Steidle Building Renewal Project

Rendering courtesy of Mascaro Construction Company

Technical Report I

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Construction Option

Executive Summary

For this report, the general aspects of the Steidle Building Renewal Project are covered. This includes the client information, project delivery details and the various building systems that are being implemented for the project. This report also contains a summary schedule and square foot cost estimate for the project.

This project is owned by The Pennsylvania State University and will be occupied by the Department of Materials Science and Engineering (MatSE). MatSE has steadily grown to the point where the Steidle Building is no longer sufficient to suit their needs. Their goals for this renovation are to upgrade the facility, reorganize spaces, promote collaborative environments, and create a modern atmosphere reflective of the department.

The Steidle Building project was designed by EYP Architects and Engineers and is being managed by Mascaro Construction Company. As part of the design process, EYP consulted with Keast and Hood Company for structural engineering and with Pennoni Associates for civil engineering work. Mascaro was contracted by Penn State as the construction manager at-risk for this projected. Their project team is overseen by the Project Executive and has a full-time on-site Project Manager. Under the Project Manager are the Site Superintendent, Project Administrator, Project Engineer and MEP Coordinator. In addition to the project delivery and project team structures, a site logistics plan was developed for each of the three phases, which may be found in Appendix A.

There are major renovations and new construction occurring for the structural and MEP systems, as well as a focus on creating a sustainable building. The structural system for the existing building uses steel columns supporting concrete slabs while the new central wing uses a variety of different concrete structural systems. The mechanical systems primarily uses two 70,000 CFM AHU's and two 65.000 CFM EAHU's to serve the building through a medley of FCU's, VAV's and RHC's. The electrical system is based on a 4000 Amp Main-Tie-Main Switchgear that receives electricity from Penn State's steam plant. Finally, this project has applied for a LEED certification with an end goal of a LEED Silver Rating.

The final part of this report describes the project's schedule and costs. The summary schedule begins preconstruction services, then proceeds to show how the project is scheduled over the three phases, including how the phases overlap with each other. Construction began on July 14th, 2014 and final completion is expected on July 18th, 2016. The costs for this project were determined by using a square foot cost estimate derived from RS Means 2015. The determined overall cost of the building is $21.5 million. However, the actual cost of the building is $40 million. This discrepancy is assumed to be because the estimate is for a new building with more typical, less advanced systems.

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Client Information

Although the primary owner is The Pennsylvania State University, the end users will be the Department of Materials Science and Engineering (MatSE), a part of the College of Earth and Mineral Sciences. MatSE provides education and research opportunities on material properties, applications and limitations. It has promoted collaboration between its students, researchers and faculty in order to provide a well-rounded curriculum. Over the years, MatSE's breadth of subjects has steadily expanded along with its technical capabilities. As a result, it has become an internationally recognized leader in materials education and research. However, this growth has also led to a shortage of space in the Steidle Building. Additionally, the building has only undergone minor retrofits over the past 70 years and has become insufficient to properly facilitate the kinds of research that MatSE wishes to conduct. MatSE's end goals for this project are to upgrade the facilities to meet the demands of the growing department, reorganize laboratory and office spaces to better serve research and education, create engaging and collaborative spaces, and to create a professional, modern atmosphere reflective of the department.

Project Details

For this project, Penn State hired EYP Architects and Engineers to design the Steidle Building. EYP then consulted with Keast & Hood Co. for the structural design and with Pennoni Associates Inc. for civil engineering work. Once the designs were finalized, the project was bid out in April of 2014. In the end, Mascaro Construction won the bid and became the Construction Manager At Risk for the Steidle Building Project. Mascaro then selected its subcontractors from among a list of Penn State's prequalified subcontract bidders and awarded contracts to over a dozen companies. A visual breakdown of the project delivery system, as well as a list of the primary subcontractors who were selected, can be found in Figure 1.

Mascaro's project team for this job is relatively small when compared to jobs of similar value. There is only one Project Engineer, one Site Foreman and one Site Superintendent for the entire site. It should be noted, however, that there is an MEP Coordinator that handles the HVAC, Electric, Plumbing and Fire Protection subcontractors – the project engineer manages the other trades on site. There is also a Project Administrator, who runs the trailer operations and is responsible for project documentation. Above these four is the project manager, who tracks the on-site production, manages the expenses, and maintains the project schedule. The project manager also reports to the Project Executive for Mascaro. For further details on the project staffing, refer to Figure 2.

