AEI Team
#04-2013

February 22, 2013

Innovative Construction Management and Construction Methods

ASCE | STUDENT COMPETITION

Team 04-2013

Our one true aim is to enhance the quality of the communities we work with through innovative ideas and an integrated design approach.

Ingenuity | Quality | Enjoyment | Integrity

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Executive Summary

Our construction management team is excited to provide skills and expertise for the construction of the new Reading Elementary School. With our services, the Reading School District will experience an innovative construction experience which is both within budget and meets the schedule required by the Reading School District. Our preconstruction team has collaborated with the school's design specialists to ensure a high quality product. Planning and coordination has been broken into five main sections in this report. Below is a summary of construction measures and planning executed to guarantee a successful project.

Section I: Project Delivery – The state of Pennsylvania requires a CM Agency with Multiple Prime delivery method. A Design-Assist approach is being utilized to encourage collaboration between design professionals and CM/Contractor.

Section II: Building Information Modeling (BIM) - BIM will provide savings in both cost and schedule, and instill the owner with confidence in our team's dedication and ability to deliver a successful project. Revit has been used to create a virtual model. Clash detections were performed to discover building system interferences before construction begins, providing cost savings on wasted materials and maximizing filed productivity. A 4D model was created to better understand construction sequencing and scheduling effects. A structural model was developed, making steel estimates detailed and accurate. Virtual mock-ups were created for constructability and architectural review, eliminating substantial costs, time and resources associated with the construction of an infield mockup.

Section III: Innovative Engineered Systems – Multiple innovative building systems were incorporated to create a high-performance product. Prefabricated insulated panels provide a high performance enclosure system, saving on construction costs and schedule. A Rammed Aggregate Pier foundation system will provide 20% cost savings, as well as schedule savings and greater bearing capacity. A light-weight green roof system will minimize storm water runoff and heat island effect, while also providing an integrative learning experience for students. A basement footprint modification is proposed to mitigate cost and performance issues associated with the original complex footprint. LEED Silver Certification will be achieved at minimal additional cost, largely in part to the multiple innovative engineered systems.

Section IV: Site Logistics, Phasing and Planning - Site logistics and phasing plans have been developed to guarantee worker safety and an efficient, effective, fast-paced schedule. Three dimensional logistics and phasing plans were created to aid and better communicate these developments. A crane location and associated pick visual was created to ensure efficient use of the crane during precast panel erection. A proactive commissioning plan was developed to save the owner long term operating costs.

Section V: Natatorium/Clinic Addition – The community pool, 24-hour clinic and administrative space requested by AEI have been proposed as an Add Alternate to the project. This work would include full demolition of part of the existing school for a community natatorium and interior demolition of the remainder of the building for the clinic and administrative space. Construction would commence June 2, 2014, with Substantial Completion September 5, 2014.

With this vast collection of innovative construction ideas and engineered systems, the Reading School District can expect a high performance building delivered within a $19,000,000 budget and an aggressive yet confident schedule of 16 months for the Reading Elementary School new construction and renovation of the existing elementary school. Following is a more detailed breakdown of the five sections described above.

Introduction Reading Elementary School is the focus of the Annual Architectural Engineering Student Design Competition for 2013. Located in an urban setting in Reading, Pennsylvania, the three story elementary school has been shaped by the integrative design and construction strategies of our team with the goal of achieving a constructable and affordable high performance building for both the school district and the community. The elementary school is also required to qualify or exceed LEED certification under the LEED 2009 for Schools New Construction and Major Renovations.

The mission of our team is wide spread, but strives to be purposeful in creating a building that is flexible and maintainable for the school district and provide a space with multiple resources that help a community thrive and flourish. The design of Reading Elementary has been carefully planned to meet several goals. These goals include: helping students learn and increasing test scores, increasing daily attendance from students, improving teacher satisfaction and overall employee retention, improving operations and maintenance costs over the life cycle of the building while building the school at a reasonable, median cost to Pennsylvania. Ideally, Reading Elementary School Project is a platform for the growth of a community.

Team Mission Statement

Our one true aim is to enhance the quality of the communities we work with through innovative ideas and an integrated design approach.

Team Core Values

Ingenuity | Quality | Enjoyment | Integrity

Ingenuity – Our team strives to bring an original and inventive perspective to the design and construction of Reading Elementary that inspires community members and students.
Quality – Our team strives to bring a degree of excellence unmatched by competitors.
Enjoyment – Our team believes that the working together in an integrated and collaborative environment can bring enjoyment to the design and construction process.
Integrity – Our team believes in abiding by a set of strong more and ethical values. Please reference our integration paper for more detail on team values and goals.

Project Goals The city of Reading is in need of a catalyst to propel it into forward movement towards a healthy and thriving community. The team approached this project as an opportunity to provide just that. The excitement and enjoyment surrounding this project would encourage learning at an elementary level, setting Reading's families and its youngest citizens on a path toward education, success and a bright future.

Based on this thought process, the developed team goal was *to create an innovative, high-performance environment in a way that stimulates involvement in both education & the community.* To achieve this main goal, detailed project tactics or strategies were developed to guide the design process and major team decisions. These three project tactics included **Functionality**, **Efficiency** and **Appeal**. When these three tactics were attained the ultimate goal yielded positive outcomes for the community.

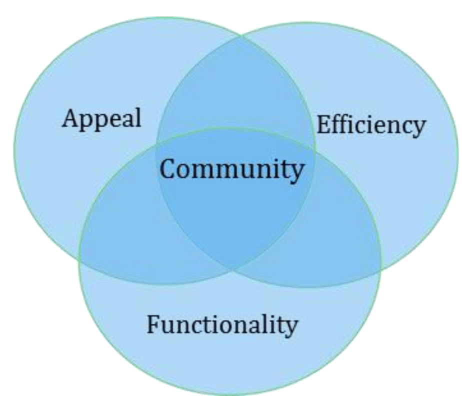


Figure 1: Project Tactic Visual

The first tactic is to design all building systems and components to best serve their specific functions within the building. This was achieved by breaking down the building into smaller packages which have distinct, unique and identifiable functions which drove the design of the building systems within each package. A few examples of the packages that were developed include Building Enclosure, Classrooms, Administration, Multi-Purpose Room and Natatorium and Clinic Renovation. The team defined the most critical functions of each of these packages, and made sure to revert back to this definition whenever design issues or questions came about. These ideas were manifested in the project tactic of **Functionality**.

The next tactic is to create a building which is affordable and long lasting, allowing the community to get optimal use out of the building. This is achieved by designing and engineering building systems which will best serve the building's inhabitants over an extended building lifecycle. Analysis of all systems using life cycle cost assessments and sound engineering judgment also led to the accomplishment of this tactic. These ideas were manifested in the project tactic of **Efficiency**.

The third and final tactic is to create an appealing building design which attracts people to it both inside and out of the community. By creating this appeal, students, families and faculty will be more inclined to be a part of this positive learning environment. This was achieved by creating a visually appealing and comfortable environment that accommodates all occupants. These ideas were manifested in the project tactic of **Appeal**.

One major hurdle when working through the design and construction planning of the project was balancing the three previously defined project tactics. For instance, the most efficient mechanical system might be a major hindrance on achieving the function of the classroom. Or, what might be an appealing design architecturally may not be the most energy efficient. Successful team integration and communication was extremely helpful in having insight from multiple design specialties in deciding what was best for the overall outcome of the project. In these instances, we also made sure to keep in mind the overarching team goal as defined previously of providing an innovative, high-performance environment in a way that stimulates involvement in both education and the **Community**. Each team member was held accountable in not only their discipline's system designs, but more importantly in the overall success of achieving both the team goals and project tactics.

Master Plan Construction phasing and sequencing was initially devised based on the supplied architectural documents for Reading Elementary school and altered as our design developed. The supplied construction documents became the basis for the design and engineering design decisions for the project. From these documents, and the given constraints we have developed our master plan for the construction of the new Reading Elementary School as well as the clinical space and natatorium. The basis for our master plan consists of two central ideas. Phase 1 of the Master Plan is to 1) build the new construction project, and Phase 2 is to 2) concurrently renovate the existing elementary school that is located on the same lot as the new construction building to house the clinical space and natatorium.

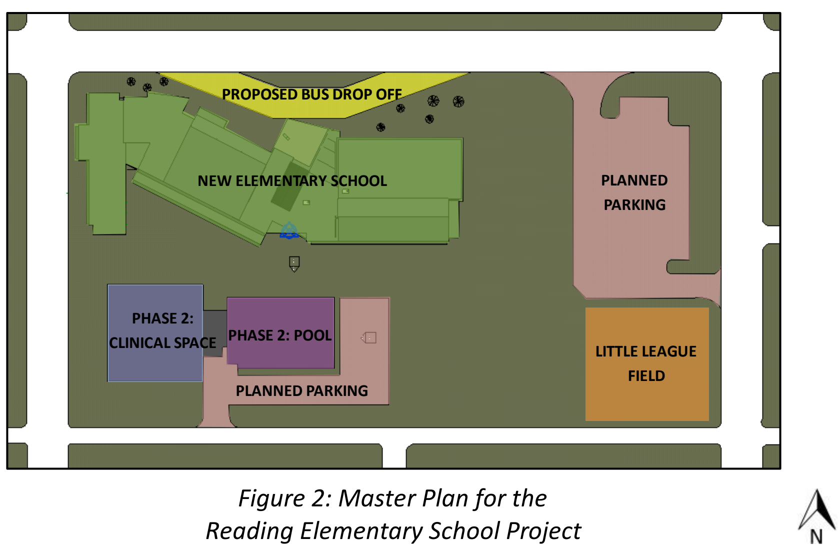


Figure 2: Master Plan for the Reading Elementary School Project

A major design change agreed upon was the positioning of the new elementary school on the proposed site. When compared to the original site plane, the new elementary school has been flipped along the y-axis due to the effort of conserving open space, locating a new bus loop, and providing a secure facility. Reference Figure 3 & Figure 4 to compare the original site plan with the proposed changes.

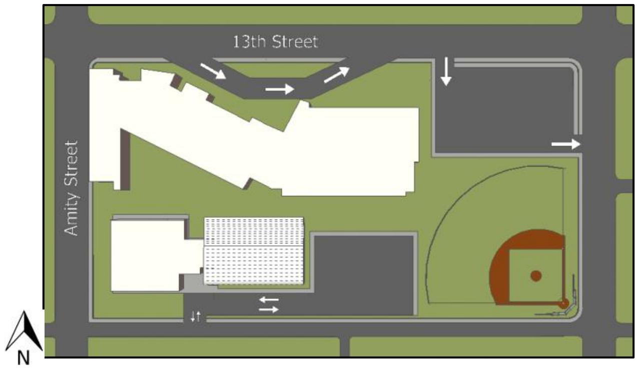


Figure 3: New Site Plan

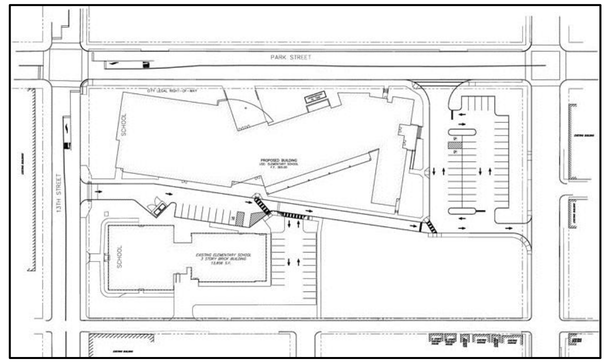


Figure 4: Original Site Plan

Additionally, the existing elementary school will house the 24 hour clinical space requested by the city in the east wing of the building and also the natatorium in the west wing of the building. The decisions to renovate the building versus construct a separate structure were largely due to the need to preserve open space for elementary school students. The details will be discussed further in the Phase II section of this proposal. Reference Appendix K for a larger view of the Master Plan.

Section I: Project Delivery

Project Delivery Method

By state standard and requirements, the Reading Elementary school will be a publically bid, Multiple Prime Contract with Construction Management Agency. Reading School District will contract with our construction manager team along with the other major trades involved with the project including, but not limited to the electrical subcontractor, mechanical subcontractor, steel contractor, concrete subcontractor, and precast wall panel subcontractor. There will be several other trades involved in the construction of the school as well that will cover other scopes of work including roofing, fire protection & sprinkler, security, flooring, and interior finishes. Reading Elementary school will also be responsible to hold these contracts.

Although this is the standard for public work in Reading, opportunities exist to modify the project delivery method in Pennsylvania. We propose that the project delivery method be modified to Construction Management Agency with Multiple Prime Design-Assist Subcontractors. Although at a premium, the benefits to modifying the project delivery method could help alleviate possible problems encountered in the construction process, but more specifically with the renovation of the existing building.

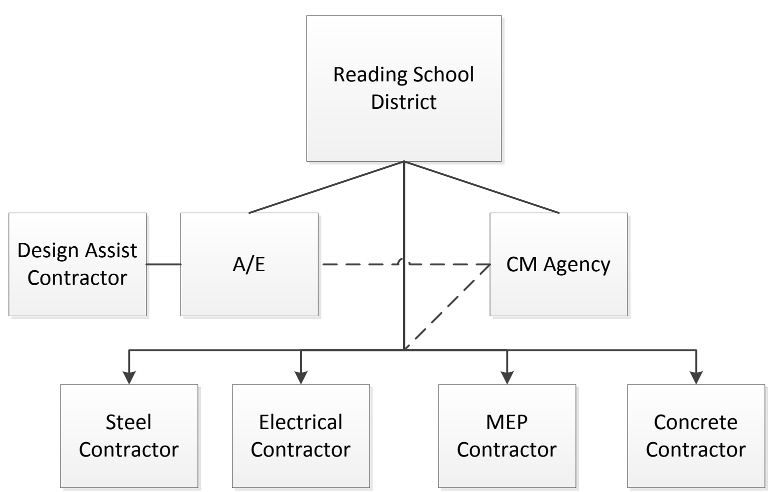


Figure 5: Multiple Prime with Construction Management Agency Summary

Due to the nature of work of renovations, change orders for unforeseen conditions will likely be inevitable.

The role of Design-Assist subcontractors will be to provide constructability and value engineering during the upfront preconstruction planning for this project. During the renovation, the project will benefit from the ability for the team to catch design errors in the upfront planning and better adjust to changes in the field. The planning and construction phases of the project also have ability to take place in a more condensed time window and the opportunity for a shortened construction schedule when compared with the traditional design-bid-build approach.

Budget The budget for the Reading Elementary School project has been determined based on an overall square foot estimate using RS Means and combined with school district spending and resource allocation information to better assess the reality of the school district's limitations. This information was found specifically at openpagov.org. The actual construction cost for the estimated systems be found in the construction estimate portion and Appendix D of this proposal.

From the square foot cost estimates, Reading Elementary School was first expected to total $19,343,000.00. This number was determined using union labor for the Reading Area and the building's given parameters. The construction cost for the renovation of the existing elementary school to house the clinical spaces and natatorium totals near $3,000,000. Reference Appendix B for a detailed breakdown of the Renovation Budget. Government information revealed by openpagov.org demonstrated an annual budget for Facilities & Maintenance at Reading Area School District from year to year of about $1,000,000. Reading School District's revenue sources stem from local, state, and federal money along with other miscellaneous sources that provide a fraction of the district's revenue. In 2009, enrollment was at about 17,600 students. From these allocated funds, the school district spent a total of $215,100,555 in total funds for 2009-2010.

Based on the above processes and considerations, the proposed design and construction budget for Reading Elementary was determined to total $22,343,000. We propose that a construction budget of $19,000,000 be implemented for both the construction of the new elementary and renovation of the existing school, with $16,000,000 allocated exclusively for the new construction because of our team's assertiveness in design and constructability efforts. Reference Appendix B for the proposed budget of the project.

