/12
67	**B.5 MILESTONE COMPLETE STRUCTURAL STEEL**	1 day	Thu 12/20/12	Thu 12/20/12
68	pour concrete slab on deck	20 days	Fri 12/14/12	Wed 1/9/13
69	EC rough in stone under slab	15 days	Thu 11/29/12	Tue 12/18/12
70	stone under slab	20 days	Thu 11/29/12	Tue 12/25/12
71	**B.4A MILESTONE COMPLETE COMPLETE EC UNDERGROUND ROUGH IN**	1 day	Fri 11/9/12	Fri 11/9/12
72	CMU walls	40 days	Wed 12/12/12	Mon 2/4/13



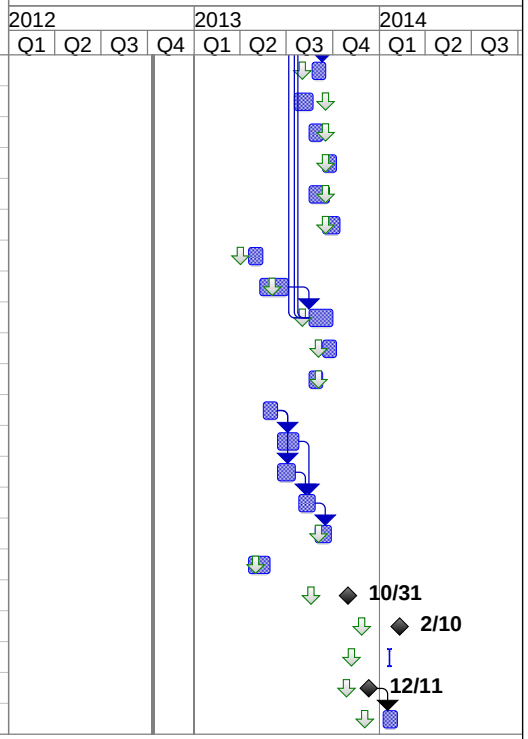
ID	Task Name	Duration	Original Baseline Start	Original Baseline Finish
73	Pour concrete slab on grade	20 days	Tue 12/4/12	Fri 12/28/12
74	**B.6 MILESTONE COMPLETE CONCRETE SLAB ON GRADE**	1 day	Tue 1/1/13	Tue 1/1/13
75	cold formed metal framing and sheathing	50 days	Wed 12/12/12	Mon 2/18/13
76	spray urethane insulation	28 days	Wed 1/9/13	Fri 2/15/13
77	air barrier membrane	28 days	Wed 1/9/13	Wed 1/9/13
78	wood blocking & sheathing on roof	25 days	Wed 12/12/12	Mon 1/14/13
79	HVAC set roof curbs	5 days	Wed 12/12/12	Mon 12/17/12
80	PC Set Roof Drains	10 days	Wed 12/12/12	Mon 12/24/12
81	roofing	45 days	Tue 12/25/12	Sun 2/24/13
82	HVAC Set roof top equipment	5 days	Tue 12/25/12	Mon 12/31/12
83	metal roof ladders	20 days	Thu 5/2/13	Wed 5/29/13
84	aluminum windows & curtain walls	55 days	Fri 2/1/13	Tue 4/16/13
85	deliver steel lintels	1 day	Wed 12/12/12	Wed 12/12/12
86	masonry veneer	65 days	Fri 1/25/13	Tue 4/23/13
87	insulated metal wall panels	65 days	Fri 1/25/13	Tue 4/23/13
88	metal soffit and fascia	50 days	Fri 2/22/13	Tue 4/30/13
89	roof metal edges	30 days	Thu 4/18/13	Wed 5/29/13
90	Exterior Caulking	50 days	Tue 2/12/13	Thu 4/18/13
91	aluminum entrance doors/sliding doors	30 days	Fri 5/17/13	Thu 6/27/13
92	**B.9 MILESTONE COMPLETE EXTERIOR SHELL**	1 day	Thu 5/9/13	Thu 5/9/13
93	**B.10 MILESTONE BUILDING TO BE WATER TIGHT**	1 day	Thu 2/28/13	Thu 2/28/13
94				
95	**BUILDING FINISHES**	**314 days?**	**Sat 4/5/14**	**Mon 2/10/14**
96	metal stairs	30 days	Mon 12/31/12	Fri 2/8/13
97	interior railings	50 days	Fri 1/11/13	Wed 3/20/13
98	interior h.m. frames	50 days	Thu 1/10/13	Tue 3/19/13
99	interior metal stud framing	50 days	Thu 1/10/13	Thu 1/10/13
100	**B.13 MILESTONE BEGIN INTERIOR PARTITIONS & MEP ROUGH INS**	1 day	Tue 2/5/13	Tue 2/5/13
101	**B.14 MILESTONE COMPLETE WALL ROUGH INS AND INSPECTIONS**	1 day	Fri 6/28/13	Fri 6/28/13
102	**B.7 MILESTONE INSTALL MEP ABOVE CEILING ROUGH IN**	69 days	Tue 1/1/13	Thu 4/4/13
103	interior drywall and spackling	50 days	Mon 2/25/13	Thu 5/2/13
104	interior caulking	100 days	Wed 3/27/13	Thu 8/8/13
105	ceramic & porcelain wall & floor tile	60 days	Fri 4/5/13	Fri 4/5/13
106	painting	100 days	Fri 4/12/13	Fri 8/23/13
107	wall coverings	30 days	Mon 7/22/13	Tue 8/27/13
108	**B.19 MILESTONE COMPLETE ALL INTERIOR WALL FINISHES AND TRIM**	1 day	Mon 11/11/13	Mon 11/11/13
109	acoustical ceiling grid	35 days	Fri 5/24/13	Thu 7/11/13
110	**B.15 MILESTONE INSTALL CEILING GRID**	1 day	Tue 6/25/13	Tue 6/25/13