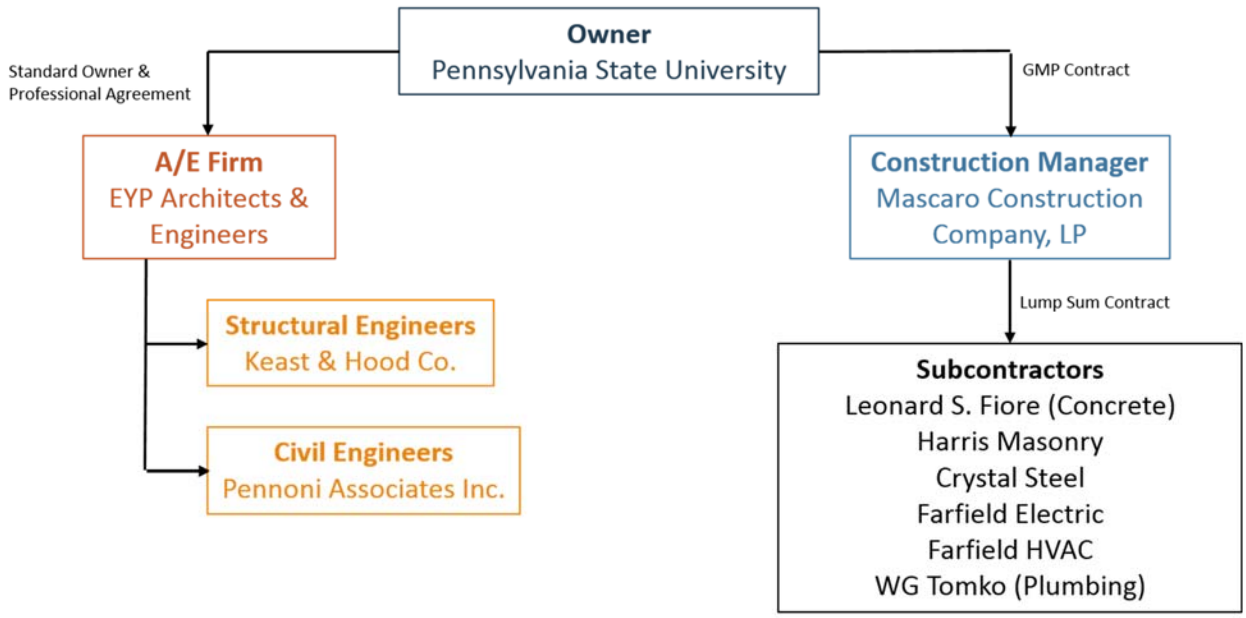


Figure 1 – Breakdown of the Project Delivery System

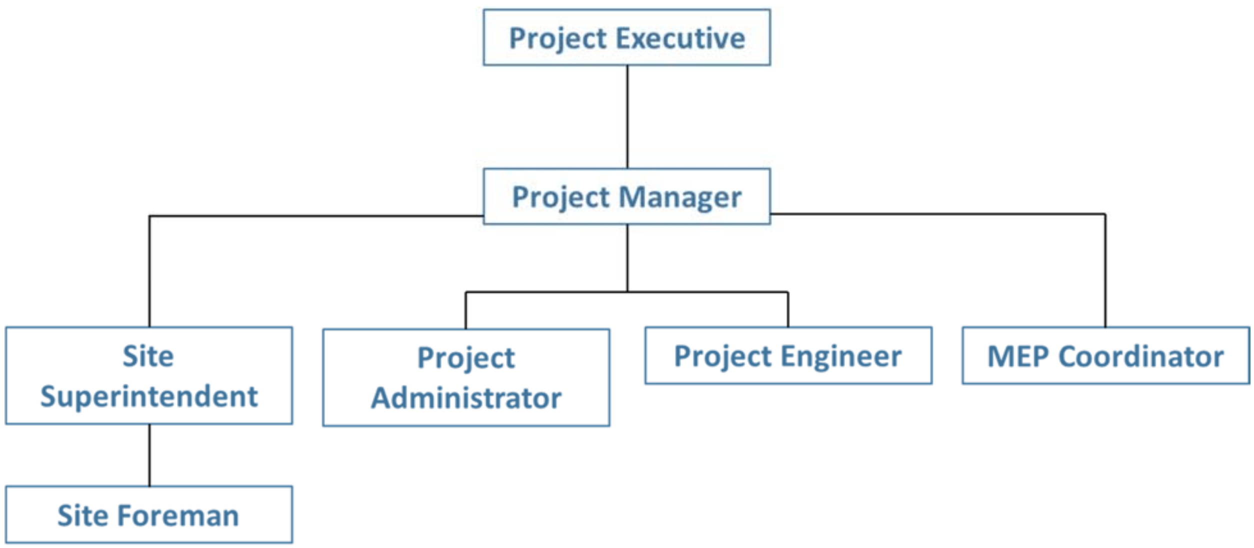


Figure 2 – Staffing Plan for the Steidle Building Renewal Project

The logistics for this project are broken down into three phases: demolition, structural work and interior work. The construction site itself is very condensed, with only just enough room for a few site trailers and delivery trucks. The site is surrounded by roads that need to remain open to the north and to the east and classroom buildings to the south and to the west. There are two entrances for deliveries and are assigned to a specific type of vehicle. The southwest corner entrance is for small delivery trucks, like pick-up trucks or vans. The southeast entrance is for large delivery trucks, like semis, flatbeds or cranes. For further details, refer to the site logistics plans in Appendix A.