From this construction budget, the construction team performed detailed analysis of the designed systems to construct a more accurate pricing for the building. These estimates include the General Conditions Estimate, mechanical and electrical systems estimates, green roof estimate, foundation estimate, structural steel estimate, and enclosure system estimate. This information is dissected within the Cost Estimate section of our proposal and detailed within our Appendices.

Construction Schedule The proposed schedule is 16 months long, beginning June 2013 and concluding September 2014. This schedule includes the full construction of the new elementary school following with the renovation of the existing school providing a retrofitted building for the natatorium and 24 hour clinical space. Phase 2 of construction will immediately start after the school year commences in June 2014. In addition to construction activities, further critical activities were added to mitigate scheduling issues which would delay substantial completion. These activities include design completion, submittals, mill orders and material deliveries. A separate Design and Procurement Schedule was developed to plan these activities and can be seen in the supporting drawings at the end of the

Table 1: General Conditions Summary

Reading Elementary GC Summary		
General Conditions	**Cost**	
Staffing	$	673,880.00
CM Reimbursables	$	229,040.00
Temporary Utilities	$	157,667.00
Temporary Facilities	$	60,400.00
Total Cost:	**$**	**1,120,987.00**

submittal. The long lead items identified by construction team include: steel, precast panels, kalwall system, mechanical and electrical equipment. Also, see the supporting drawings for a foldout of the detailed schedule of the new elementary school and renovation.

Cost Estimate The general conditions estimate Summary was determined off of a 16 month schedule and amounts to $1,120,987. This number includes Staffing, CM Reimbursables, Temporary Utilities and Temporary Facilities and is approximately 5.89% of the total project budget. This is evenly split over 16 months of construction at $70,062. Refer to *Table 1* above, as well as Appendix B for a more detailed General Conditions Estimate breakdown and breakdown of the Project Budget.

The detailed structural estimate has been determined utilizing the design of steel system and several takeoffs performed using RAM software. The steel system consists of 271 tons of steel and totals at $1,574,810. Refer to Appendix C for a detailed steel estimate.

The enclosure cost is comprised of the material and installation pricing of both the Carboncast Insulated Wall Panels and the glazing. The total cost of the CarbonCast Insulated Wall Panels is $1,285,200. Glazing costs will total at $611,000. Costs for mullions, aluminum framing, and light shelves are budgeted for $100,000. This package totals at $1,996,200.

The proposed green roof system for the new elementary school is supplied by American Hyrdotech. The green roof is located on the west wing of the building and will serve as a learning environment accessible to teachers and classes. Based on information from American Hydrotech, the total cost for this green roof will total at $121,400. Reference Appendix D for a detailed cost estimate breakdown.

The estimate for the rammed aggregate pier foundation system totals at $617,600 based on a 20% savings of the estimated micropiles system of $772,000.

Section II: Building Information Modeling

Virtual Mockups For Reading Elementary, not only was a detailed model prepared in Revit that integrates the architectural model with the MEP and structural elements, but virtual mockups were built to show a more detailed representation of certain spaces. A virtual mock up for the typical classroom has been created in SketchUp and has been used to coordinate between the MEP design for the building and lighting elements along with structural interfaces.

The preconstruction mockup will be used to test construction details, performance, and convey the architectural appearance of the final space. Virtual mockups are advantageous because they cut down the cost of an infield physical mockup. This not only saves on costs, but reduces time and allows resources to be used in the field for production. The typical classroom mockup allowed for our team to make decisions and quick alterations to our design.

Additionally, virtual mockups were created for site logistics plans for both proposed phases of construction, as well as substantial completion. The

Figure 6: Virtual Mock Ups Created in Trimble SketchUp

proposed use for these additional mockups includes renderings, 3D animations, and constructability assessments. Reference Appendix F for the virtual mockups provided by our team.

Clash Detection A series of clash detection analyses were performed throughout the preconstruction process as design developed to minimize schedule delays and provide cost savings on wasted equipment. Critical spaces were determined by designers and construction specialists. These areas included MEP intensive areas such as corridor plenums, as well as critical and unique spaces such as classrooms and the multipurpose room. Constructability issues and critical design adjustments were addressed at the preconstruction stage rather than in the field. Refer to Appendix E for an example of the clash reports.

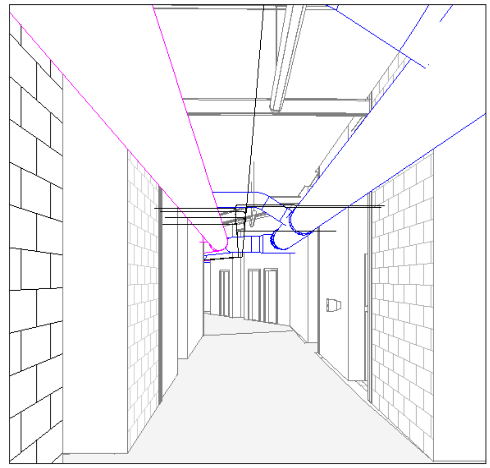


Figure 7: Screenshot depicting a clash between column and duct

4D Modeling Related to Virtual Design & Construction, a complete 4-Dimensional model of the new elementary school has been developed with Navisworks. Its purpose is intended to create a visual communication of the construction phasing and construction sequencing with the client and construction team.

Proactive Commissioning The developed model for Reading Elementary will be enhanced in order to provide more value for the client in relation to the Facilities Operations & Maintenance department within the school district. Cost savings will be found in minimized maintenance time and therefore less staffing. Utilizing Maximo an Asset Management Software, the client can better track their current equipment with a unique identifier for each piece of equipment and maintain best practices among their facilities managers. All Owners' Manuals for equipment can also be integrated into the model.

Section III: Innovative Engineered Systems

Precast Panel Enclosure System The enclosure system will be CarbonCast Insulated Wall Panels. This is a non-loadbearing, precast panel system with a face brick and limestone veneer finish. The wall panel is made up of two concrete wythes, one located on the interior and one on the exterior, separated by continuous insulation and held together with a carbon fiber shear truss system. The panels use less concrete because of the interior insulating foam and a lightweight carbon fiber shear truss and reinforcing system, which makes these panels lighter in weight compared to other precast concrete panels. The panel also delivers an exceptional acoustical barrier and will shield noise coming from off of 13th & Amity Street.

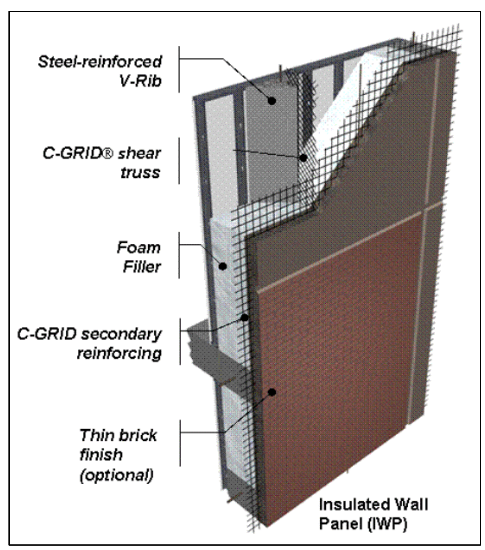


Figure 8: Insulated Wall Panel

The concrete panel is cast off site and delivered on a just in time delivery schedule. Upon delivery, the panels will be lifted into place and completed within 25 days. The typical size of a panel will be 28' long by 14' high and weigh approximately 35,000 pounds. These dimensions were chosen based on the column spacing from classroom to classroom. Because of the size, the panels will be transported on an A-frame for delivery. Panels will use bolted connections. Once lifted into place, the interior side of the panel has been already prepared by the manufacturer and is ready to paint or receive wall coverings. The panels will be critical picks, and our suggested crane was sized based on these picks. Logistics were also influenced by the size of these panels, as three crane locations will be needed to safely make all picks. Upon completion of the system, the panels provide a 3-hour fire rating for the elementary school and an R-Value up to R-30. To achieve the minimum u-value of 0.69 for the wall system, the R-Value needed is R-15. Construction and Mechanical team members worked with wall panel manufacturers to achieve an R-Value of R-26.

CarbonCast panels also make it possible for the construction project to achieve several LEED points as well. The opportunities that are most applicable to our project would include SSc7.1 – Heat Island Effect, Non Roof, EAc1 – Optimize Energy Performance, MRc4.1 – Recycled Content, 10%, MRc5.1 – Regional Materials, 10% Extracted, and MRc5.2 – Regional Materials, 20% Extracted.

The approximate cost for material and installation of the precast panel system supplied by High Concrete Group, the manufacturer and installer of these panels, is $27.00/SF. Based on the exterior area of the building and the quantity of panels needed; the total cost for this enclosure excluding glazing is $1,285,200.00. High Construction Group is also headquartered in Denver, Pennsylvania which is located 20 miles from Reading, Pennsylvania making transportation of the panels quick and easy.

Light Weight Green Roof The green roof system is being proposed as an occupiable space where teachers and students will access for learning opportunities. This will be done by planning a space with walkways, hardscaping pavers and benches for an interactive learning environment. The paving system will be constructed so that the rainwater runs through the open joint assembly and beneath into the roofing to a slightly sloped deck where the water will be guiding to the drains.

A proprietary system, American Hydrotech, will be the proposed supplier of the green roof system and remainder of the roofing system for Reading Elementary School. The advantage of using a proprietary system is that all the components are from one manufacturer and designed to work together. This is an advantage with the occupiable green roof since the manufacturer will now confirm the warranty for the entire system. Hydrotech's Garden Roof will transform our flat roof above the west wing of the building into an actual learning environment for students. The system is designed as a lightweight, low profile Garden roof Assembly.

Figure 9: Hydrotech Garden Roof Assembly (American Hydrotech Inc., 2013)

The Extensive Assembly system by Hydrotech utilizes 3"-4" of growing media and requires little maintenance. The system helps to mitigate the urban heat island effect and reduces stormwater runoff. Rainwater is stored in the drainage layer and will sustain plants for short periods of time in between rainfall. This system combined with Hydrotech's Ultimate Assembly for Plazas and Roof Terraces will create the roof terrace space needed for the proposed educational space.

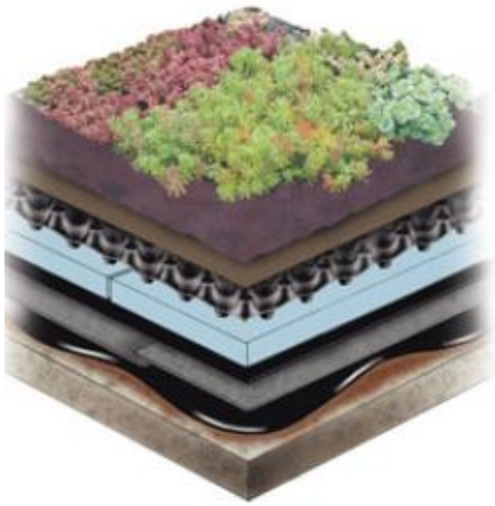


Figure 10: Extensive Assembly (American Hydrotech Inc., 2013)

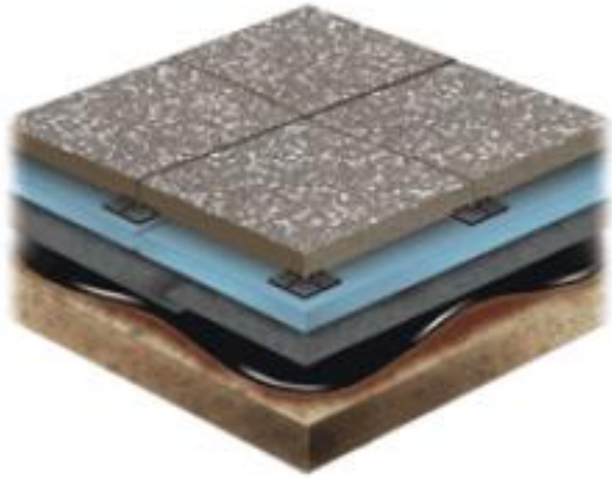


Figure 11: Ultimate Assembly for Plazas[1] *(American Hydrotech Inc., 2013)*

The flat roofs on the elementary school design will utilize a Protected Membrane Roofing system. With this system, the arrangement of roofing components is roof deck, waterproofing membrane, and moisture-resistant insulation. This system is also commonly referred to as an "upside down roof" and protects the waterproofing membrane from harsh weather and temperatures, roof traffic, and other elements.

Rammed Aggregate Pier Foundation System A Rammed Aggregate Pier system was selected for Reading Elementary due to overwhelming constructability benefits when compared to micropiles and paired with the geotechnical conditions of the site. The geotechnical report served as the baseline to determining a proper foundation system. With unsuitable subsurface conditions, conventional spread footings were not the right choice for the building. Depths ranging from 7 to 20 feet continuously encountered unconsolidated fill of coal ash, coal cinders, oyster shells, glass, brick and rock fragments. This type of site is also prone to sinkholes. From recommendations, a deep foundations system was elected to be the most appropriate for the site conditions.

Micropiles were calculated to cost $772,570. When consulting with industry members, the mentioning of Rammed Aggregate Piers surfaced. After further research and contact with GeoStructures, Inc., Rammed Aggregate Piers will be the proposed foundation system for the new elementary school as well as the new wing of the existing elementary school which will support the natatorium.

Figure 12: Rammed Aggregate Pier System[4]

A Rammed Aggregate Pier system offers many advantages to a site stressed by unsuitable soil conditions. When implemented successfully, this foundation system will increase the strength of the soil from 1500PSF to 7000-10000PSF. Piers will be installed at a rate of 30-60 piers per day and allow for the possibility of cost savings of 20-50%. Rammed Aggregate Piers are also sustainable because they use local and recycle aggregates. Once the piers are installed, the spread footings will be poured over the piers to finish the foundation system. Refer to Figure 12 for a visual depiction of RAP's.

A thorough quality control plan is needed with the used of Rammed Aggregate Piers on this project, due to the concern of sinkholes. A contingency has been developed of 15% of the foundation system costs for an alternative to RAP's should issues arise with sinkholes. A micropile foundation system is proposed as the RAP's backup system. This system is reliable for sites with sinkhole issues due to the fact that the foundation is supported on bedrock. A micropile system also allows for faster and cheaper installation than other alternative options, such as an engineered soil system for example. Based on the results of the borings detecting no sinkholes on site, no issues are anticipated. However, their prevalence in surrounding areas calls for a viable quality control plan which assures a reliable foundation.

Basement Footprint Modification The construction team is proposing to simplify the basement layout. Due to the complexity of the given design, additional construction costs would be spent to construct the layout of the wall system with so many odd dimensions, as opposed to something smaller and much more simplified. The team is proposing to eliminate these odd wall angles and value engineer a more simplified system. This will provide cost and schedule savings, and also provide a much more constructable structure. With the current design, performance issues are a far larger concern. For example, the wall configuration poses concerns for waterproofing the mechanical and electrical spaces in the basement. Also, when consulting with the other disciplines of our integrated team, the basement footprint can be sized down and still house the stairwell, elevator room, and mechanical and electrical equipment. The total savings estimated for this design change totals at $75,000.

Structural Steel System The structural steel system of the building was decided based on cost comparisons with a concrete structural system. The structural steel frame utilizes W10 and W12 columns with beams ranging from W8 to W14. Steel offers many benefits for our building including fast erection for an accelerated schedule, strength against high wind loads, and the highest strength to weight ratio of building materials to create a lightweight structure. Two story columns, spliced at the 3rd floor, will be used for the first and second stories to minimize picks and detailing. This was a design suggestion proposed by our construction team. The structural system is also comprised of braced frames and reinforced masonry walls along with composite metal deck on each floor. Refer to Appendix C for a detailed steel estimate breakdown.