ID	Task Name	Duration	Original Baseline Start	Original Baseline Finish
111	PC AG san/rw	40 days	Mon 12/17/12	Fri 2/8/13
112	PC overhead pipe rough in	40 days	Mon 1/21/13	Thu 3/14/13
113	PC insulation	30 days	Fri 3/15/13	Wed 4/24/13
114	PC drop sprinkler heads	30 days	Fri 5/24/13	Thu 7/4/13
115	PC casework fixtures	20 days	Mon 6/3/13	Fri 6/28/13
116	PC toilet fixtures	20 days	Thu 6/27/13	Wed 7/24/13
117	PC kitchen equipment hookups	20 days	Thu 8/15/13	Tue 9/10/13
118	HC hangers	20 days	Thu 1/10/13	Wed 2/6/13
119	HC pipe install	30 days	Mon 1/21/13	Thu 2/28/13
120	HC Duct install	40 days	Mon 1/21/13	Thu 3/14/13
121	HC ATC rough-in	30 days	Mon 1/21/13	Thu 2/28/13
122	HC GRD install	20 days	Mon 6/3/13	Fri 6/28/13
123	HC Equipment & Final Connections	50 days	Mon 3/4/13	Thu 5/9/13
124	HC kitchen equipment hook ups	10 days	Mon 9/2/13	Fri 9/13/13
125	EC rough in walls	45 days	Wed 12/12/12	Fri 2/1/13
126	EC Overhead rough in	50 days	Thu 1/10/13	Tue 3/19/13
127	EC cable tray	20 days	Sat 2/2/13	Tue 3/19/13
128	EC wiring	50 days	Wed 3/20/13	Mon 5/27/13
129	EC light fixtures	35 days	Mon 6/3/13	Fri 7/19/13
130	EC wiring devices	12 days	Tue 5/28/13	Wed 6/12/13
131	EC fire alarm & security	40 days	Wed 5/1/13	Tue 6/25/13
132	EC kitchen equipment hook ups	15 days	Mon 8/26/13	Fri 9/13/13
133	EC hook-ups and final connections	40 days	Mon 7/1/13	Tue 8/20/13
134	p.l. casework millwork	40 days	Fri 5/24/13	Thu 7/18/13
135	resilient tile floor and base	25 days	Fri 6/21/13	Thu 7/25/13
136	seamless vinyl flooring	25 days	Wed 7/17/13	Fri 8/16/13
137	carpet tile	40 days	Tue 9/17/13	Fri 11/8/13
138	rubber stair treads/riser & landings	25 days	Tue 9/17/13	Mon 10/21/13
139	install doors and hardware	30 days	Wed 7/17/13	Thu 8/22/13
140	interior glass	30 days	Sat 7/27/13	Tue 9/3/13
141	wood wall panels	30 days	Wed 9/11/13	Mon 10/21/13
142	visual display surfaces	20 days	Mon 7/22/13	Wed 8/14/13
143	signage	30 days	Thu 9/12/13	Tue 10/22/13
144	install wood ceiling	30 days	Wed 9/11/13	Mon 10/21/13
145	drop acoustical ceiling tiles	35 days	Wed 9/4/13	Mon 10/21/13
146	**B.17 MILESTONE INSTALL FINISHED CEILINGS**	23 days?	Tue 10/8/13	Wed 11/6/13
147	**B.18 MILESTONE ENERGIZE PERMANENT POWER**	1 day	Mon 7/1/13	Mon 7/1/13
148	toilet compartments	25 days	Mon 7/22/13	Tue 8/20/13