Building Systems

Structural

The structural system for the existing building utilizes steel beams supporting concrete decks for the interior frame and load-bearing masonry walls for the exterior system. The roof is supported by a network of steel trusses for the east and west wings and long-span steel girders for the north side of the building. For the renovation, the exterior walls are being cleaned and touched up in order to preserve the historic look of the building. Meanwhile, the steel beams are being covered with Gypsum Wall Board, similar to the rest of the interior wall finishes.

On the other hand, the new central wing expansion primarily utilizes a concrete structural system with various subsystems used throughout. The second floor deck utilizes post-tensioned beams that run along the column lines through the 80 seat classroom and the computer learning lab. Since both of these rooms require a wide open space to promote the educational environment, having columns in the space is not allowed. However, there are columns on the floors above that are located right in the middle of the rooms. Since these columns and their respective loads cannot be supported by columns underneath, post-tensioned beams are utilized instead to support these columns. The third and fourth floor decks comprise of a flat plate concrete slab system to support the lab spaces above. The only item of note for these slabs is that there is additional reinforcing around the two mechanical shaft openings in each slab. This helps to prevent localized deformations in the slab for these semi-cantilevered areas. The fifth floor slab utilizes a one-way concrete slab system that is significantly deeper than the other slabs. That is because the fifth floor is where the mechanical penthouse is located, which houses the AHU's, Exhaust Air Handling Units (EAHU's), and other pieces of heavy equipment. These isolated loads create high bending forces in the slab beneath them, so deep concrete beams had to be utilized in order to counteract these forces.

The penthouse itself does not use a concrete system, but rather employs a steel framing system to support its enclosure. Of particular note are the roof wells where the exhaust fans for the EAHU's reside, as well as the exhausts for the fume hoods in the laboratories. Due to the fact that space would be limited in this area once the AHU's and EAHU's were installed, special coordination considerations had to be made for the steel in this area.

Mechanical & Plumbing

The mechanical system for this project is primarily serviced by two 70,000 CFM AHU's located in the fifth floor penthouse. These AHU's facilitate heating and cooling throughout the building through a variety of reheat coils, fan coil units, and VAV boxes. The reheat coils only provide heating to the supply air whereas the fan coil units and terminal boxes provide both heating and cooling to their respective spaces. The system uses 100% outside air intake, but recycles air through the fan coil units in the office spaces in order to lighten the heating and cooling loads.

On the other side of the mechanical system are the two 65,000 CFM EAHU's, also located in the penthouse. These EAHU's primarily service the lab spaces, where research often produces contaminants as experimental byproducts that need to be exhausted from the space. A unique feature of the exhaust system in the lab spaces is the use of portable exhaust extractors, or PEX devices. These PEX devices are either used for local bench work extraction or are hard-connected to equipment pieces that need dedicated exhaust lines. Another feature of this system is that it utilizes a Heat Recovery Unit in order to provide additional heating to the outside air before it reaches the AHU's. This helps to cut the demand on the AHU's, leading to smaller and less expensive units than originally needed.

While the air systems are located in the penthouse, the heat exchangers, system pumps, domestic water heaters, and glycol heating systems are located in the mechanical wing just to the west of the main building. This area is being completely gutted as part of the renovation so that brand new equipment that can handle the increased building demands may be installed. It is in this area that the steam line from Penn State's steam plant connects to the building to provide low-pressure steam for heating.

Electrical

The building houses a 4000 Amp Main-Tie-Main Switchgear that receives electricity from the aforementioned steam plant and distributes it to the entire building. The system itself is broken down into three distinct subsystems. The first is the emergency standby system that powers the emergency lighting and equipment in the event of a power failure. The second is the low-voltage system (120/208V) that powers the receptacles and low-demand equipment of the building. The third is the high power system (277/480V) that powers all of the lighting and high-demand equipment. Panelboards are localized to service specific areas of the building and are serviced from each floors east and west electrical rooms where the conduit risers are located.

