Mueller Laboratory Renovation: Final Proposal

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Executive Summary

The Mueller building renovation includes the full gutting of four of the building's seven flours. A large portion of the demolished materials will include ductwork and HVAC piping. This large quantity of similar construction debris makes the project a prime candidate for a large scale recycling effort. The possibility of recycling both on site and off site will be discussed. Furthermore, as the project moves from demolition to construction, transitioning methods of recycling will be examined. Associated costs with these methods can also be investigated.

This project also includes abatement of asbestos on the floors being renovated. This abatement takes up a not insignificant part of the schedule. Alternated methods of abatement will be looked at, as well as the legal requirements. Saving schedule time by increasing manpower for abatement, or by canceling the abatement all together, are both possibilities. Each option has its own ramifications on the project cost.

Roof reinforcement is necessary for new air handling units (AHUs) to be installed. Alternate placement of these units may eliminate the need for reinforcement. Different placement of the AHUs on the roof may change the reinforcement requirements. This opens up possibilities for structural breadth studies. Alternate AHUs that are lighter are another possibility. Different units, and different unit locations, would both have an impact on the mechanical system, another breadth opportunity.

Site logistics are another issue of the project. Located on the busy PSU campus requires a small job site, as well as disturbance to pedestrian traffic in the area. Alternate material storage and contractor parking locations are discussed. Use of space south of the project could open possibilities for a safer, cleaner job site. A more general study of different site possibilities is necessary.

Recycling

The Mueller building renovation includes significant gutting of four floors of the building. This demolition will create a large amount of construction waste, which could just be thrown in dumpsters and hauled away. However, Penn State seeks to be as sustainably minded as possible. Penn State currently diverts 60% of its waste from landfills by recycling and composting as much as possible. For all construction work Penn State requires the recycling or reuse of 75% of project waste. The following materials Section 8.11 of Penn State's general conditions for construction contracts states that "The contractor is required to recycle and/or salvage 75% of construction, demolition, and land clearing waste." To that end, Penn State specifically seeks to recycle or reuse the following materials:

•Cardboard
•Clean dimensional wood
•Beverage and food containers
•Brick and CMU
•Ferrous and non-ferrous metals
•Recyclable Plastic
•Gypsum wallboard
•Asphalt and concrete paving
•Ceiling Tile
•Carpeting
•Existing Windows
•Used equipment oil
•Useable appliances

More study is needed to see exactly how recycling can be implemented on the Mueller renovation. Demolition occurring early in the project will require large dumpsters to hold the ductwork, piping, and other demolition debris that are to be recycled. When the project moves into its construction phase there will be less to be recycled, so large dumpsters, and the jobsite space for them, will no longer be required. This transition between demolition and construction recycling needs to be carefully coordinated.

Another recycling solution was suggested by Dr. Riley during proposal presentations. There exist some companies that, for a fee, take unsorted demolition and construction debris and will sort and recycled them offsite at their own facility. This method would obviously accelerate the project schedule, since workers would not have to sort debris for recycling. Also this would eliminate the need for multiple recycling dumpsters for different materials. However, the cost of this service is unknown, and needs further research.

It is expected that a combination of both onsite and offsite recycling could be implemented to both save schedule time as well as minimize cost. Materials that are easy to sort for recycling, such as large pieces of ductwork and piping, could be recycled on site. More mixed debris such as gypsum, wood, conduit, and other waste could be sorted offsite. Whether such a solution is feasible will be researched next semester.

Knowledge gained from this research can be applied to more than just the Mueller project. Maximizing recycling on both new construction and building renovations is a critical industry issue. Minimizing the waste going to landfills is a huge step in making construction more sustainable. Any methods that make implementation of recycling easier, cheaper, or less time consuming without compromising results will benefit the entire construction industry. Interviewing companies that sort and recycle mixed construction debris may show great promise and encourage growth in this part of the recycling industry. Or perhaps more efficient ways of recycling on site can be found and their effectiveness demonstrated. Either way, studying the best way to recycle construction debris is crucial for sustainable construction.

Asbestos Abatement

In addition to general project waste, the Mueller renovation includes asbestos abatement on 4 of the building's 7 floors. Pennsylvania's Department of Environmental Protection (DEP) requires asbestos abatement prior to any demolition or renovation if the asbestos containing material (ACM) is "friable." The DEP states "any material that may be destroyed, broken or reduced to powder through normal hand pressure is considered friable and subject to regulations regarding abatement."