ID	Task Name	Duration	Original Baseline Start	Original Baseline Finish
149	toilet accessories	20 days	Wed 8/21/13	Mon 9/16/13
150	fire protection specialties	30 days	Wed 7/17/13	Thu 8/22/13
151	motorized projection screens	20 days	Thu 8/15/13	Tue 9/10/13
152	roller window shades	20 days	Wed 9/11/13	Mon 10/7/13
153	wire mesh partitions	30 days	Thu 8/15/13	Mon 9/23/13
154	metal lockers	25 days	Wed 9/11/13	Mon 10/14/13
155	install hood and walk-ins	20 days	Thu 4/18/13	Wed 5/15/13
156	Kitchen Tile	40 days	Fri 5/10/13	Thu 7/4/13
157	install and setup food service equipment	35 days	Thu 8/15/13	Mon 9/30/13
158	glass wall folding partition	20 days	Wed 9/11/13	Mon 10/7/13
159	loading dock equipment	20 days	Thu 8/15/13	Tue 9/10/13
160	Paint Gym Ceiling	20 days	Fri 5/17/13	Thu 6/13/13
161	gymnasium equipment	30 days	Fri 6/14/13	Thu 7/25/13
162	gymnasium dividers	25 days	Fri 6/14/13	Thu 7/18/13
163	resilent athletic floor	25 days	Fri 7/26/13	Mon 8/26/13
164	telescoping bleachers	25 days	Tue 8/27/13	Fri 9/27/13
165	hydraulic elevators	30 days	Thu 4/18/13	Wed 5/29/13
166	**B.21 MILESTONE START-UP AND COMMISSION EQUIPMENT AND SYSTEMS**	1 day	Thu 10/31/13	Wed 10/3/12
167	**B.23 MILESTONE COMPLETION OF ALL CONSTRUCTION ACTIVITIES**	1 day	Mon 2/10/14	Mon 2/10/14
168	**B.24 MILESTONE OBTIAN CERTIFICATION OF OCCUPANCY**	1 day	Mon 1/20/14	Mon 1/20/14
169	**B.22 MILESTONE PUNCHLIST PREPARATION AND COMPLETION**	21 days	Wed 12/11/13	Tue 1/7/14
170	closeout and warranties	20 days	Wed 1/8/14	Tue 2/4/14



Appendix B Detail Structural Estimate notes

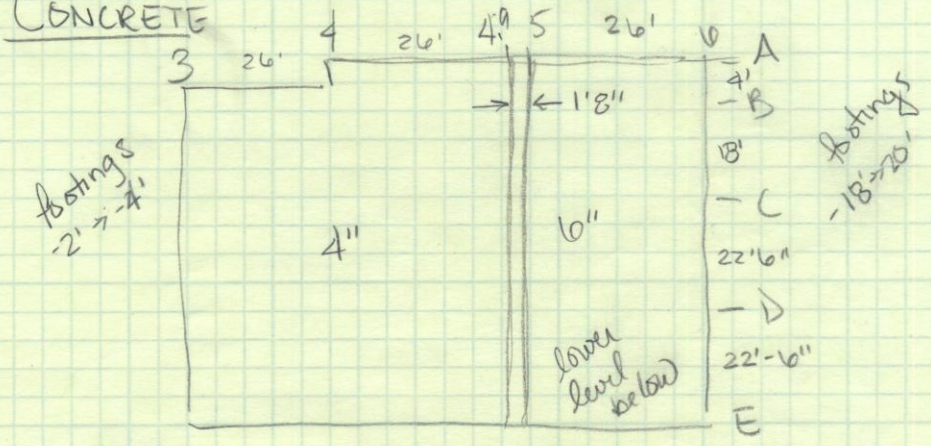
STRUCTURAL

'TYPICAL BAY'