Sustainability

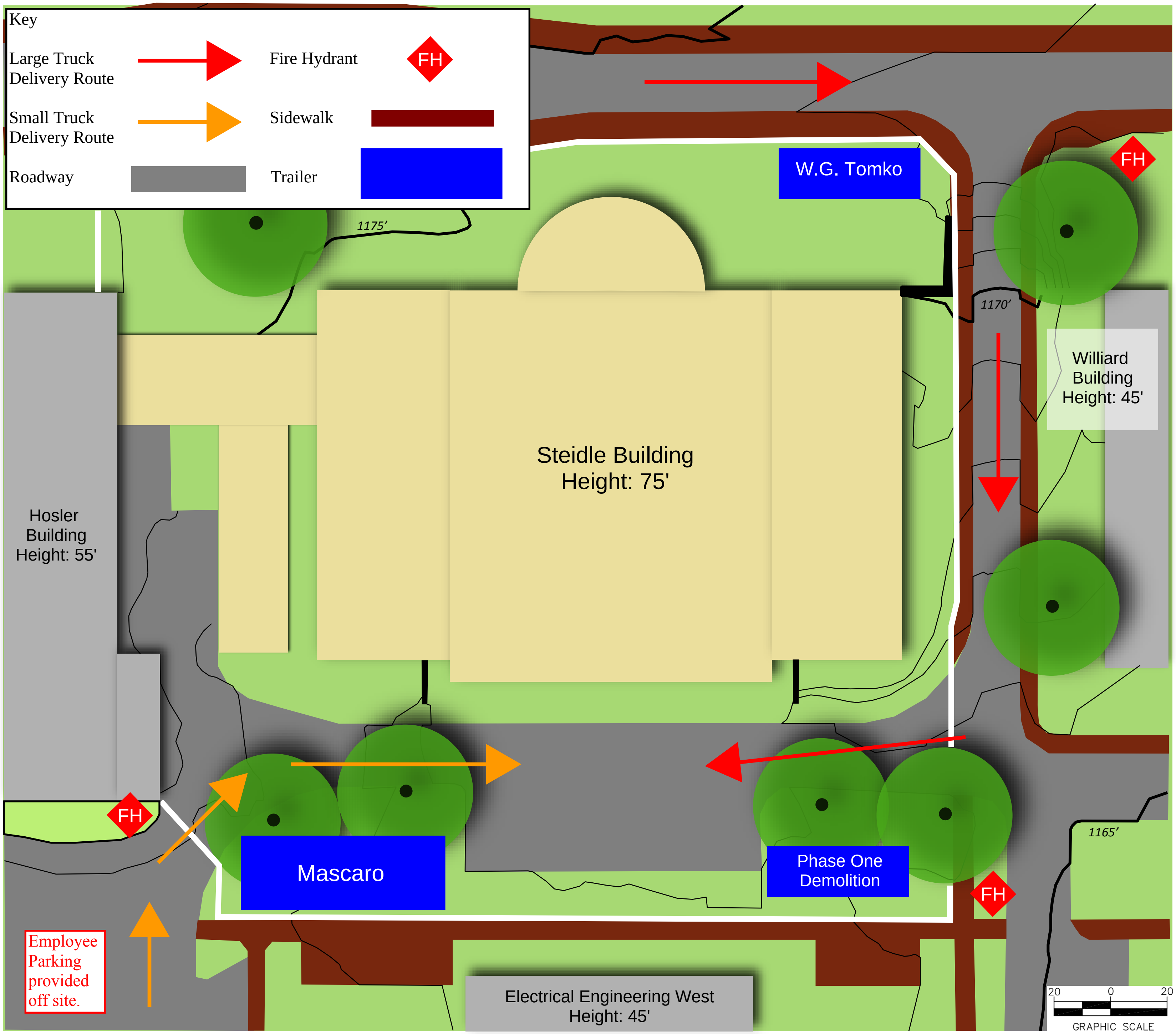
This project has applied for a LEED certification with an end goal of a LEED Silver Rating. Due to the nature of the renovation, sustainable design options were limited to natural lighting, solar reflectance, and HVAC system commissioning. Many of the sustainable site credits were already present due to the building's location on campus. The biggest focus for sustainability is on utilizing materials that were regionally produced, were manufactured with recycled content, and/or were created with low VOC content.