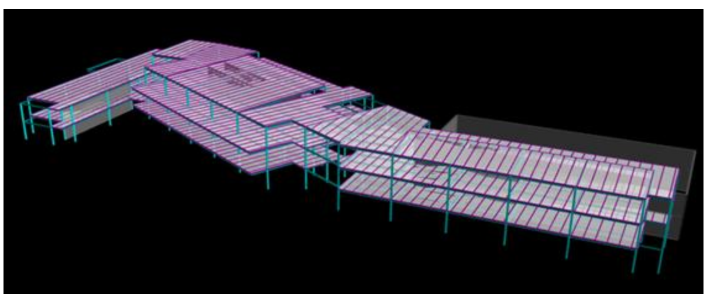


Figure 13: Structural System

LEED Certification The Reading Elementary School project is required to achieve LEED Certification. After careful consulting between team members and using LEED 2009 for School – New Construction and Major Renovations, the team believes that LEED Silver (52 LEED Points) will be achieved with little to no extra cost. Of these points, the construction management points tracked include Recycled Content and Regional Materials. The team believes that LEED Silver is the best option for this project to pursue, as it balances sustainable building and design and the Reading Taxpayers' monetary contributions most efficiently. See Appendix H for a LEED point breakdown and reference our integration report for backing documents to support point attainment.

Figure 14: LEED Silver Symbol

Waste Management Plan A construction waste management plan will be executed to ensure proper recycling of as much waste as possible. The plan identifies materials that are to be diverted from disposal, as well as utilizes a source-separated recycling plan versus comingled. The source separated plan has a target recycling rate of 90% of all waste. Some recycled materials will be used as a small revenue source if separated, specifically scrap metals. The logistics plan accommodates these plans ideally, with a large area for multiple recycling containers which is located near the entrance gate which provides easy access. To view the entire waste management plan, refer to Appendix J.

Section IV: Site Design, Logistics and Phasing

Site The Reading Elementary School project will be located at the intersection of 13th & Amity Street. This location was chosen based on the surrounding buildings found in the area. By placing the elementary school in this location, it will be surrounded by commercial buildings and a local church and also be conveniently located in between two public bus stops. The site layout was configured based upon the central idea to flip the entire footprint of the building along the y-axis. Refer to Figure 15 for an updated site plan designed in Trimble SketchUp. The main reason for this change was to position the multipurpose spaces (gymnasium & cafeteria) in the school next to the planned parking lot on the east end of the property. Also the building has been oriented to maximize open outdoor space as well.

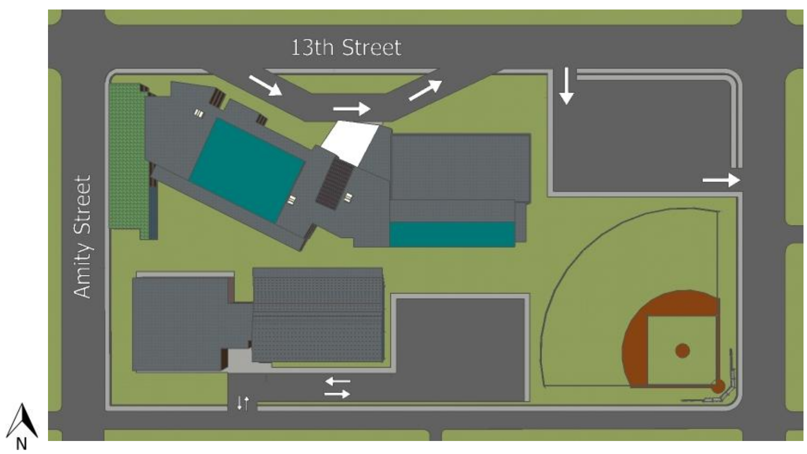


Figure 15: Master Site Plan

The bus loop has also been eliminated from the center of the property and relocated to the north of the site where buses will enter and exit utilizing Amity Street. Visitors to the building during after school hours when the multipurpose space is in use will be able to access the space using the east set of doors conveniently located adjacent to the public parking lot. This change is a security and safety advantage to the rest of the school as well by limiting the traffic within the rest of the building. During school hours, visitors will still utilize the east parking lot, but then proceed to access the building through the main entrance in order to check in at the administration office. Security information can be referenced in detail in the integration report.

Logistics The site logistics plan was dictated mostly by the small size of the property. The construction of the new elementary school will take place in three phases, moving from west to east for the entire building, with exception to the construction of the basement structure and foundation. Construction sequencing was conducted based on the value engineered modified basement footprint. The Zone 2 basement foundation and structure will be completed prior to work starting in Zones 1 and 3. Upon completion of Zone 2 basement construction, foundations will be installed for Zones 1 and 3. Steel will follow after, working from west to east. Once the structure is erected, metal decking, slabs, rough-in and finishes will follow on a floor by floor basis moving upwards from floor 1 to floor 3.

Job site trailers for the construction manager are collocated on the east side of the property with the proposed design-assist subcontractor trailers. Also on the east end of the property, contractors will make use of lay down areas, storage, and dumpster locations. There is one access road for construction traffic and deliveries. The access road is located at the north of the site off of Amity Street. Deliveries will be made utilizing this route and exit the site using the turnaround space located at the south of the site. There is also an onsite tire wash location to prevent mud from dragging onto the streets.

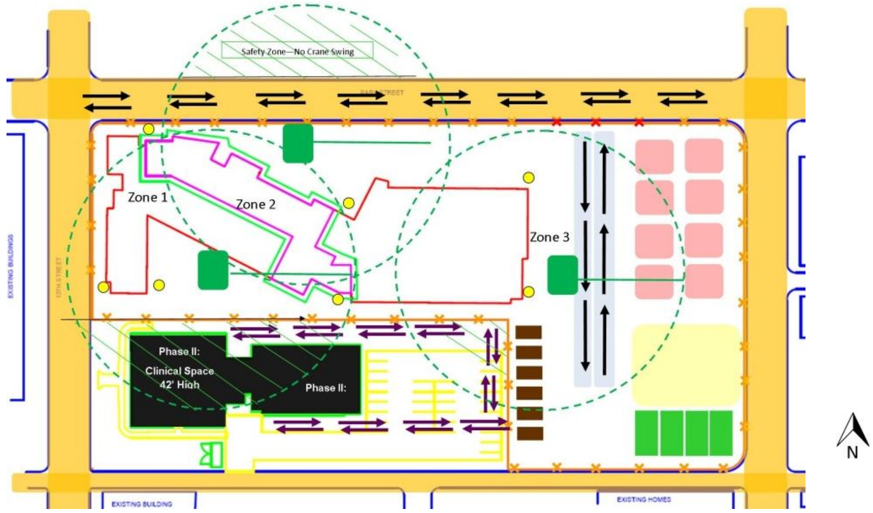


Figure 16: Site Logistics

Because of the limited space onsite, the construction will take advantage of the benefits of utilizing a crawler crane. Crawler cranes will move around site and perform many lifts in different areas without having to set up a large crane in a permanent location. The tracks provide support for the crane during lifts and therefore the crane does not need outriggers. The crane path will follow the suggested sequencing route from west to east. Timber mats will be provided by the contractor in order to make using a crawler crane feasible on the unsuitable soils found onsite. To determine the size of the crane needed, our critical lifts were determined. Our proposal includes the suggestion to utilize a precast panel wall system. The system weighs 90PSF and at 14' high, we have concluded that our panels will be a maximum of 28' long, totaling our critical lift at 35,000 lbs. From this calculation, the Terex Demag CC 1500 with luffing fly jib has been chosen for our construction needs. Crane sizing calculations and suggested crane specifications can be referenced in Appendix G. The suggested crane's capacity and reach during critical picks allows for all critical picks to be made from the three proposed crane locations as depicted on our Site Logistics Plan in Figure 16. The multiple necessary crane locations provides another reason why a crawler crane is most feasible for this project. Suggesting a crane with a capacity high enough to eliminate even one proposed crane location is unfeasible. Please reference the above Figure 16 and Appendix L for a larger version of the Site Logistics Plan and additional phasing plans.

Geothermal Field The mechanical system for the building will be comprised of a geothermal field with 44 boreholes drilled to 300 feet. The 300 feet maximum drill depth does not interfere with the bedrock found on the site (Bedrock is found at 315 feet).

Constructability concerns for the geothermal field swayed our group from placing the geothermal field directly under the parking lot. Due to the possibility of encountering sinkholes when connecting the drilled wells through the use of trenches, it makes most sense to use the open space between the school and parking lot for the field. The close

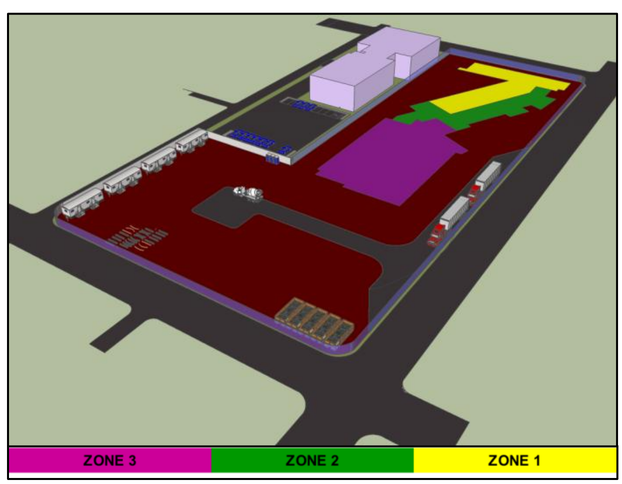


Figure 17: Construction Phasing Plan

proximity to the school allows for shorter runs which mean faster construction and better energy efficiency. Avoiding the weight of a large parking lot will be better for the durability of the field. A 10% construction contingency was budgeted for this system in the case of encountering sinkholes. The geothermal field was priced at $616,424.00.

Excavation The excavation of unsuitable soils will take place in June 2013. The process will take approximately ten days. From the geotechnical report we know that the site is positioned over land with unsuitable soils and that there is a possibility of encountering sinkholes. The site will need to be cleared and grubbed prior to the initial start of Zone 1 foundations and structure. Bulk excavation extenuates from the basement located in the center region of the architectural plans. The excavation for the basement is a part of Zone 2 as designated by the site logistics plan. The estimated cubic yardage to be excavated is 3657 CY. The excavation was priced at $73,032.50. The total sitework package amounts at $350,000.

Section V: Phase II

Phase II - Renovation of Existing Elementary School Phase II is being proposed as an Add Alternate, and is planned to include the natatorium 24-hour clinic and administration space in the location of the current elementary school. The west portion of the school would be repurposed and include the clinic and administrative space, while the east portion would be completely demolished, and be the footprint for the natatorium. Construction of this phase has been scheduled to start in the beginning of June 2014, when students have departed for summer vacation, and be completed in late September.

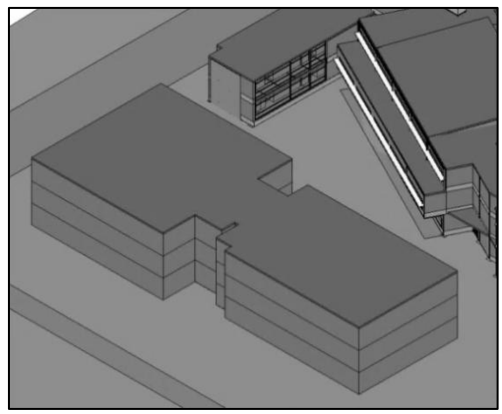


Figure 18: 3D Model of Existing Elementary School

In order to properly assess the design requirements behind the renovation, the documented assumptions include:

1) The existing building is an elementary school with what appears to be a gymnasium on the east side of the building
2) Demolition of the Gymnasium will occur, while west side of building preserved for clinical and administration space
3) The structure is a steel structure
4) The gymnasium on the east side was slab on grade
5) Interior Columns must be considered in redesigning the clinical and administration spaces
6) Utilize the same construction contractors to perform this Phase II work
7) Structure similar to new gymnasium

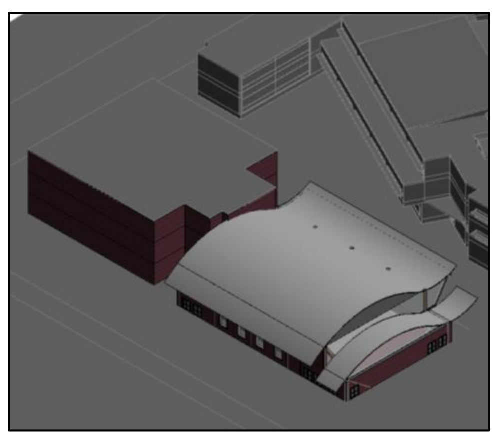


Figure 19: 3D Model with Phase 2 Improvements

Because the building was not originally designed to sustain an indoor swimming pool only half of the building will be repurposed. The first floor of the west wing has been redesigned to house the clinical spaces for the project, while the east wing which was assumed to be the gymnasium will be demolished and rebuilt to properly support the design of the natatorium.

Asbestos Abatement An asbestos abatement plan was considered due to the possibility of encountering asbestos during the renovation process of an existing building. Because of the serious health concerns related to the exposure of asbestos, the Pennsylvania Department of Environmental Protection regulates the removal of asbestos form commercial buildings. According to the Department of Environmental Protection (DEP), the Department of Labor and Industry is responsible for the enforcement of Pennsylvania Asbestos Occupations Accreditation and Certification Act and must be notified five days prior to the work onsite. When notifying the Department of Labor and Industry, the abatement plan must be submitted along with the certifications of any workers that will be involved in the removal process.

If asbestos is detected it must be removed before any demolition or renovation of the building. The DEP follows the Environmental Protection Agency's standards set by the National Emission Standard for Hazardous Air Pollutants. The standard requires the EPA to be notified ten days prior to removal of any asbestos onsite. Also, proper notification of federal, state, and local agencies must be adhered to as well.

If more than 260 linear feet, 160 square feet, or 35 cubic feet of asbestos is required to be removed the project will need to adhere to NESHAP regulations for abatement. Please see references for the 61.150 Standard for waste disposal for manufacturing, fabricating, demolition, renovation, and spraying operations.

Demolition Demolition is scheduled for a two week window when school concludes in June 2013. The demolition will start with the entire demolition of the east wing (or old gymnasium). Once the demolition is finished, the contractor will move to the interior of the west wing of the building and demo the space for preparation of the interior construction for the clinical space.

Phasing & Schedule The logistical planning for the building will propose that the east end of the building where the natatorium will be located take first priority over the clinical space. Once demolition is done on the east wing, this contractor will move to the interior of the west wing and remove all interior walls and finishes leaving the structural system and a clean slate to start with the clinical space. The clinical space will make its home on the first floor of the building and this is the extent of the renovation. The second and third floors can be looked separately by the school district to assess future expansion and additional uses.

With demolition done on the east wing, Rammed Aggregate Piers will be installed followed by the spread footing and concrete work will begin to create the structure needed for a 6 lane, 25 meter indoor swimming pool.

Cost Estimate The additional scope of work contributed to the overall project from the pool and clinical spaces allows for a competitive advantage among contractors bidding for the elementary school work. The same contractors performing work for the Reading Elementary School will be awarded the scope of work for the existing building as well. From our previous project delivery method proposal, these contractors will be design-assist and help to improve the design of the building prior to initial start of construction. The renovation of the existing building will total approximately $3,000,000.

Conclusion In conclusion, the most appropriate measure of success would be an evaluation of whether our project goals were achieved, which in turn would result in the attainment of our team goal.

Functionality will be achieved with a more collaborative Design-Assist project delivery method, allowing for more, allowing contractors to perform constructability reviews and value engineering. Virtual Mockups provide the owner with a visual understanding of the building's components as well as the contractor with a better feel for how to build the spaces. Clash Detections minimize field issues and concerns. A Proactive Commissioning Plan will ensure that building systems and components continuously operate as intended.

Efficiency will be achieved with an aggressive yet realistic schedule with thoroughly reviewed logic. Rammed Aggregate Piers will provide a cheaper and faster, yet still reliable, solution to sinkhole issues outlined in the Geotechnical Report. A developed logistics plan and three dimensional visual of both phases of construction ensure a smooth flowing construction process, even on the most work intensive days. Additional monetary and schedule savings, as well as better quality assurance opportunities lie in the proposed basement footprint modification.