On the schedule this abatement takes from five to fifteen days for each floor, adding up to forty days of schedule time. If the ACM is not friable, perhaps abatement could be canceled, saving more than a month of schedule time, as well as the costs associated with abatement. Penn State's reasons for pursuing the abatement should be examined, especially since the three un-renovated floors of the building will still have asbestos at the conclusion of the project. If however the ACM is friable and abatement is necessary, methods to speed up the process should be examined. Additional manpower or longer workdays will shorten the schedule, but will have an effect on the project cost. This too can be analyzed.

Roof Deck Reinforcement

Early in the project the roof deck is scheduled to be reinforced from underneath to allow the new heavy air handling units to be placed on the roof deck. W8x40 and W12x65 beams are to be run underneath existing concrete beams supporting the roof deck. These large beams also require complex anchoring the concrete beams they support, as seen in the detail below.

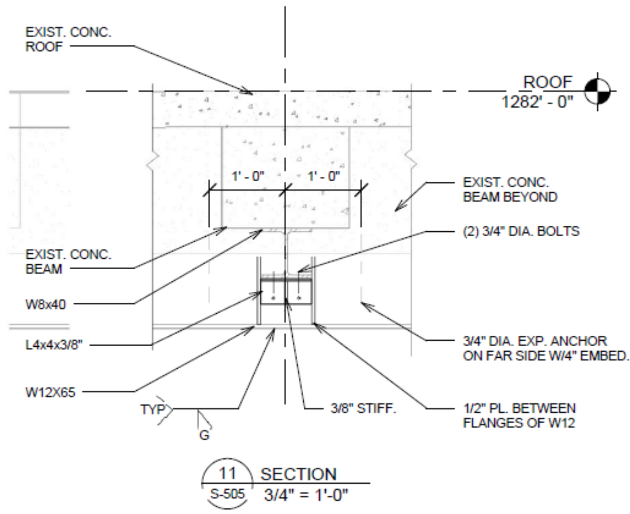


Figure 1. Roof deck reinforcing beams

This installation of steel reinforcement requires the demolition on the sixth floor to be complete. Investigating other ways to reinforce the roof deck, or alternate locations for the air handling units that would not require roof deck reinforcement, could prove valuable. If a solution is found that does not require roof deck reinforcement then the placement of the AHUs is no longer dependent on the completion of the sixth floor demolition. This would lead to both schedule and cost savings. However, if reinforcement is required, alternate methods should be investigated. Perhaps installation of vertical columns instead of horizontal beams could provide the necessary reinforcement. Or, if horizontal reinforcement is necessary, prefabrication of the reinforcement components might save schedule time. Either way, further investigation is warranted.

This research can also fulfil several breadth requirements. Calculating the structural loads of the AHUs on the roof and the resulting required reinforcement delves into Structural breadth. All the loads on the roof, as well as the capability of the existing roof structure, will need to be known before alternate AHU placement and methods of reinforcement can be investigated.

If relocating the AHUs to near the edge of the roof is advantageous structurally, the AHUs may need to be shielded by a viewing screen in an Architectural breadth investigation. Existing buildings in the area should be examined to see their methods of hiding rooftop air handling equipment. If a view block is needed, it should match the ductwork-concealing brick shafts being constructed on the corners of the Mueller building during the renovation.

And lastly, comparison of the existing AHUs and lighter weight options with similar performance both are part of a Mechanical breadth study. A higher cost unit whose weight was significantly less would eliminate the requirement of roof reinforcement costs, perhaps leaving the project cost unchanged but shortening the project schedule. If AHUs should be moved for structural reasons, the impact of the move on the planned ductwork and piping routes should be examined.

Site Logistics

From the north side of the Mueller Building to the south side the ground drops roughly 15 feet over a 150 foot run. This ten percent grade carries rainwater off the site to even steeper slopes south of the building, as seen in the topographic map below.

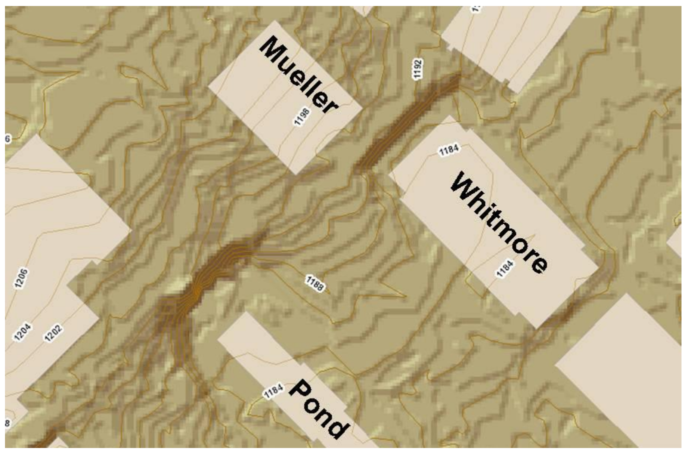


Figure 2. Red lines represent 2 ft contours.