Project Schedule and Cost

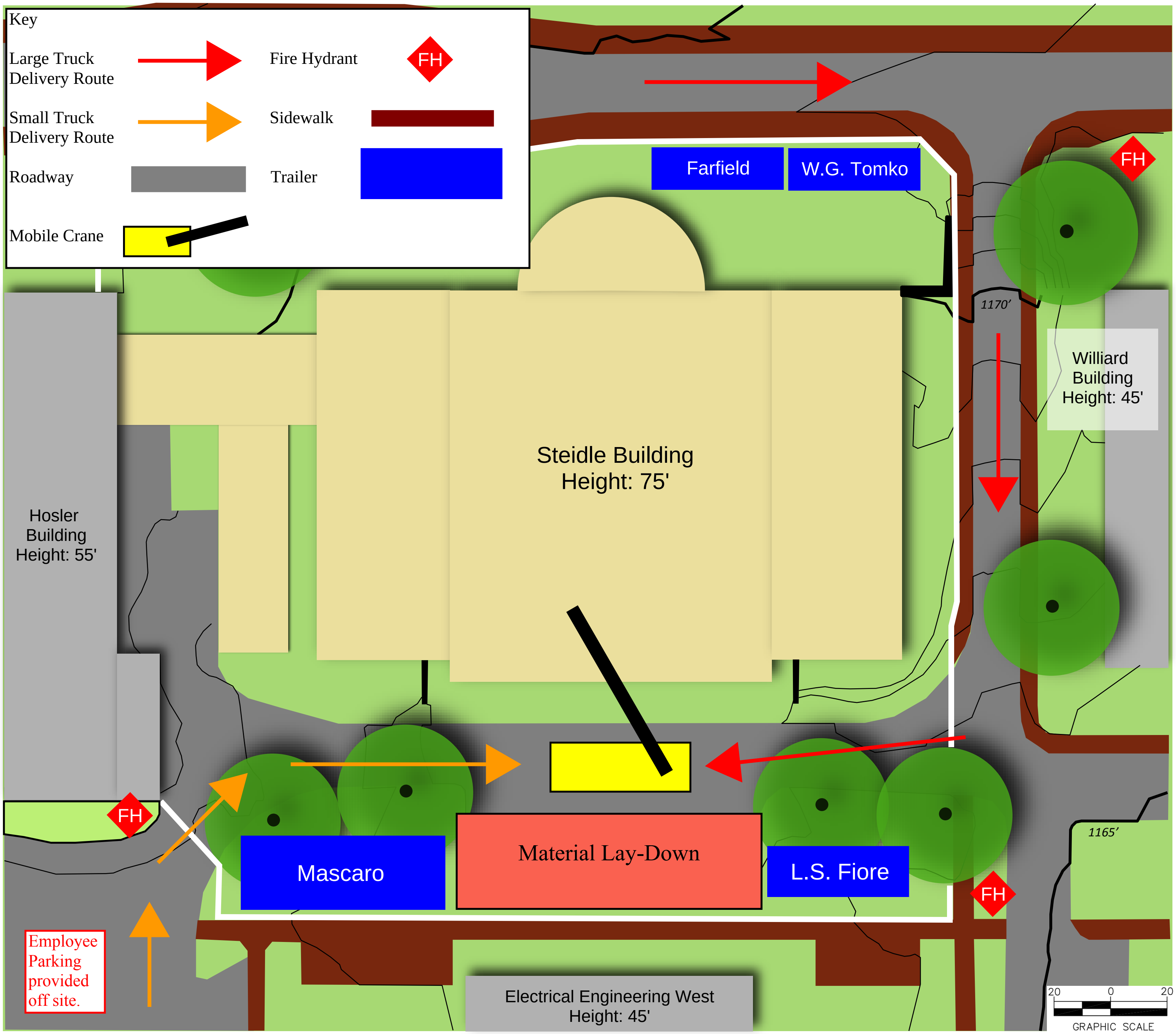
The schedule for the Steidle Building Renewal Project has two key driving factors. The first is the construction of the central wing's concrete structure. This is critical as the majority of the interior work is concentrated within this area, so delays to the new structure result in overall delays for the trades who need to work in that area. The other driving factor is the intense amount of MEP work happening in the building. A research-focused facility like this is very intensive in terms of the MEP work happening. Furthermore, coordination of all the MEP work and trades is vital to completing the project on time and on budget. The schedule, found in Appendix B, reflects the schedule's emphasis on these areas.

As for the project's cost, it is estimated that the building cost is $42 million and the overall construction cost is $52 million. That means that this building's cost per square foot is about $520. To see how this compares to industry averages, a square foot estimate was conducted. The building spaces were broken down by function and by whether it is in the existing building or the new central wing. After adjusting for height, perimeter, location and size, the estimated building cost is $21.5 million. This is 48.8% below the actual building cost. There are several reasons for this discrepancy. First, while the RS Means classifications are close to the space functions, there are still significant differences between the classification and the actual building function. Also, about two thirds of this project focuses on renovation work. While that may meant that there are fewer structural costs in this area, it also means that there will be higher interior and MEP costs. Second, RS Means Square Foot Costs 2015 was used to obtain the price values. Thus, it was assumed that the time modifier was 1.0. Lastly, the Electrical and HVAC system designs for this project is much more intensive and expensive than those required for traditional classroom and office spaces. When coupled with the specialized nature of the exhaust system and the use of localized panelboards, the actual costs will be significantly higher than the estimated costs, which are unable to quantify these parameters.