Appeal will be achieved by guaranteeing constructability of the designed project and all of its new high performance systems. This includes the Green Roof Assemble, Architectural Insulated Precast Panels, and unique Natatorium design.

By working hand in hand with designers throughout the project, our construction team is confident in a smooth and successful project delivery at a competitive yet realistic cost. We strongly believe that we have helped accomplish our overarching team goal of *creating an innovative, high-performance environment in a way that stimulates involvement in both education & the community.* The integrated structure and culture exhibited by our team throughout the course of this project have resulted in a submission that successfully answered Reading School District's needs in a superior manner.

Team Mission Statement

Our one true aim is to enhance the quality of the communities we work with through innovative ideas and an integrated design approach.

Team Core Values

Ingenuity | Quality | Enjoyment | Integrity

Contents

A-References

American Hydrotech Inc. (2013). *Garden Roof Assembly.* Spring 2013. Web. <http://www.hydrotechusa.com/assemblies/garden-roof-assembly>.

Building Green, Inc. (2013). *Geopier Rammed Aggregate Pier System*. Fall 2012. Web. <http://www.buildinggreen.com/auth/productDetail.cfm?PRODUCTID=4847>.

CityRating.com (2013). *Reading Crime Statistics: Pennsylvania (PA)*. Fall 2012. Web. <http://www.cityrating.com/crime-statistics/pennsylvania/reading.html>.

The Computer Integrated Construction Program (2011). *BIM Project Execution Plan Version 1.0.* Fall 2012.

Commonwealth Foundation for Public Policy Alternatives, Inc. (2013). *Expense Category Detail – Adjusted for Inflation, Reading SD.* Fall 2012. Web. http://www.openpagov.org/education_revenue_and_expenses.asp>.

FIXr (2013). *Skylight Installation Cost.* Fall 2012. Web. <http://www.fixr.com/costs/skylight-installation>.

Geopier Foundation Company (2012). *Geopier Rampact System.* Fall 2012. Web. <http://www.geopier.com/Geopier-Systems/Rammed-Aggregate-Pier-System/Rampact-System>.

Harrington, Gregory E., and Kristin Collette (2012). *NFPA 1 Fire Code Handbook*. Quincy, MA: National Fire Protection Association, Fall 2012. Print.

High Concrete Group, LLC (2010). *CarbonCast® Insulated Wall Panels*. Fall 2012. Web. <http://www.highconcrete.com/products/Components/structural/CarbonCast-High-Performance-Insulated-Wall-Panels.cfm>.

Leadership in Energy and Environmental Design (2008). *LEED 2009 For Schools New Construction and Major Renovations.* Fall 2012. Web. <http://www.usgbc.org/ShowFile.aspx?DocumentID=5547>.

National Precast Concrete Association (2012). *Architectural Precast Concrete Wall Panels Connection Guide.* Fall 2012. Web. <http://precast.org/wp-content/uploads/2012/01/ArchitecturalConnectionsGuide.pdf>.

Reed Construction Data Inc. (2013). *RSMeans Online Version 5.0.1.* Fall 2012 – Spring 2013. Web. <http://www.rsmeansonline.com/SearchData>.

United States Census Bureau (2013). *Reading (city) QuickFacts from the US Census Bureau*. Fall 2012. Web. <http://quickfacts.census.gov/qfd/states/42/4263624.html>.

B-General Conditions Estimate & Project Budget

Project Budget

Project Budget - New Elementary School			
Division/Subdivision	**Base Cost**	**%**	**SF Cost**
Bidding Requirements	$ 462,400.00	2.89%	$ 4.74
General Requirements	$ 976,000.00	6.10%	$ 10.01
Concrete	$ 844,800.00	5.28%	$ 8.66
Masonry	$ 1,905,600.00	11.91%	$ 19.54
Metals	$ 1,793,600.00	11.21%	$ 18.40
Woods & Plastics	$ 182,400.00	1.14%	$ 1.87
Thermal & Moisture Protection	$ 571,200.00	3.57%	$ 5.86
Doors & Windows	$ 723,200.00	4.52%	$ 7.42
Finishes	$ 1,651,200.00	10.32%	$ 16.94
Specialities	$ 275,200.00	1.72%	$ 2.82
Equipment	$ 688,000.00	4.30%	$ 7.06
Furnishings	$ 454,400.00	2.84%	$ 4.66
Conveying Systems	$ 160,000.00	1.00%	$ 1.64
Plumbing	$ 992,000.00	6.20%	$ 10.17
HVAC	$ 2,160,000.00	13.50%	$ 22.15
Electrical	$ 2,160,000.00	13.50%	$ 22.15
Total Building Budget	**$ 16,000,000.00**	**100.00%**	**$ 164.10**

Project Budget - Renovation			
Division/Subdivision	**Base Cost**	**%**	**SF Cost**
Bidding Requirements	$ 86,700.00	2.89%	$ 4.34
General Requirements	$ 183,000.00	6.10%	$ 9.15
Concrete	$ 278,400.00	9.28%	$ 13.92
Masonry	$ 357,300.00	11.91%	$ 17.87
Metals	$ 306,300.00	10.21%	$ 15.32
Woods & Plastics	$ 34,200.00	1.14%	$ 1.71
Thermal & Moisture Protection	$ 107,100.00	3.57%	$ 5.36
Doors & Windows	$ 135,600.00	4.52%	$ 6.78
Finishes	$ 219,600.00	7.32%	$ 10.98
Specialities	$ 51,600.00	1.72%	$ 2.58
Equipment	$ 129,000.00	4.30%	$ 6.45
Furnishings	$ 85,200.00	2.84%	$ 4.26
Conveying Systems	$ 30,000.00	1.00%	$ 1.50
Plumbing	$ 186,000.00	6.20%	$ 9.30
HVAC	$ 405,000.00	13.50%	$ 20.25
Electrical	$ 405,000.00	13.50%	$ 20.25
Total Building Budget	**$ 3,000,000.00**	**100.00%**	$ 150.00

General Conditions Estimate

Reading Elementary GC Summary	
General Conditions	**Cost**
Staffing	$ 673,880.00
CM Reimbursables	$ 229,040.00
Temporary Utilities	$ 157,667.00
Temporary Facilities	$ 60,400.00
Total Cost:	**$ 1,120,987.00**

Reading Elementary Staffing Strategy						
Personnel	**Hours**	**Rate/HR**	**Weeks**	**Rate/Wk**	**Months**	**Cost**
Field Office						
Project Superintendent	40	$ 81.88	64	$ 3,275.00	15	$ 209,600.00
Project Manager	40	$ 81.88	64	$ 3,275.00	15	$ 209,600.00
Project Engineer - (LEED AP)	40	$ 50.00	60	$ 2,000.00	14	$ 120,000.00
Safety Superintendent	8	$ 81.88	56	$ 655.00	13	$ 36,680.00
Administration	40	$ 30.00	60	$ 1,200.00	14	$ 72,000.00
BIM Engineer	10	$ 50.00	52	$ 500.00	12	$ 26,000.00
				Total Cost:		**$ 673,880.00**

Reading Elementary Reimbursable Costs				
Construction Reimbursables	**QTY**	**Units**	**Unit Cost**	**Cost**
Janitorial Services	60	Weeks	$ 800.00	$ 48,000.00
Office Supplies	16	Month	$ 75.00	$ 1,200.00
Office Equipment	16	Month	$ 210.00	$ 3,360.00
Personal Computers	16	Month	$ 1,250.00	$ 20,000.00
Internet	16	Month	$ 125.00	$ 2,000.00
Computer Software	1	LS	$ 10,000.00	$ 10,000.00
Personal Phones	16	Month	$ 600.00	$ 9,600.00
Drawings/Specifications	1	LS	$ 10,000.00	$ 10,000.00
Postage/Shipping	16	Month	$ 700.00	$ 11,200.00
Vehicles				
Project Superintendent	16	Month	$ 550.00	$ 8,800.00
Project Manager	16	Month	$ 550.00	$ 8,800.00
Job Site Storage	16	Month	$ 100.00	$ 1,600.00
First Aid Supplies	16	Month	$ 55.00	$ 880.00
Travel	1	LS	$ 8,500.00	$ 8,500.00
Water/Coffee	16	Month	$ 75.00	$ 1,200.00
PPE	1	LS	$ 2,000.00	$ 2,000.00
Small Tools	16	Month	$ 300.00	$ 4,800.00
Fire Extinguishers	1	LS	$ 1,000.00	$ 1,000.00
Site Drinking Water	16	Month	$ 225.00	$ 3,600.00
Snow Removal	1	LS	$ 7,500.00	$ 7,500.00
Truck Wash	1	LS	$ 65,000.00	$ 65,000.00
			Total Cost:	**$ 229,040.00**

Reading Elementary Temporary Utilities				
Temporary Utilities	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Initial Tie In	1	LS	$ 2,500.00	$ 2,500.00
Electrical Power	1100	CSF/Floor	$ 51.50	$ 56,650.00
Water	16	Month	$ 69.50	$ 1,112.00
Lighting	1100	CSF/Floor	$ 42.95	$ 47,245.00
Heating	1100	CSF/Floor	$ 45.60	$ 50,160.00
			Total Cost:	**$ 157,667.00**

Reading Elementary Temporary Facilities				
Temporary Facilities	**QTY**	**Units**	**Unit Cost**	**Cost**
Office Trailers	2	Each	$ 10,525.00	$ 21,050.00
Office Furniture	16	Month	$ 1,200.00	$ 19,200.00
Temporary Fencing		LF		$ -
Construction Signage	50	Each	$ 75.00	$ 3,750.00
Sanitary Facilities	12	Each	$ 200.00	$ 2,400.00
Parking	40	Space	$ 350.00	$ 14,000.00
			Total Cost:	**$ 60,400.00**

Reading Elementary Bonds & Insurances				
Bonds & Insurances	**QTY**	**Units**	**Project Cost**	**Cost**
Payment & Performance Bond	1	%	$ 19,000,000.00	$ 190,000.00
Insurance				
General Liability	0.75	%	$ 19,000,000.00	$ 142,500.00
Automobile	0.25	%	$ 19,000,000.00	$ 47,500.00
Builder's Risk	0.25	%	$ 19,000,000.00	$ 47,500.00
Permits	0.5	%	$ 19,000,000.00	$ 95,000.00
			Total Cost:	**$ 522,500.00**

Project Contingency	
Contingency	**Cost**
Contingency (5%)	$ 950,000.00

Note* - Bonds & Insurances and Project Contingency is not included in the summary GC Costs above.

C- Detailed Steel Estimate

Total Structure Gravity Beam Takeoff					
Beams					
Size	LF	Cost/LF (Incl. Materials, Labor, Overhead & Profit)	Total Cost	Daily Output	Duration
W8X10	931.00	$27.01	$25,146.31	600	1.55
W8X13	100.25	$31.28	$3,135.82	600	0.17
W8X24	24.50	$48.53	$1,188.99	550	0.04
W8X31	34.00	$58.61	$1,992.74	550	0.06
W10X12	190.25	$29.90	$5,688.48	600	0.32
W10X17	60.00	$37.00	$2,220.00	600	0.10
W10X33	44.00	$61.36	$2,699.84	550	0.08
W10X39	48.00	$69.96	$3,358.08	550	0.09
W10X49	254.75	$84.29	$21,472.88	550	0.46
W10X88	208.00	$150.00	$31,200.00	640	0.33
W12X14	443.75	$28.00	$12,425.00	880	0.50
W12X16	100.25	$31.50	$3,157.88	880	0.11
W12X19	360.25	$35.86	$12,918.57	880	0.41
W12X40	1842.00	$67.15	$123,690.30	775	2.38
W12X45	78.00	$75.58	$5,895.24	775	0.10
W12X53	30.00	$86.30	$2,589.00	750	0.04
W12X58	154.00	$93.47	$14,394.38	750	0.21
W12X120	80.00	$181.16	$14,492.80	960	0.08
W12X136	32.00	$195.00	$6,240.00	950	0.03
W12X152	160.00	$210.00	$33,600.00	950	0.17
W14X22	724.25	$35.00	$25,348.75	990	0.73
W14X26	459.00	$40.00	$18,360.00	990	0.46
W14X30	520.50	$51.43	$26,769.32	900	0.58
W14X34	366.00	$58.35	$21,356.10	810	0.45
W14X43	1133.75	$71.19	$80,711.66	810	1.40
W14X48	235.25	$76.13	$17,909.58	800	0.29
W14X53	198.00	$86.00	$17,028.00	800	0.25
W14X61	570.50	$86.61	$49,411.01	775	0.74
W14X68	1246.75	$95.88	$119,538.39	760	1.64
W14X90	98.00	$125.11	$12,260.78	740	0.13
W16X26	426.50	$38.98	$16,624.97	1000	0.43
W16X40	60.00	$58.58	$3,514.80	800	0.08
W16X67	60.00	$94.67	$5,680.20	760	0.08
W21X48	20.00	$95.00	$1,900.00	900	0.02
			$743,919.84		**14.51**

Total Braced Beam Takeoff					
size	LF	Cost/LF	Total Cost	Daily Output	Duration
HSS2x2x3/16	190	$13.34	$2,534.60	780	0.24
HSS2x2x1/8	190	$13.34	$2,534.60	780	0.24
HSS3x3x3/8	38	$13.34	$506.92	780	0.05
HSS2.5x2.5x1/4	190	$13.34	$2,534.60	780	0.24
			$8,110.72		**0.78**

Total Structure Gravity Beam Takeoff					
Columns					
Size	LF	Cost/LF (Incl. Materials, Labor, Overhead & Profit)	Total Cost	Daily Output	Duration
W10X33	1332.50	$61.36	$81,762.20	550	2.42
W10X39	288.00	$69.96	$20,148.48	550	0.52
W10X45	24.00	$78.56	$1,885.44	550	0.04
W10X49	96.00	$84.29	$8,091.84	550	0.17
W12X53	12.00	$86.30	$1,035.60	750	0.02
W12X65	24.00	$104.43	$2,506.32	700	0.03
W12X79	24.00	$125.65	$3,015.60	640	0.04
W14X53	12.00	$86.00	$1,032.00	800	0.02
W14X61	72.00	$97.54	$7,022.88	780	0.09
W14X82	144.00	$128.34	$18,480.96	760	0.19
			$144,981.32		**3.55**

D-Total Construction Estimate

Detailed Estimate			
Scope of Work	**$**	***Scope of Work***	**$**
General Conditions	$ 1,120,987.00		
Sitework		**Enclosure**	
Grading	$ 10,000.00	Precast Panels	$ 1,233,840.00
Excavation	$ 73,032.50	Glazing	$ 361,987.00
Dewatering	$ 3,701.00	Storefront (Atrium)	$ 350,000.00
Hauling	$ 36,335.95	Bullet Proof Glass	$ 270,000.00
Foundation		**Green Roof**	$ 121,141.00
Subbase	$ 3,970.40	**Roofing**	$ 1,394,638.00
Rammed Aggregate Piers	$ 617,600.00	**Mechanical**	
Shoring	$ 187,011.30	Air Handling Units	$ 223,440.00
Structure		VRV System	$ 20,735.00
Metal Decking	$ 438,750.00	Heat Pumps	$ 376,200.00
Concrete	$ 366,427.30	Geothermal Pumps	$ 50,000.00
Rebar	$ 5,470.00	Geothermal Boring	$ 277,356.00
Forms	$ 14,960.00	**Electrical**	
Finishing /Curing	$ 17,355.00	Panelboards	$ 23,790.00
Steel		Breakers	$ 16,595.00
Beams	$ 743,900.00	Switchboard	$ 10,000.00
Columns	$ 145,000.00	Automatic Transfer Switch	$ 24,200.00
Braced Frames	$ 8,000.00	Generator	$ 235,400.00
Detailing	$ 67,000.00	Transformers	$ 60,100.00
CMU Walls	$ 175,760.00	**Total:**	**$ 9,084,682.45**

The above table documents the systems that have been estimated by our construction team from the data provided by our integrated team as a whole.