Without proper prevention sediment and other contaminants could run off the site and into storm drains, contaminating a wide area.

On the north side of the site is the access road to the Mueller renovation. It branches off from the PSU Library loading dock. Currently construction dirt, mud, and debris on trucks can easily enter the Library driveway and nearby Curtain road. Furthermore, that stretch of Curtain road is subject to particularly heavy pedestrian traffic both on the sidewalks and crossing the road. Deliveries to the site and trucks hauling away debris have to enter this congested stretch of road

Relocating the site access road to the south could solve these problems. A proposed new job site perimeter is shown below.

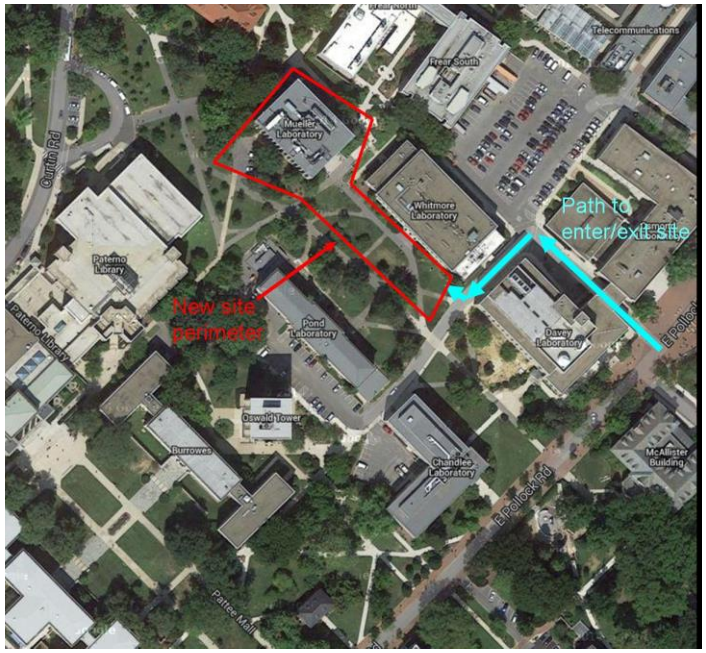


Figure 3. New site perimeter and entrance.

The new site entrance is from the south, with the existing service road between Whitmore and Davey Laboratories acting as an access road. The large area between Whitmore and Pond laboratories has only a slight grade, minimizing runoff concerns. This space could contain contractor parking, material storage, and a truck wash station. There is also a redundant sidewalk, such that with careful planning the north-south pedestrian traffic could remain unimpeded. This larger, flatter job site would be safer, less crowded, and minimize contamination of the site's surroundings. Impact to project cost is minimal, while a larger site could speed up the project schedule.

This plan is not perfect. Access to Whitmore Lab would be compromised. Also deliveries would now have to use Pollock road, which also has heavy pedestrian traffic. Only a full investigation weighing benefits and disadvantages will tell whether moving the job site south is feasible.

Conclusions

All of these alternate construction options deserve further investigation. The degree to which recycling and asbestos abatement is pursued will have an effect on both project schedule and cost. Finding an option where roof reinforcement is unnecessary would also cut costs and schedule duration. And examining other possible project parking and delivery areas affect both the project's impact on its community and the environment. Studying each of these options more will quickly show which are not viable and which do have potential to reduce cost, duration, and impact on the building's environment.

Appendix 1: Breadth Studies

Structural

The Mueller renovation requires reinforcement of the roof deck to allow larger, heavier air handling units (AHUs) to be installed on the roof. Calculating the structural loads of the AHUs on the roof and the resulting required reinforcement will show what alternatives are possible. Only through this structural analysis can the viability of changing the location of the AHUs be seen. The possibility of vertical column reinforcement, instead of horizontal beam reinforcement, can be checked through structural investigation.