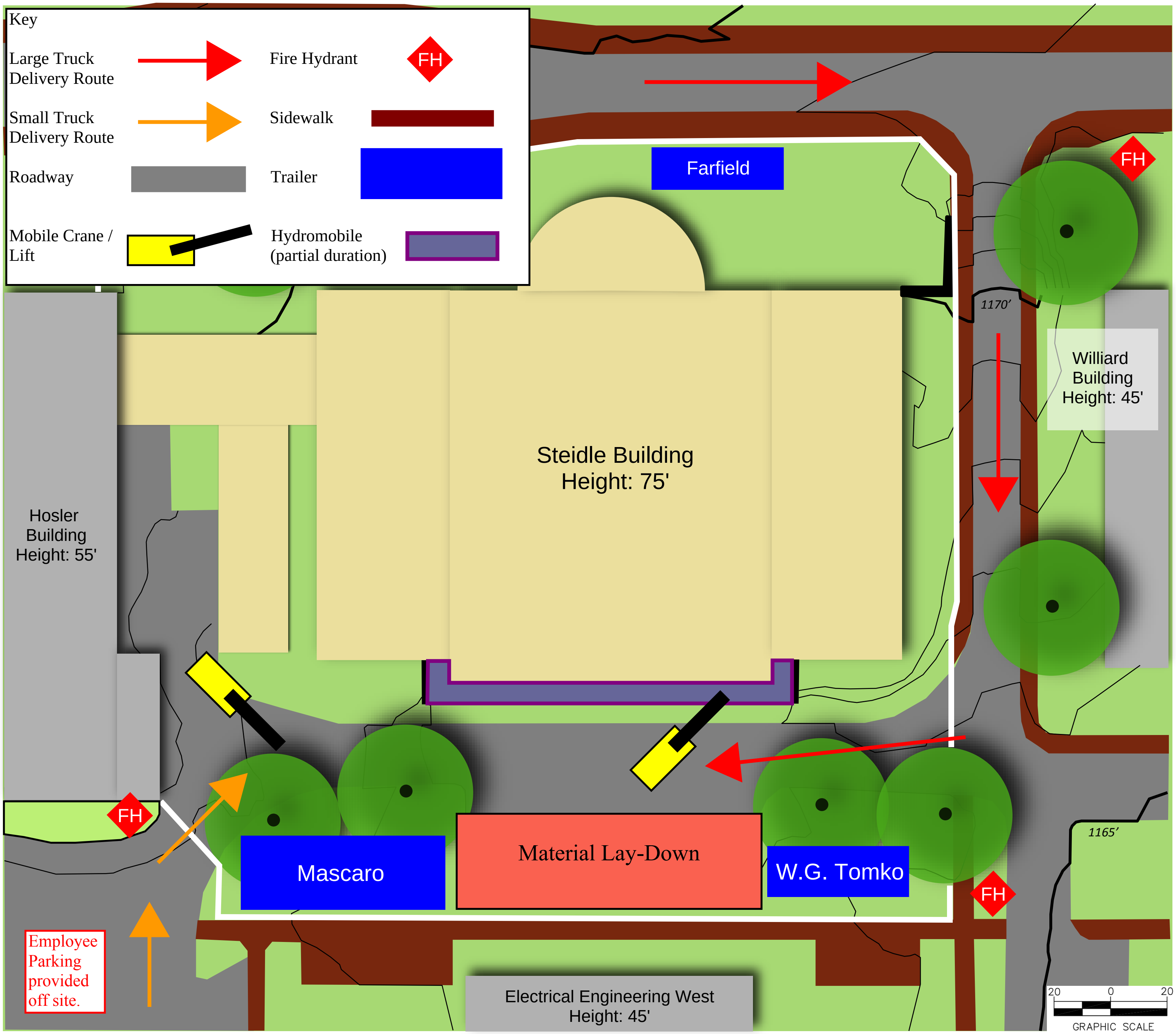
Appendix A: Site Logistics Plan, Phase I - Demolition