E-Clash Detection

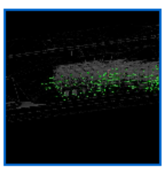
Mechanical vs. Lighting: Below is a screenshot of a clash report .html which was composed to detect issues between mechanical and steel systems. With these reports, team members diagnosed each clash individually and made necessary alterations. The model was updated based on the information provided in the clash reports such as clashing tolerance, clash type and the status of each clash. Team members updated statuses when clashes were fixed. Refer to the link below for the entire clash report of the screenshot depicted.

Clashes

Report Batch

Steel Vs. Mechanical Clash

Tolerance	0.00ft
Total	3
New	3
Active	0
Reviewed	0
Approved	0
Resolved	0
Type	Hard
Status	OK



Name	Clash1
Distance	-0.34ft
Description	Hard
Status	New
Clash Point	5.23ft, 28.68ft, 388.69ft
Grid Location	14-36 : Level Base
Date Created	2012/12/10 21:41:15

Item 1

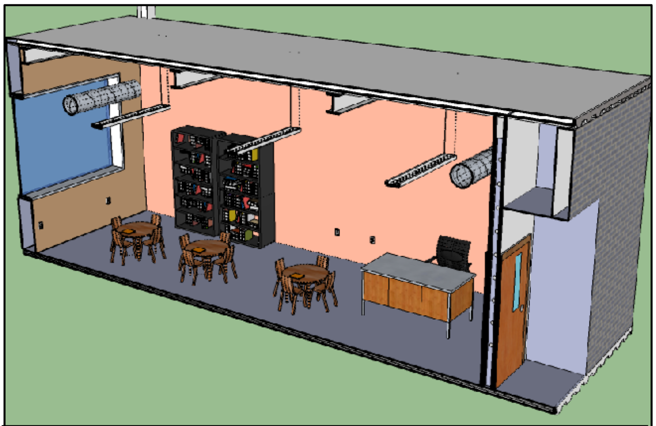
Element ID	999946
Layer	Level 1
Item Name	Steel ASTM A992
Item Type	Solid

Item 2

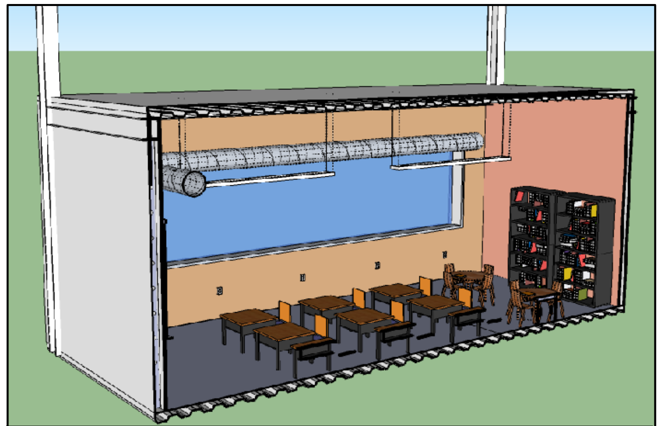
Element ID	721719
Layer	Mechanical LVL 2
Item Name	Round Duct
Item Type	Solid

Y:\AEI Team 1\CM\Clash 1\Steel vs. Mechanical\Steel vs. Mechanical.html

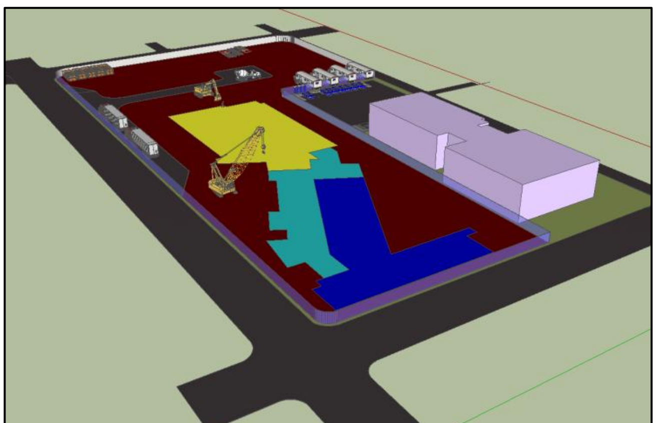
F–Virtual Mockups



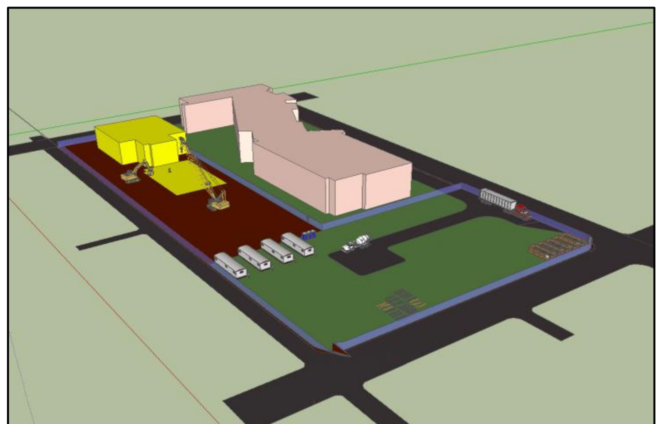
Virtual MockUp 1: Typical Classroom Section



Virtual MockUp 2: Typical Classroom Section



Virtual MockUp 3: Phase 1 Site Logistics

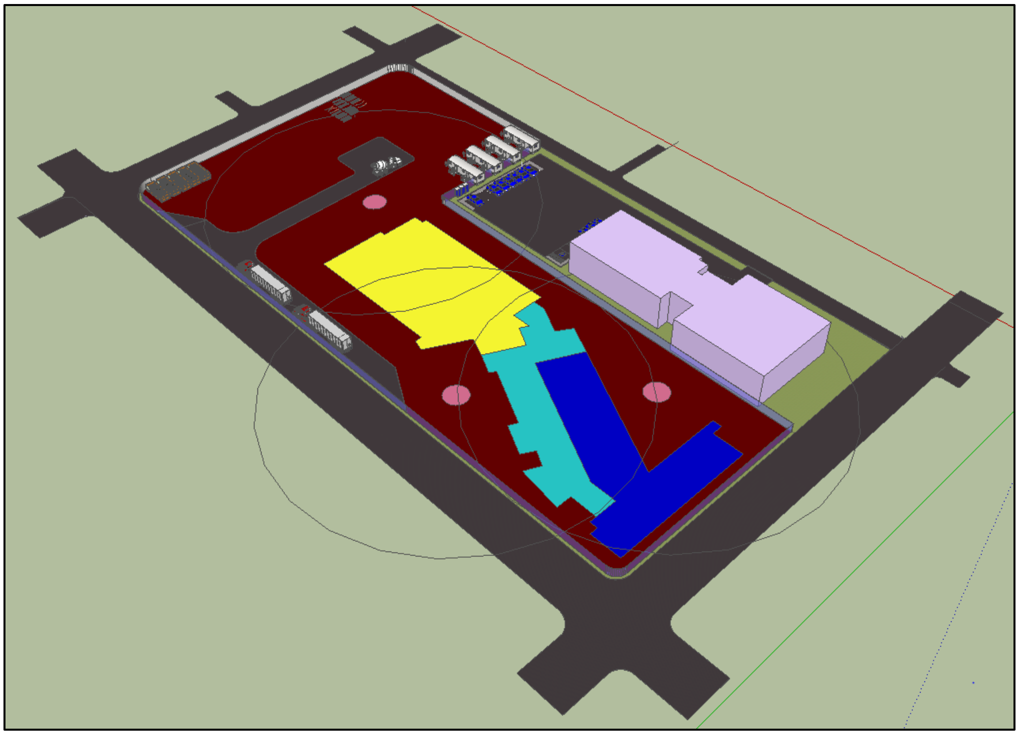


Virtual MockUp 4: Phase 2 Site Logistics

Above are four examples of virtual mockups which were modeled to help communicate and better understand some of the team's design and ideas. The virtual mockups of the typical classroom were beneficial in planning coordination between the teams' engineered systems and interior layout and space planning. The logistics mockups were beneficial in space planning during construction. This visualization help the team better layout spaces for material deliveries, trailer locations, laydown areas and crane placement. After completing the logistics mockup, the team is confident in the most efficient use of the site during construction.

G- Crane Specifications

This crane was chosen based on the critical lift for the precast enclosure system. The weight of a panel totals at 35,000 lbs.
Demag CC1500



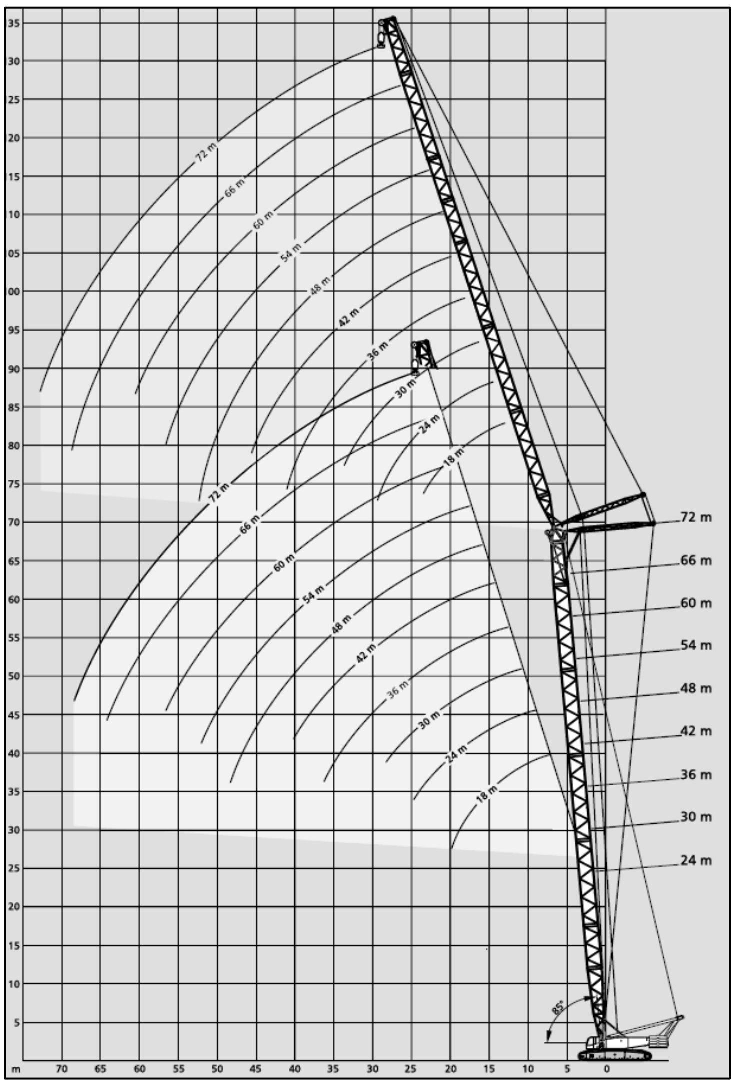
Above is a site logistics plan with proposed crane placements. The proposed crawler crane locations are depicted with pink circles. A 140’ radius is shown at each location. The crane at each location is to be set back 35’ from the building footprint. This setback is needed to minimize loads on surrounding buildings and foundations caused by the weight of the crane. The setback also allows enough room for the crane boom to clear 45’ (42’ height of the building + 3’ clearance) at the face of the building while maintaining an angle at which the boom can clear the required 140’ radius. However, with such a large jib selected, clearance is not a major issue. The selected crane is highlighted in yellow on the sizing chart, which is laid out in meters and tons. Refer to conversions and calculations below.

54 m	Main boom · Hauptausleger · Flèche principale					
	Radius Ausladung Portée	Fly jib · Hilfsausleger · Fléchette				
	m	18,0	24,0	30,0	36,0	42,0
	15	53,3	-	-	-	-
	16	51,3	-	-	-	-
	17	49,5	44,5	-	-	-
	18	47,7	42,8	-	-	-
	19	46,1	41,4	37,0	-	-
	20	44,6	40,0	35,7	-	-
	21	43,4	39,1	34,8	31,3	-
	22	42,2	38,2	33,9	30,4	-
SW	23	41,1	37,3	33,2	29,8	26,0
	24	40,1	36,4	32,5	29,1	25,5
	26	-	34,8	31,2	28,1	24,5
	28	-	33,3	29,9	27,1	23,7
	30	-	31,8	28,7	26,1	23,0
	34	-	-	26,5	24,2	21,5
	38	-	-	-	22,6	20,1
	42	-	-	-	21,0	18,8
	46	-	-	-	-	17,5
	50	-	-	-	-	-

Radius:
46 m = 150.9 ft.

Capacity:
17.5 tons (46m) = 35,000 lb.

Therefore, a 46 meter boom with 42 meter jib would be appropriate to make the most critical pick of 35,000 lb at 140 feet. It is extremely imperative that the precast panel contractor place the crane as specified in order to assure no picks exceed the 140' radius, as extending the crane to its maximum radius would lower the crane capacity to 35,000 pounds, which is exactly the minimum capacity required for precast panels.



Load Chart/Specifications: http://www.bigge.com/crane-charts/crawler-crane-charts/Demag-CC1500.pdf

H- LEED Silver Breakdown

Point Breakdown			
Category	**Points Possible**	**Points Earned**	**Comments**
Sustainable Sites	25	19	
Water Efficiency	10	4	
Energy & Atmosphere	35	13	
Materials & Resources	14	5	
Indoor Environment Quality	15	9	
Innovative Design	6	1	
Regional Priority	4	1	
Total:	109	52	LEED Silver

Example of Point Attainment:

Water Use Reduction Calculation for LEED Credit- 2 points

Water Closets						
FTE	Female Ratio	Uses/Day	FTE	Male Ratio	Uses/Day	**Total Uses**
1323	0.5	3	1323	0.5	1	**2646**

Urinals						
FTE	Female Ratio	Uses/Day	FTE	Male Ratio	Uses/Day	**Total Uses**
1323	0.5	0	1323	0.5	2	**1323**

Lavatory Faucet						
FTE	Duration	Uses/Day	FTE	Male Ratio	Uses/Day	**Total Uses (min)**
1323	30	3				**1984.5**

LEED Baseline (gpf)	Baseline usage (gal)	Baseline Cost	Our Design (gpf)	Our Design Usage (gal)	Our Cost	Savings
1.6	4233.6	$22.95	1.1	2910.6	$15.78	**$7.17**

LEED Baseline (gpf)	Baseline usage(gal)	Baseline Cost	Our Design (gpf)	Our Design Usage (gal)	Our Cost	Savings
1	1323	$7.17	0	0	$0.00	**$7.17**

LEED Baseline (gpm)	Baseline usage (gal)	Baseline Cost	Our Design (gpm)	Our Design Usage (gal)	Our Cost	Savings
1.5	2976.75	$16.13	0.5	992.25	$5.38	**$10.76**

Savings Per Year	**$9,160.52**
Water Use Reduction	**45.74%**

Shown above is a LEED Scorecard point breakdown for Materials and Resources. This section is depicted to show plans and efforts anticipated to achieve the points shown above. Some points were unachievable due to the nature of the project, such as Building Reuse. Seven of the fifty one points that are planned to be achieved for LEED Silver Certification will be attained through the Materials and Resources section. Refer to Supporting Documents in the team Integration Report for a more in depth point breakdown.