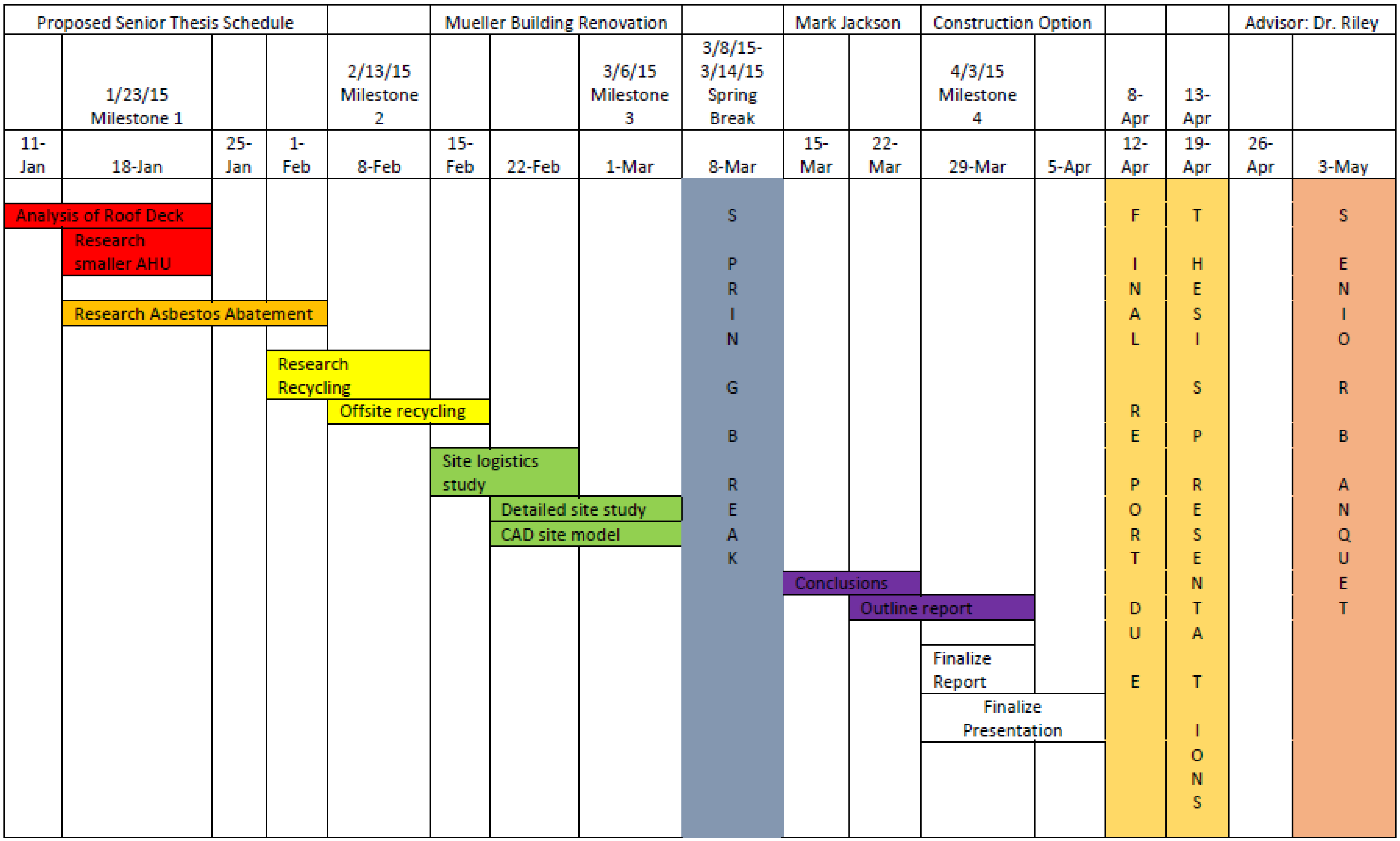
Architectural

If for structural reasons it makes sense to relocate the AHUs to near the edge of the roof then the AHUs may need to be shielded by a viewing screen. Existing buildings in the area should be examined to see their methods of hiding rooftop air handling equipment, as well as the materials used. If a view block is needed, perhaps it should match the ductwork-concealing brick shafts being constructed on the corners of the Mueller building during the renovation. The impact of any proposed view block on AHU maintenance and repair should also be investigated.

Mechanical

Comparison of the existing AHUs with lighter weight options of similar performance should be studied. A higher cost unit whose weight was significantly less would eliminate the requirement of roof reinforcement costs, perhaps leaving the project cost unchanged but shortening the project schedule. However, perhaps no lighter weight units have similar enough performance. If so, the building's requirements should be reexamined to check whether or not a smaller, less capable AHU would be acceptable. If from the structural analysis it is found that AHUs should be moved to eliminate the need for reinforcing, the impact of the move on the planned ductwork and piping routes should be examined. Also, if one large AHU can be broken into smaller component pieces (separate heating and cooling coils, separate heat exchanger, etc.) perhaps this distribution of AHU components across the roof will require less or no roof reinforcement.

Appendix 2: Spring Analysis Schedule



Legend	
Analysis 1	AHU placement/roof reinforcement
Analysis 2	Asbestos mitigation requirements
Analysis 3	Recycling optimization
Analysis 4	Site logistics study and 3D model

Milestone	Description
1	Structural/mechanical breadth complete, schedule/cost changes calculated.
2	Abatement research and recycling research complete.
3	Site study and 3D model complete.
4	Final report complete, 2nd draft of presentation slides complete.