Appendix A: Site Logistics Plan, Phase II - Structural Work

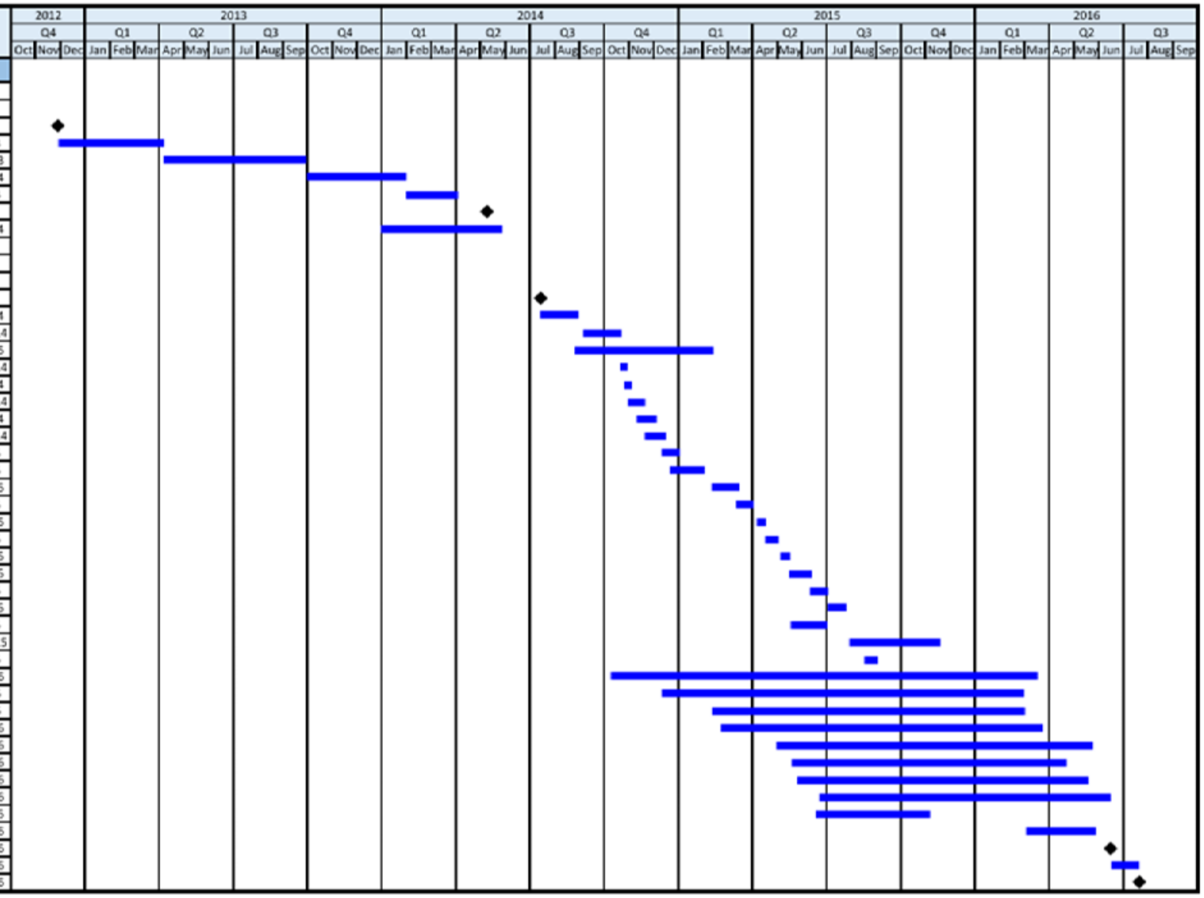


Appendix A: Site Logistics Plan, Phase III - Interior Work



Appendix B: Summary Schedule

Activity Name	Duration	Start	Finish
Steidle Building Renewal Project			
Pre-Construction			
Begin Project	0	11/27/2012	
Schematic Design	85	11/27/2012	4/4/2013
Design Development	90	4/4/2013	10/1/2013
Construction Documents	84	10/2/2013	1/31/2014
GMP Estimate / Bidding	60	2/3/2014	4/4/2014
Notice to Proceed	0	5/8/2014	
Permitting	131	1/31/2014	5/27/2014
Construction			
Start Construction	0	7/14/2014	
Abatement & Salvage Central Wing	43	7/14/2014	8/29/2014
Bulk Demo Central Wing	64	9/2/2014	10/22/2014
Demo Existing Building Interior	64	8/25/2014	2/12/2015
Bulk Excavation Central Wing	5	10/20/2014	10/24/2014
Install Micro Piles	12	10/23/2014	11/4/2014
F/R/P Pile Caps, Elevator Pit, Grade Beam	20	10/30/2014	11/19/2014
Backfill Central Wing	20	11/11/2014	12/5/2014
F/R/P 1st Floor Columns Central Wing	10	11/20/2014	12/16/2014
Prep and Place SOG Central Wing	10	12/9/2014	1/2/2015
F/R/P 2nd Floor Deck Central Wing	40	12/23/2014	2/4/2015
F/R/P 2nd Floor Columns Central Wing	32	2/9/2015	3/13/2015
F/R/P 3rd Floor Deck Central Wing	23	3/10/2015	4/2/2015
F/R/P 3rd Floor Columns Central Wing	8	4/6/2015	4/14/2015
F/R/P 4th Floor Deck Central Wing	17	4/15/2015	5/2/2015
F/R/P 4th Floor Columns Central Wing	10	5/4/2015	5/14/2015
F/R/P Penthouse Deck Central Wing	27	5/14/2015	6/10/2015
F/R/P Penthouse Pads & Beams Central Wing	21	6/11/2015	7/2/2015
Erect Penthouse Framing Steel	22	7/2/2015	7/24/2015
Replace Exterior Windows	44	5/18/2015	7/1/2015
Install Roofing & Metal Panel System Central Wing	111	7/29/2015	11/17/2015
Install Atrium Skylight	18	8/17/2015	9/4/2015
MEP Rough-In & Interior Finishes 1st Floor Exist.	317	10/7/2014	3/16/2016
MEP Rough-In & Interior Finishes 2nd Floor Exist.	280	12/9/2014	3/1/2016
MEP Rough-In & Interior Finishes 3rd Floor Exist.	249	2/10/2015	3/1/2016
MEP Rough-In & Interior Finishes 4th Floor Exist.	241	2/24/2015	3/23/2016
MEP Rough-In & Interior Finishes 1st Floor Central.	264	5/1/2015	5/25/2016
MEP Rough-In & Interior Finishes 2nd Floor Central.	212	5/18/2015	4/20/2016
MEP Rough-In & Interior Finishes 3rd Floor Central.	229	5/26/2015	5/18/2016
MEP Rough-In & Interior Finishes 4th Floor Central.	244	6/22/2015	6/16/2016
MEP Rough-In & Interior Finishes Penthouse Central.	97	6/16/2015	11/4/2015
MEP Start-Up & Commissioning	60	3/3/2016	5/25/2016
Substantial Completion	0		6/16/2016
University Move-In	19	6/17/2016	7/18/2016
Final Completion	0		7/18/2016