BTWN COLUMN LINES 3,6 : A-E

- GIVES 2 Slab thicknesses, part of Gym structure, part other, some LL framing

CONCRETE



- SOG → 4" section A = 52'(67') = 3484ft²

V = 4/12 (3484ft²) = 1161.3ft³ ⇒ 43CY

→ 6" section A = 26'(67') = 1742ft²

V = 4/12 (1742ft²) = 580ft³ ⇒ 21.5CY

64.5CY

- footings

95CY

(7) F3.0 V = (3')(3)(1) = 9ft³ ⇒ 63ft³ ⇒ 2.3CY

(1) F4.0 V = (4)(4)(1'3") = 20ft³ ⇒ .74CY

(3) F5.0 V = (5')(5')(1'7") = 39.5ft³ ⇒ 118.5ft³ ⇒ 4.4CY

(4) F6.0 V = (6')(6')(1'11") = 68.4ft³ ⇒ 273.6ft³ ⇒ 10.1CY

(1) F7.0 V = (7')(7')(2'4") = 112.7ft³ ⇒ 4.2CY

- floor slab on metal deck between column 5-6

$A = 26'(67') = 1742 ft^2$

$V = (2\frac{1}{2}")(1742 ft^2) = 362.9 ft^3$

$\Rightarrow 13.4 CY$

- roof slab $\Rightarrow$ none

REINFORCING BARS

4" SOG 6x6 - W2.9xW2.9 W.W.R

$\Rightarrow 348 ft^2$

6" SOG 6x6 - W2.9xW2.9 W.W.R

$\Rightarrow 1742 ft^2$

footings.

F3.0 5, #5 E.W
10 bars @ 2.75'/bar

F4.0 8 #5 E.W
16 bars @ 3.75'/bar

F5.0 9 #6 E.W
18 bars @ 4.75'/bar

F6.0 15 #7 E.W
20 bars @ 5.75'/bar

F7.0 14 #7 E.W
28 bars @ 6.75'/bar

Steel

Columns

A — W10x49 (2) @ 32'
W10x33 (2) @ 52'

B — W10x33 (1) @ 16'

C — W10x33 (2) @ 32'
W10x49 (2) @ 57.5'
W12x65 (2) @ 55'

D — W10x33 (3) @ 48'
W10x49 (2) @ 62.5'

E — W10x33 (4) @ 64'
W10x49 (1) @ 42'

Beams

Main Level Framing

W18x40	8x26' ⇒ 208'	
W12x19	2x15' ⇒ 30'	
W18x35	2x26'-18' ⇒ 76'	
W12x26		6'
W21x50	5x22'	110'
W16x26	22-26	48'
W14x22	2x6'	12'
W18x40		22'

Low Roof Framing Plan

W12x26		26'
W16x40	1	25'
W 14 x 22	12x26'	312'
W16 x31	18+3(22)	84'
W16x26		110'
W12x19	2x26	52'
W14x38	44+26	70'

Sloped Roof Framing Plan

W18x35	26'
W24x55	22.5'
W12x44	22.5'

Support Joists

STEEL SUMMARY

	PIECES	LENGTH	WEIGHT (TONS)
W10x49	7	200'	4.9
W10x33	12	216'	3.5
W12x65	2	63'	2.04
W12x19	4	82'	.78
W12x26	2	32'	.42
W12x44	1	23'	.51
W14x22	14	360'	3.9
W19x38	2	70'	1.3
W16x26	8	168'	2.08
W16x31	4	85'	1.32
W16x40	1	50'	1