I-Hazard and Safety Plan

Activity	Hazard	Action
Excavation	Heavy Equipment, Cave Ins, Falls,	Careful and Coordinated Excavation, Using Proper Shoring, Communication of Dump Trucks & Workers
Blasting	Dynamite, Flying Rock	Safe Distance before Blast
Foundations	Heavy Equipment, Falls	Proper Communication, Awareness of Deliveries & Trucks,
Roofing	Falls, Falling Materials	Safety Cabling, Toeboards In Place,
Glazing Installation	Falls	Harnesses Used in JLGs and on Hoists
Elevators	Falls	Proper Tieoffs During Installation & Inspection, Platforms Installed Above and Below Every 5 Floors for Fall Protection & Falling Materials
Welding	Fires, Electrocution, Burns, Sight Damage	Flammable Materials Away from Flame, Wires Terminated, Hot Work Permits Approved, Proper PPE, Screens and Eyewear
Rigging/Steel Erection	Falling Material, Crane Planning	Crane Inspected and Assembled Correctly, Site Awareness before Pick
University Traffic	Public Safety 24/7	Coordination with Penn State on all Safety Concerns, Safety Fencing, Safety Lighting, Alternate Pathways, Covered Walkways, Signage
Truck Deliveries	Congestion, Caught In Betweens	Delivery Schedules Posted, Deliveries Arrive in AM
Ladders	Falls	Ladder Inspections,
General Concern	Trips, Slips, Falls, Damaging Materials, Respect Onsite	Site kept clean and organized, Floors swept of miscellaneous debris and unneeded equipment removed,
Propane/Chemical Storage	Explosions, Fires	Designated Lockers kept in Loading Dock Area, Proper Labeling of Materials

J- Waste Management Plan

In order to minimize construction waste and incorporate recycling into this project our team developed a construction waste management plan. This plan will identify materials that are to be diverted from disposal and the job recycling rate to be achieved for this project. This plan will also include strategies for the prevention of waste before it is generated. The project waste management plan will be distributed and reviewed in a pre-construction meeting with all prime contractors and suppliers. Any parties found not compliant to this procedure subject to a first-warning, second- fine and/or withholding of payment.

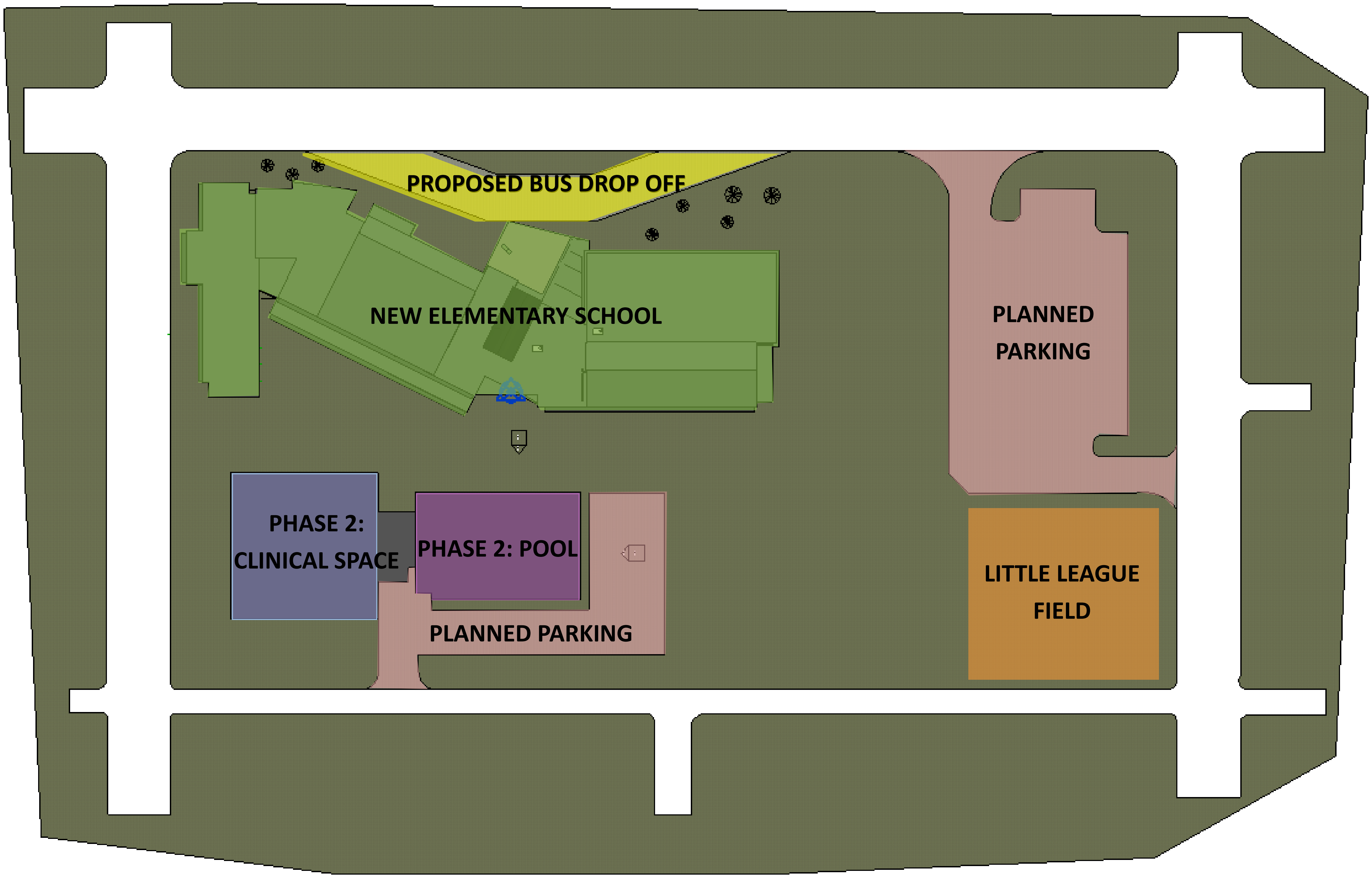
The goal for this project will be at least to recycle at least 50% of non-hazardous construction debris for Phase 1 and 2 of the project. The materials to be recycled for this project are as follows:

- Brick
- Cardboard
- Concrete
- Dirt
- Drywall
- Glass
- Metal
- Paper
- Plastic
- Rock
- Roofing
- Wood (untreated)

This project will utilize source-separated recycling versus comingled recycling. This decision was based many factors for this particular project. Comingled recycling uses less space on site, but the advantages to a separated recycling program were larger and more ethical for sustainable project to abide by. Source-separated recycling yields a facility recycling rate of above 90%, much higher than comingled facilities. The recycling costs are much lower for source-separated when compared to comingled, and revenues are often paid for certain materials if separated. The project will recycle drywall and ceiling tiles and these materials will sometimes be thrown out at comingled recycling centers from Phase 2 as well. Certain recycling containers will be present the entire time of construction. Other containers, such as drywall, will only be on site during the demolition of the Phase 2 building and finishes stages. This planning will save space and require less recycling containers.

Recycling construction and demolition debris actually has cost benefits when compared to traditional disposal of waste materials. A study performed by The Institution Recycling Network found that it costs around $105 per ton to dispose of mixed debris in a landfill, plus $31 per ton for transportation to the landfill, for a total of $136 per ton. When materials are sorted before recycling there is a decrease in cost. At the low end of the spectrum is concrete, block, and brick which costs $10 per ton to recycle, and $11 per ton to transport. That’s a total cost of $21 per ton, less than one-sixth the cost of disposal. Metals also have a low recycling cost ($27 per ton total cost). These are two of the highest tonnage material in construction and demolition debris and will result in a savings for the project.

K-Master Plan

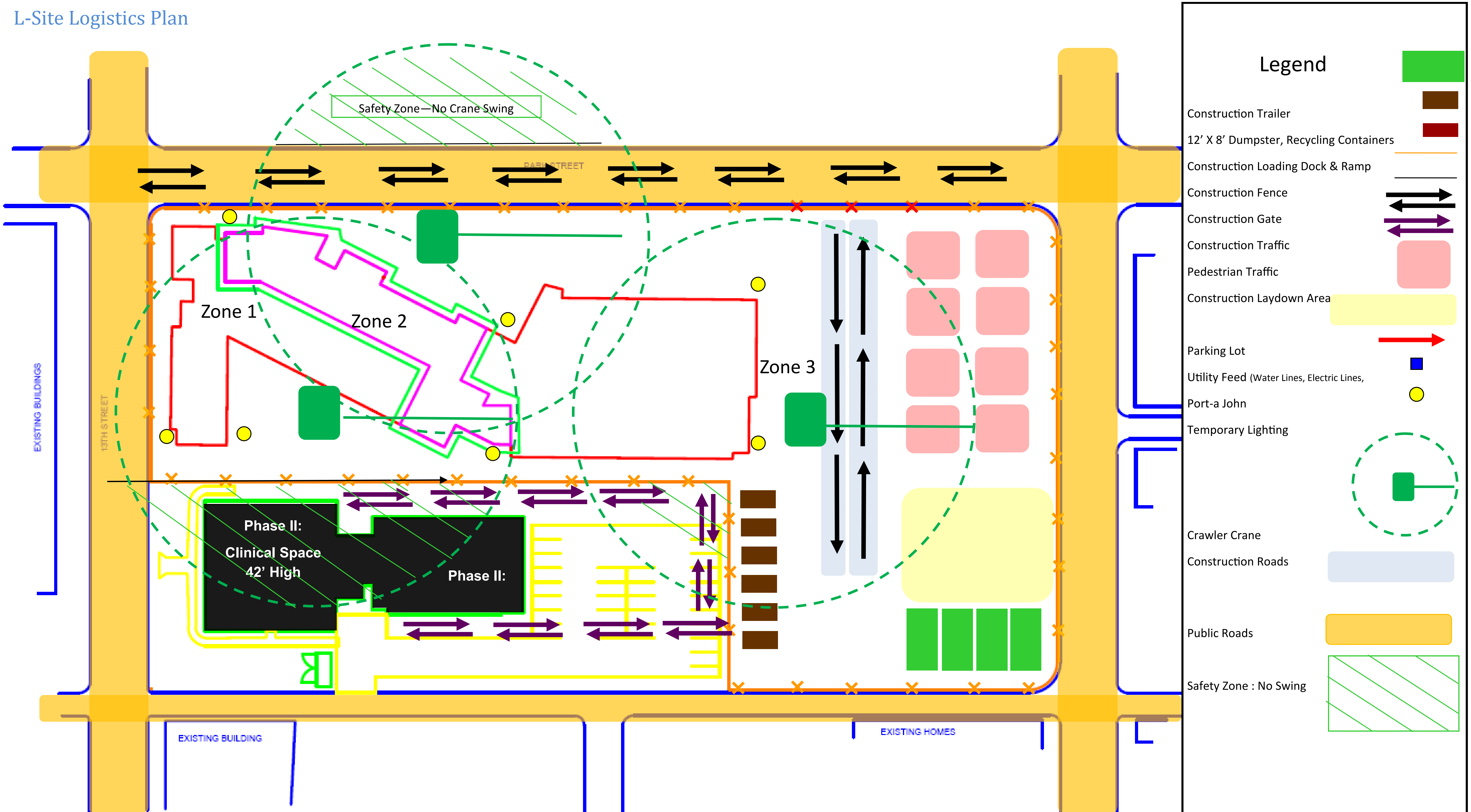


LEGEND:

- New Elementary School Construction
- Phase 2: Pool
- Phase 2: Clinical
- Planned Parking
- Proposed Bus Drop-off
- Little League Field

Master Plan:	Reading Elementary School Project AEI Team #04-2013	Update: 3 Date: 2/20/13

L-Site Logistics Plan



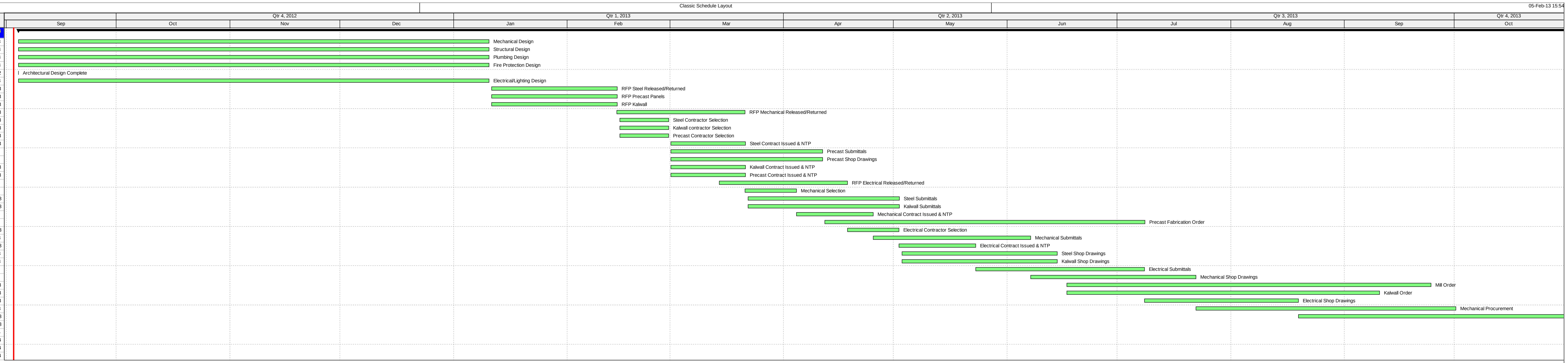
*Note: The crawler crane will be 1 crane at two locations to complete the precast panel picks.

Site Logistics: Phase 1	Reading Elementary School Project AEI Team #04-2013	Update: 4 Date: 2/20/13

Table of Contents: Supporting Drawings

Design Procurement Schedule | Classic Schedule Layout | 05-Feb-13 15:54

Activity Name	Original Duration	Start	Finish
Design & Pro	399	04-Sep-12	27-Mar-14
Mechanical Design	90	04-Sep-12*	10-Jan-13
Structural Design	90	04-Sep-12	10-Jan-13
Plumbing Design	90	04-Sep-12	10-Jan-13
Fire Protection De	90	04-Sep-12	10-Jan-13
Architectural Des	0	04-Sep-12	04-Sep-12
Electrical/Lighting	90	04-Sep-12	10-Jan-13
RFP Steel Releas	25	11-Jan-13*	14-Feb-13
RFP Precast Pan	25	11-Jan-13	14-Feb-13
RFP Kalwall	25	11-Jan-13	14-Feb-13
RFP Mechanical I	25	14-Feb-13*	21-Mar-13
Steel Contractor S	10	15-Feb-13	28-Feb-13
Kalwall contractor	10	15-Feb-13	28-Feb-13
Precast Contracto	10	15-Feb-13	28-Feb-13
Steel Contract Iss	15	01-Mar-13	21-Mar-13
Precast Submittals	30	01-Mar-13	11-Apr-13
Precast Shop Dra	30	01-Mar-13	11-Apr-13
Kalwall Contract I	15	01-Mar-13	21-Mar-13
Precast Contract	15	01-Mar-13	21-Mar-13
RFP Electrical Re	25	14-Mar-13*	18-Apr-13
Mechanical Selec	10	21-Mar-13	04-Apr-13
Steel Submittals	30	22-Mar-13	02-May-13
Kalwall Submittals	30	22-Mar-13	02-May-13
Mechanical Contr	15	04-Apr-13	25-Apr-13
Precast Fabricati	60	12-Apr-13	08-Jul-13
Electrical Contrac	10	18-Apr-13	02-May-13
Mechanical Subm	30	25-Apr-13	07-Jun-13
Electrical Contrac	15	02-May-13	23-May-13
Steel Shop Drawi	30	03-May-13	14-Jun-13
Kalwall Shop Dra	30	03-May-13	14-Jun-13
Electrical Submitt	30	23-May-13	08-Jul-13
Mechanical Shop	30	07-Jun-13	22-Jul-13
Mill Order	70	17-Jun-13	24-Sep-13
Kalwall Order	60	17-Jun-13	10-Sep-13
Electrical Shop Dr	30	08-Jul-13	19-Aug-13
Mechanical Procu	50	22-Jul-13	01-Oct-13
Electrical Procure	90	19-Aug-13	26-Dec-13
Steel Delivery On	0	21-Nov-13*	21-Nov-13
Mechanical Equip	0	27-Jan-14*	27-Jan-14
Precast Exterior I	0	20-Feb-14*	20-Feb-14
Switch Gear Ons	0	27-Feb-14*	27-Feb-14
Kalwall Onsite	0	27-Mar-14*	27-Mar-14