Appendix C - Steidle Building Renewal Project Square Foot Estimate Summary

Project Element	Existing Building - Offices	Existing Building - Labs	Central Wing - Classrooms	Central Wing - Labs
RS Means 2015 Classification	Office, 2-4 Story	College, Laboratory	College, Classroom, 2-3 Story	College, Laboratory
Number of Stories	3	1	1	4
Gross Square Footage	48,000	17,000	7,000	28,000
Perimeter	815	840	425	425
Average Floor-to-Floor Height	13.25	13	13	13.25
Base Cost / SF	**165.94**	**279.72**	**230.85**	**228.25**
Base Perimeter	535	551	350	698
Perimeter Adjustment / 100 Linear Foot	4.28	5.50	9.75	3.15
Perimeter Adjustment	**11.96**	**15.88**	**7.31**	**-8.60**
Base Story Height	12	12	12	12
Height Adjustment / Ft	1.64	1.73	2.40	1.3
Height Adjustment	**2.05**	**1.73**	**2.40**	**1.63**
Adjusted Cost / SF	**179.95**	**297.33**	**240.56**	**221.28**
Estimated Element Costs	**$8,637,620**	**$5,054,631**	**$1,683,938**	**$6,195,714**
Elevator, 3500 lb., 5 stops			$96,775.00	
Auditorium Chair, Upholstered, Spring Seat			$25,600.00	
Adjusted Element Costs	**$8,637,620**	**$5,054,631**	**$1,806,313**	**$6,195,714**
Location Modifier	0.94	0.94	0.94	0.94
Size Modifier	1.1	1.01	1.1	1.01
Total Element Costs	**$8,931,298.80**	**$4,798,866.91**	**$1,867,727.13**	**$5,882,210.87**
Total Estimated Building Cost	**$21,480,103.71**			
Total Estimated Building Cost / SF	**$214.80**			

Steidle Building Renewal Project Building Systems Estimate

	Existing Building - Offices	Existing Building - Labs	Central Wing - Classrooms	Central Wing - Labs	**Total Building System Cost**
RS Means 2015 Classification	Office, 2-4 Story	College, Laboratory	College, Classroom, 2-3 Story	College, Laboratory	
Total Building Element Costs	**$8,931,298.80**	**$4,798,866.91**	**$1,867,727.13**	**$5,882,210.87**	
Electrical System Cost	$1,446,870.41	$537,473.09	$323,116.79	$658,807.62	**$2,966,267.91**
Fire Protection System Cost	$312,595.46	$105,575.07	$46,693.18	$129,408.64	**$594,272.35**
HVAC System Cost	$1,152,137.55	$671,841.37	$268,952.71	$823,509.52	**$2,916,441.14**
Plumbing System Cost	$321,526.76	$1,218,912.19	$295,100.89	$1,494,081.56	**$3,329,621.40**
Superstructure System Cost	$928,855.08	$283,133.15	$177,434.08	$347,050.44	**$1,736,472.74**

Estimate Assumptions

The RS Means Classifications were chosen for each building element based on how closely the classi-fication matched the element. Due to the specialized anature of the project, as well as that fact that about 2/3 of the project is renovation, the estimated cost will significantly vary when compared to the actual cost.

Since RS Means Square Foot Costs 2015 was used for obtaining the construction values, the time modifier was assumed to be 1.0.

This project utilizes a 100% Outside Air HVAC system with a Heat Recovery Unit for the exhaust system. This system is utilized throughout the building and is much more expensive than conventional HVAC systems for offices or classrooms. Additionally, there is a significant amount of specialized equipment requiring dedicated exhaust lines which further increase the actual building costs. These conditions were not taken into account for the estimate as they cannot be properly quantified within the given parameters.

Finally, the electrical system for the project calls for localized panelboards for the lab spaces and the Write-Up rooms to handle the significantly higher demands of the equipment loads. This significantly increases the actual building costs compared to this estimate, which omits this factor as it cannot be properly quantified within the given parameters.

Appendix D: Presentation Notes