BASE PLATES

BP-1 $t = 3/4"$ $A = 1A^2$ E3, E4, E4.9 A4, A5, A6, B3, C3, C4, D3, D4

BP-2 $t = 1"$ $A = 1A^2$ C4.9, C5, D5, D6, E5, E6

BP-3 $t = 1\frac{1}{4}"$ $A = 2.56A^2$ A4.9, C6, D4.9

BP-4 $t = 2"$ $A = 2.56A^2$

Qty	LineNumber	Description	Unit	Material	Labor	Mat. & Labor/Unit	Estimated Total
52.3	032205500300	Welded wire fabric, sheets, 6 x 6 - W2.9 x W2.9 (6 x 6) 42 lb. per C.S.F., A185, incl labor for accessories, excl material for accessories	C.S.F.	$23.66	$32.02	$55.68	2912.064
0.05	032110502600	Reinforcing Steel, shop size extra, #5 bar, A615, grade 40, material only, included in delivered price	Ton	$36.48	$-	$36.48	$1.82
0.1	032110502650	Reinforcing Steel, shop size extra, #6 bar, A615, grade 40, material only, included in delivered price	Ton	$33.03	$-	$33.03	$3.30
0.31	032110502700	Reinforcing Steel, shop size extra, #7 to #11 bar, A615, grade 40, material only, included in delivered price	Ton	$43.88	$-	$43.88	$13.60
95	033105350150	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	C.Y.	$83.13	$-	$83.13	$7,897.35
77.9	033105350300	Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered,	C.Y.	$83.95	$-	$83.95	$6,539.71

		excludes all additives and treatments					
424	031113651000	C.I.P. concrete forms, slab on grade, bulkhead with keyway, wood, 6" high, 1 use, includes erecting, bracing, stripping and cleaning	L.F.	$0.78	$2.34	$3.12	$1,322.88
284	031113451500	C.I.P. concrete forms, footing, keyway, tapered wood, 2" x 4", 4 use, includes erecting, bracing, stripping and cleaning	L.F.	$0.16	$0.59	$0.75	$213.00
215	051223750740	Structural steel member, 100-ton project, 1 to 2 story building, W10x33, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$40.27	$5.94	$49.30	$10,599.50
200	051223750900	Structural steel member, 100-ton project, 1 to 2 story building, W10x49, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$59.74	$5.94	$68.77	$13,754.00
82	051223751100	Structural steel member, 100-ton project, 1 to 2 story building, W12x16, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$19.47	$3.71	$25.11	$2,059.02

32	051223751500	Structural steel member, 100-ton project, 1 to 2 story building, W12x26, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$31.86	$3.71	$37.50	$1,200.00
23	051223751520	Structural steel member, 100-ton project, 1 to 2 story building, W12x35, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$42.48	$4.04	$48.62	$1,118.26
360	051223751900	Structural steel member, 100-ton project, 1 to 2 story building, W14x26, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$31.86	$3.30	$36.88	$13,276.80
70	051223752300	Structural steel member, 100-ton project, 1 to 2 story building, W14x34, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$41.60	$4.04	$47.74	$3,341.80
160	051223752700	Structural steel member, 100-ton project, 1 to 2 story building, W16x26, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$31.86	$3.26	$36.82	$5,891.20

85	051223752900	Structural steel member, 100-ton project, 1 to 2 story building, W16x31, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$37.61	$3.63	$43.13	$3,666.05
50	051223753100	Structural steel member, 100-ton project, 1 to 2 story building, W16x40, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$48.68	$4.09	$54.89	$2,744.50
63	051223753140	Structural steel member, 100-ton project, 1 to 2 story building, W16x67, A992 steel, shop fabricated, incl shop primer, bolted connections	L.F.	$81.42	$4.30	$87.96	$5,541.48
11	051223650450	Steel plate, structural, for connections & stiffeners, 3/4" T, shop fabricated, incl shop primer	S.F.	$34.07	$-	$34.07	$374.77
9	051223650500	Steel plate, structural, for connections & stiffeners, 1" T, shop fabricated, incl shop primer	S.F.	$45.14	$-	$45.14	$406.26
1742	053133506800	Metal decking, steel, slab form, galvanized, 2" D, 22 gauge, type UF2X	S.F.	$2.34	$0.53	$2.90	$5,051.80
5226	053123502650	Metal roof decking, steel, open type B wide rib, galvanized, 50 to 500 Sq, 1-1/2"	S.F.	$1.75	$0.46	$2.24	$11,706.24

		D, 20 gauge					
Total							**$99,635.41**

Appendix C

Level 1: BIM Execution Planning Process

Project Title: Student Life Building, Northampton Community College

Developed with the BIM Project Execution Planning Procedure
by the Penn State CIC Research Team

http://www.engr/psu.edu/ae/cic/bimex