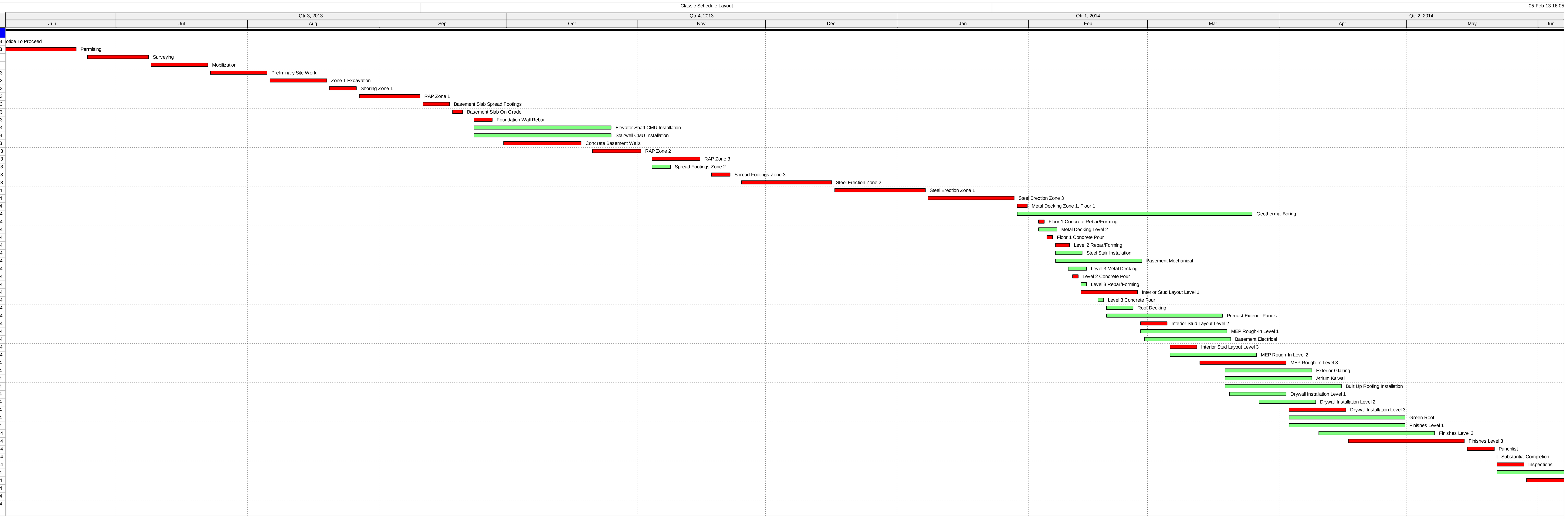
Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

Supporting Drawing i - Design & Procurement Schedule

TASK filter: All Activities

Detailed Schedule | Classic Schedule Layout | 05-Feb-13 16:09

Activity Name	Original Duration	Start	Finish
Reading Ele	289	03-Jun-13	16-Jul-14
Notice To Proceed	0	03-Jun-13	03-Jun-13
Permitting	15	03-Jun-13	21-Jun-13
Surveying	10	24-Jun-13	08-Jul-13
Mobilization	10	09-Jul-13	22-Jul-13
Preliminary Site W	10	23-Jul-13	05-Aug-13
Zone 1 Excavation	10	06-Aug-13	19-Aug-13
Shoring Zone 1	5	20-Aug-13	26-Aug-13
RAP Zone 1	10	27-Aug-13	10-Sep-13
Basement Slab S	5	11-Sep-13	17-Sep-13
Basement Slab O	3	18-Sep-13	20-Sep-13
Foundation Wall F	5	23-Sep-13	27-Sep-13
Elevator Shaft CM	25	23-Sep-13	25-Oct-13
Stairwell CMU Ins	25	23-Sep-13	25-Oct-13
Concrete Baseme	15	30-Sep-13	18-Oct-13
RAP Zone 2	10	21-Oct-13	01-Nov-13
RAP Zone 3	10	04-Nov-13	15-Nov-13
Spread Footings	5	04-Nov-13	08-Nov-13
Spread Footings	5	18-Nov-13	22-Nov-13
Steel Erection Zo	15	25-Nov-13	16-Dec-13
Steel Erection Zo	15	17-Dec-13	07-Jan-14
Steel Erection Zo	15	08-Jan-14	28-Jan-14
Metal Decking Zo	3	29-Jan-14	31-Jan-14
Geothermal Boring	40	29-Jan-14	25-Mar-14
Floor 1 Concrete	2	03-Feb-14	04-Feb-14
Metal Decking Le	5	03-Feb-14	07-Feb-14
Floor 1 Concrete	2	05-Feb-14	06-Feb-14
Level 2 Rebar/Fo	2	07-Feb-14	10-Feb-14
Steel Stair Installa	5	07-Feb-14	13-Feb-14
Basement Mecha	15	07-Feb-14	27-Feb-14
Level 3 Metal Dec	5	10-Feb-14	14-Feb-14
Level 2 Concrete	2	11-Feb-14	12-Feb-14
Level 3 Rebar/Fo	2	13-Feb-14	14-Feb-14
Interior Stud Layo	10	13-Feb-14	26-Feb-14
Level 3 Concrete	2	17-Feb-14	18-Feb-14
Roof Decking	5	19-Feb-14	25-Feb-14
Precast Exterior F	20	19-Feb-14	18-Mar-14
Interior Stud Layo	5	27-Feb-14	05-Mar-14
MEP Rough-In Le	15	27-Feb-14	19-Mar-14
Basement Electri	15	28-Feb-14	20-Mar-14
Interior Stud Layo	5	06-Mar-14	12-Mar-14
MEP Rough-In Le	15	06-Mar-14	26-Mar-14
MEP Rough-In Le	15	13-Mar-14	02-Apr-14
Exterior Glazing	15	19-Mar-14	08-Apr-14
Atrium Kalwall	15	19-Mar-14	08-Apr-14
Built Up Roofing I	20	19-Mar-14	15-Apr-14
Drywall Installatio	10	20-Mar-14	02-Apr-14
Drywall Installatio	10	27-Mar-14	09-Apr-14
Drywall Installatio	10	03-Apr-14	16-Apr-14
Green Roof	20	03-Apr-14	30-Apr-14
Finishes Level 1	20	03-Apr-14	30-Apr-14
Finishes Level 2	20	10-Apr-14	07-May-14
Finishes Level 3	20	17-Apr-14	14-May-14
Punchlist	5	15-May-14	21-May-14
Substantial Comp	0	22-May-14	22-May-14
Inspections	5	22-May-14	28-May-14
Closeout Docume	15	22-May-14	11-Jun-14
Commissioning	15	29-May-14	18-Jun-14
Final Cleanup	3	19-Jun-14	23-Jun-14
Owner Facilities T	2	24-Jun-14	25-Jun-14
Certificate of Occ	0	26-Jun-14	26-Jun-14
Owner FF&E	15	26-Jun-14	16-Jul-14

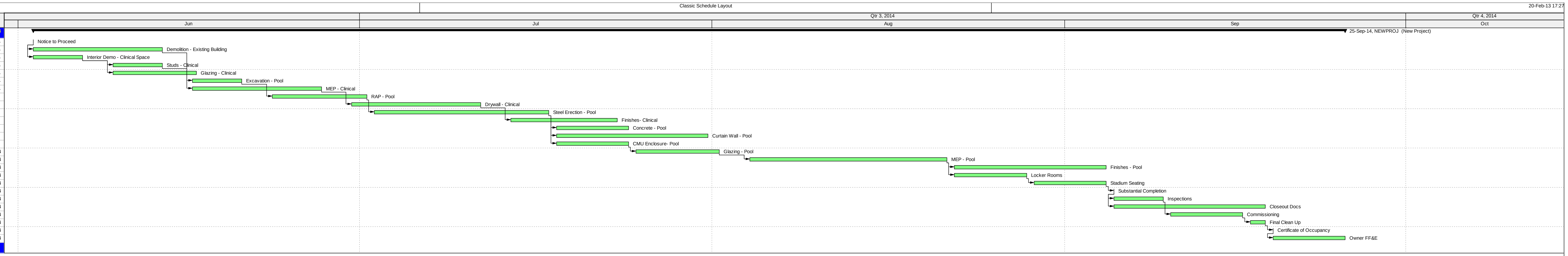


Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

Supporting Drawing II - Reading Elementary Phase 1

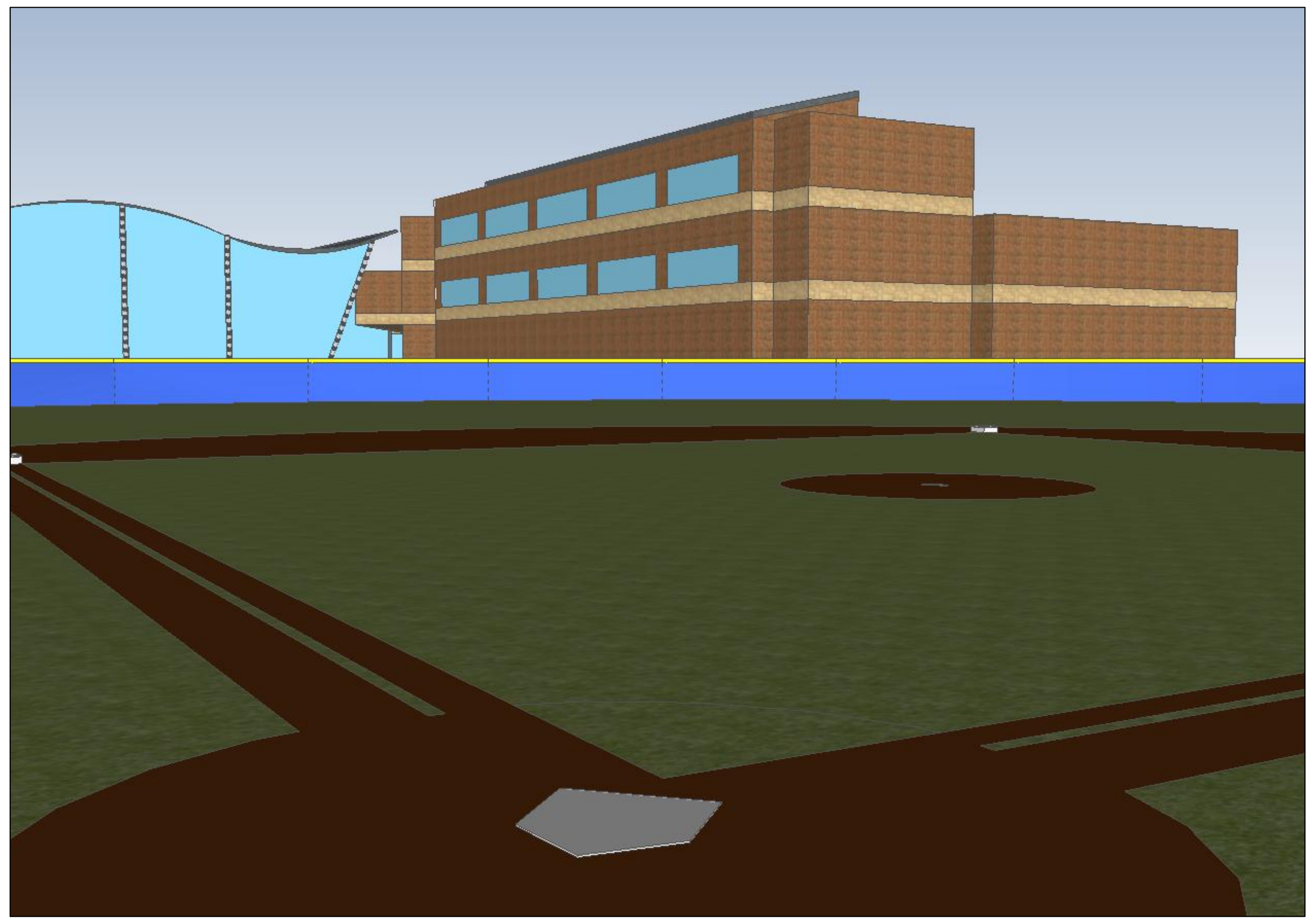
TASK filter: All Activities

Activity Name	Original Duration	Start	Finish
NEWPROJ (	84	02-Jun-14	25-Sep-14
Notice to Proceed	0	02-Jun-14	02-Jun-14
Demolition - Exist	10	02-Jun-14	13-Jun-14
Interior Demo - C	5	02-Jun-14	06-Jun-14
Studs - Clinical	5	09-Jun-14	13-Jun-14
Glazing - Clinical	6	09-Jun-14	16-Jun-14
Excavation - Pool	5	16-Jun-14	20-Jun-14
MEP - Clinical	10	16-Jun-14	27-Jun-14
RAP - Pool	7	23-Jun-14	01-Jul-14
Drywall - Clinical	10	30-Jun-14	11-Jul-14
Steel Erection - P	12	02-Jul-14	17-Jul-14
Finishes- Clinical	8	14-Jul-14	23-Jul-14
Concrete - Pool	5	18-Jul-14	24-Jul-14
Curtain Wall - Pool	10	18-Jul-14	31-Jul-14
CMU Enclosure-	5	18-Jul-14	24-Jul-14
Glazing - Pool	6	25-Jul-14	01-Aug-14
MEP - Pool	14	04-Aug-14	21-Aug-14
Finishes - Pool	10	22-Aug-14	04-Sep-14
Locker Rooms	5	22-Aug-14	28-Aug-14
Stadium Seating	5	29-Aug-14	04-Sep-14
Substantial Comp	0	05-Sep-14	05-Sep-14
Inspections	3	05-Sep-14	09-Sep-14
Closeout Docs	10	05-Sep-14	18-Sep-14
Commissioning	5	10-Sep-14	16-Sep-14
Final Clean Up	2	17-Sep-14	18-Sep-14
Certificate of Occ	0	19-Sep-14	19-Sep-14
Owner FF&E	5	19-Sep-14	25-Sep-14
EC00515 Cit	681	01-Nov-10 A	03-Jul-13

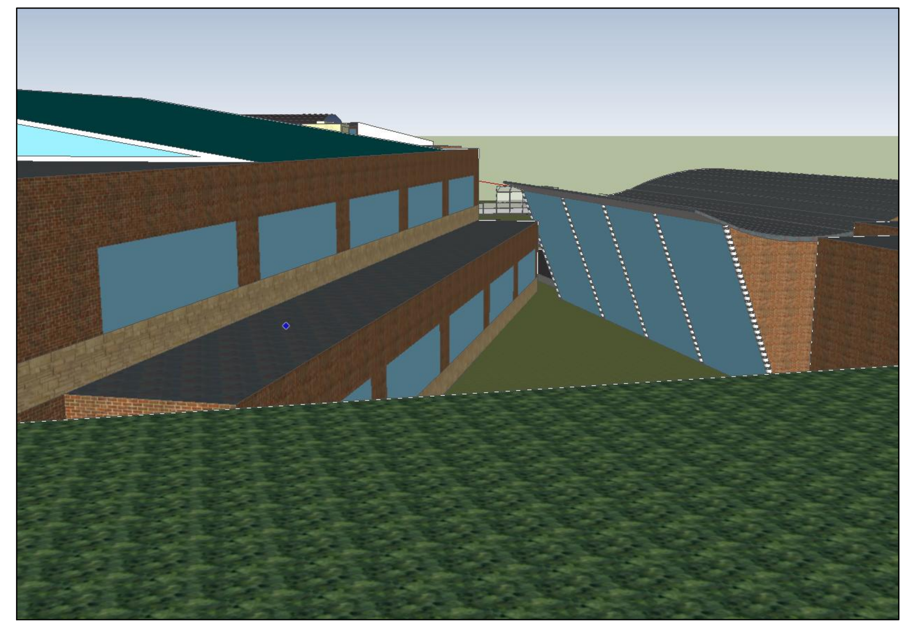


Actual Level of Effort | Remaining Work | ◆ Milestone
Actual Work | Critical Remaining Work | summary

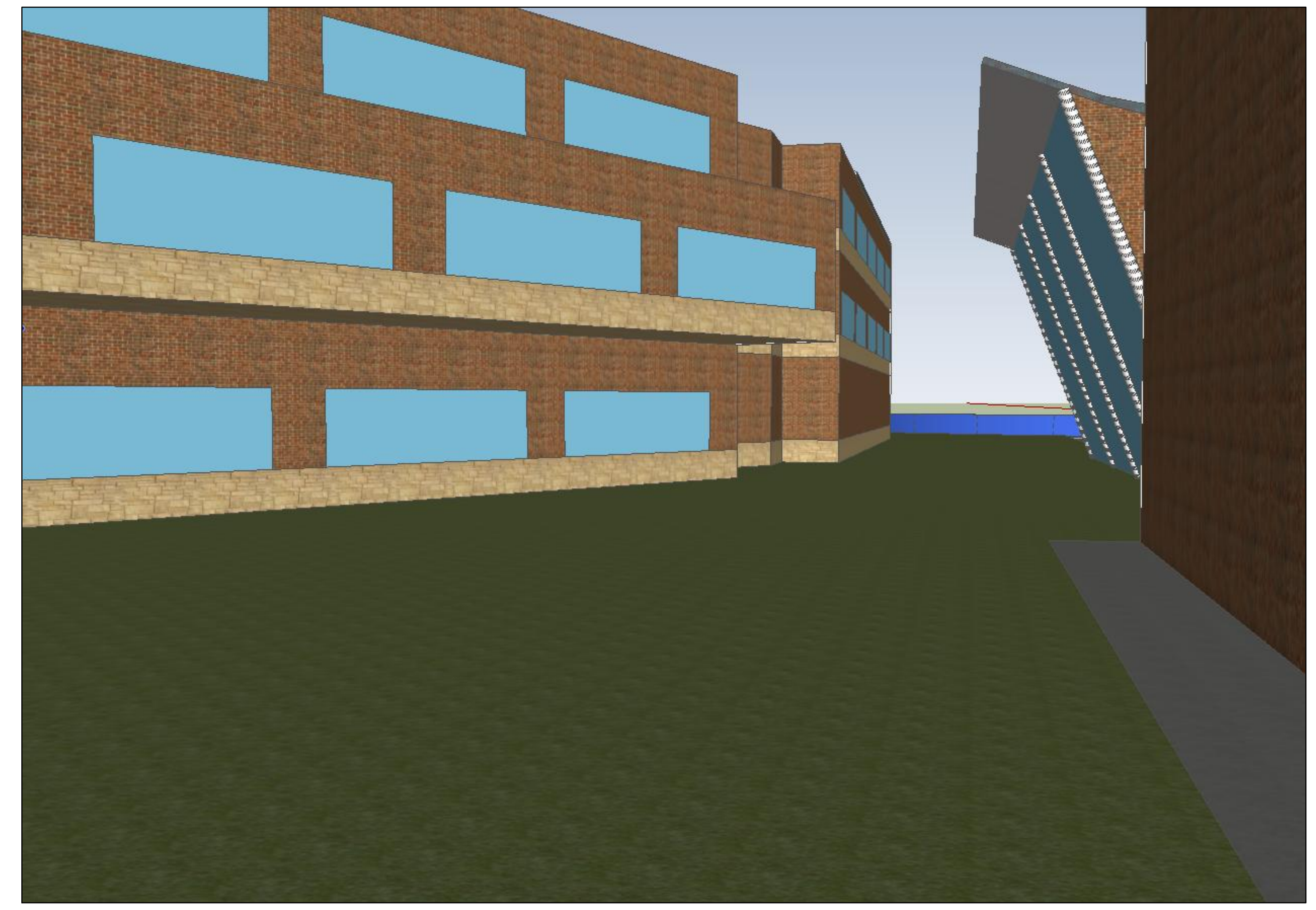
TASK filter: All Activities



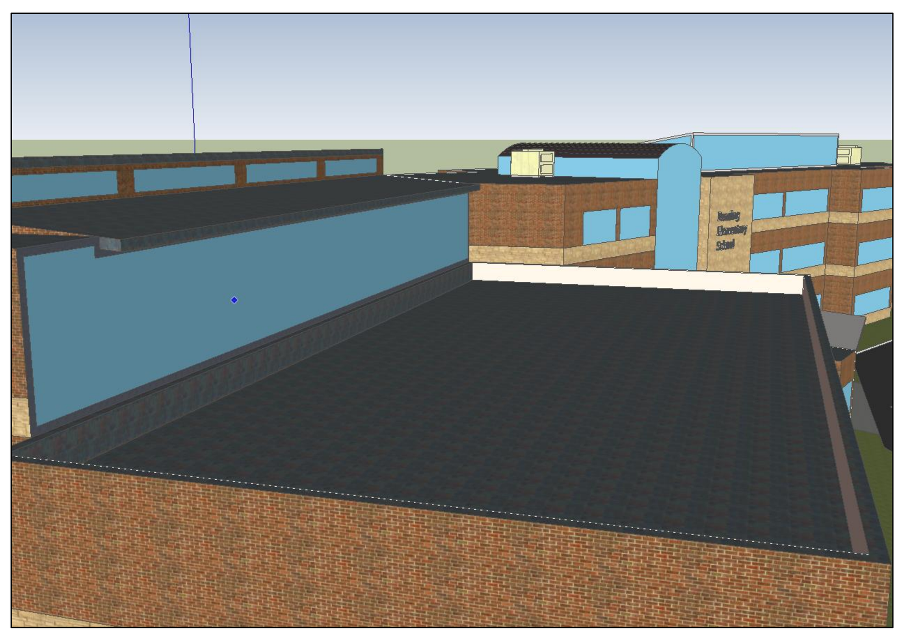
Snapshot A



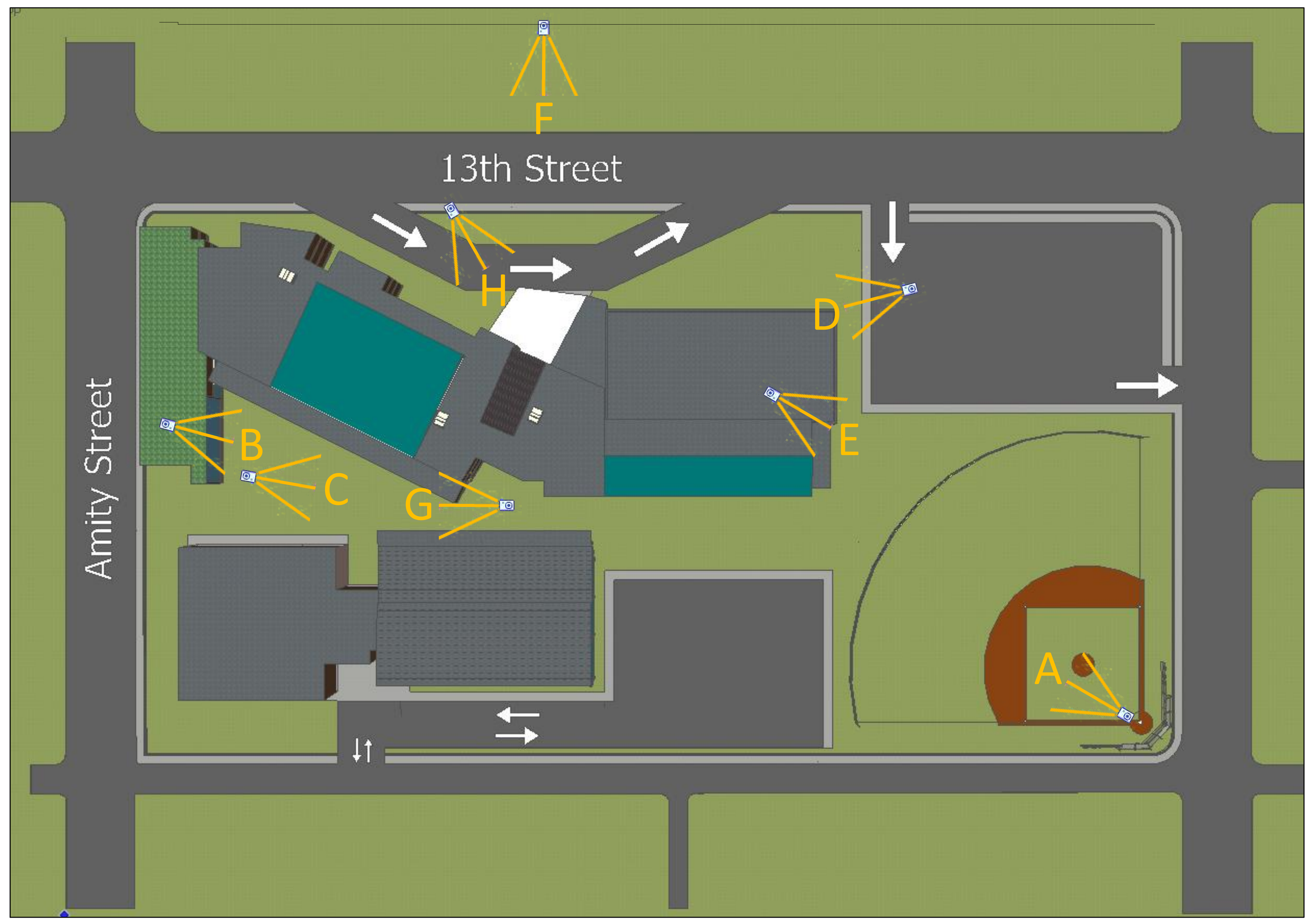
Snapshot B

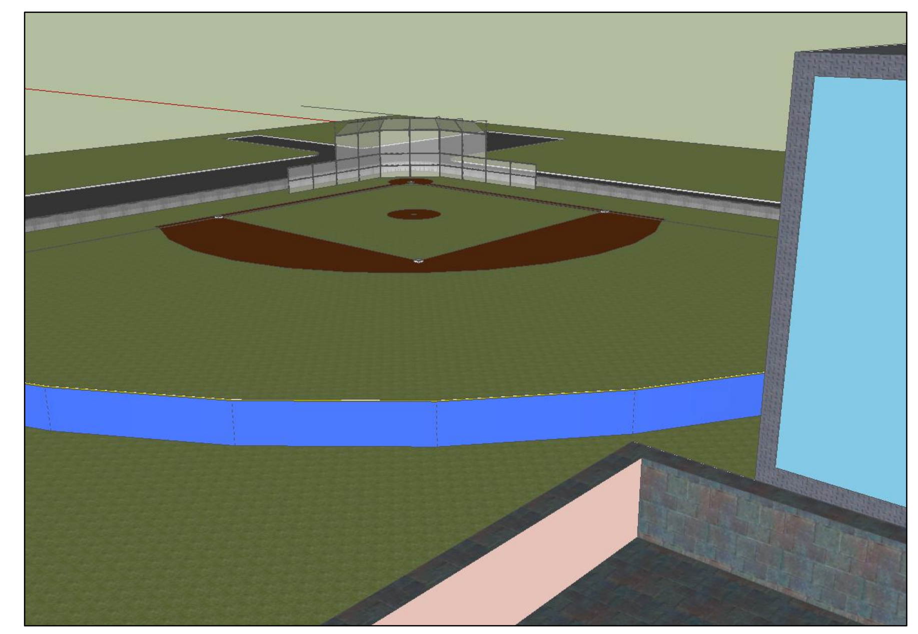


Snapshot C

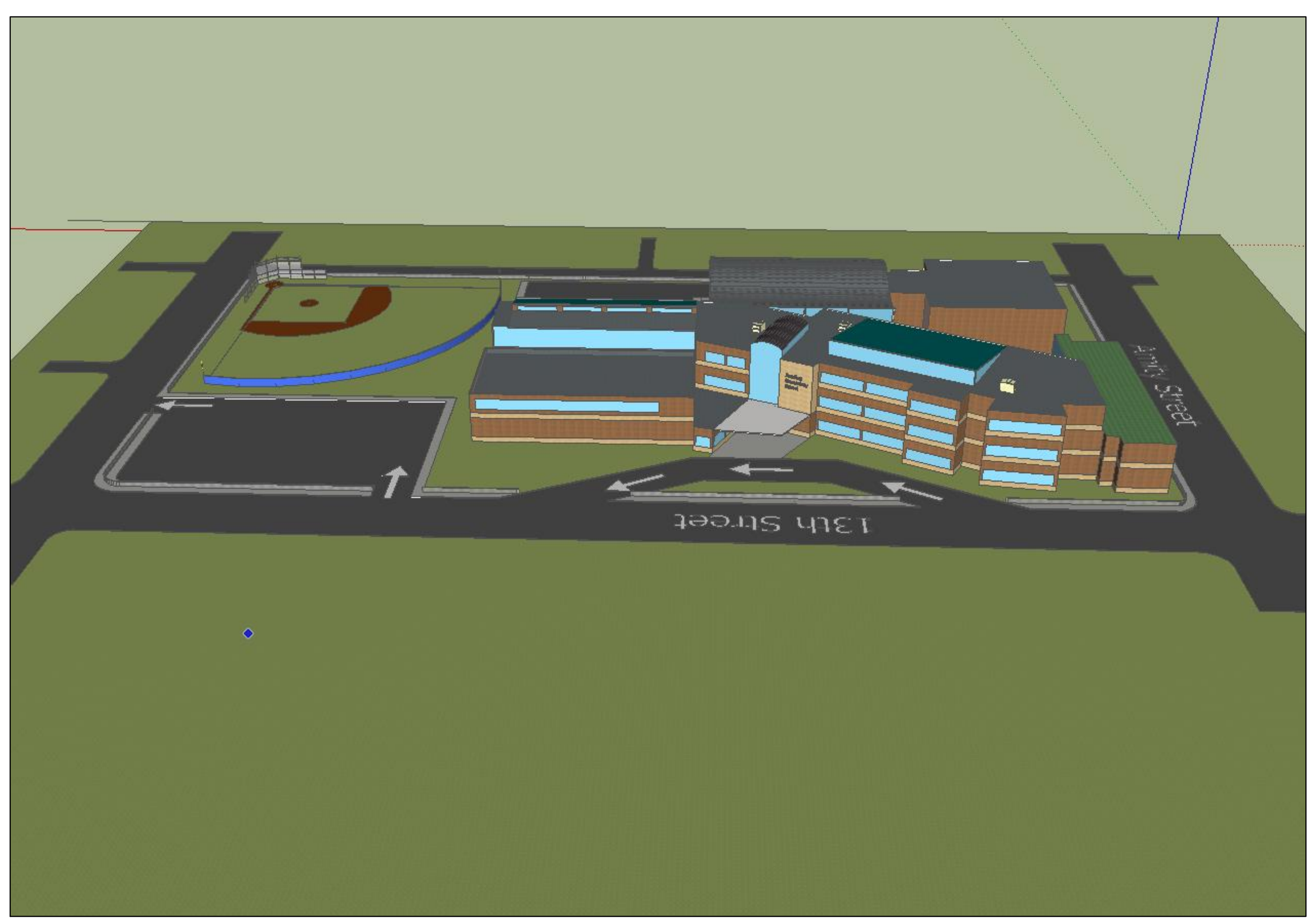


Snapshot D

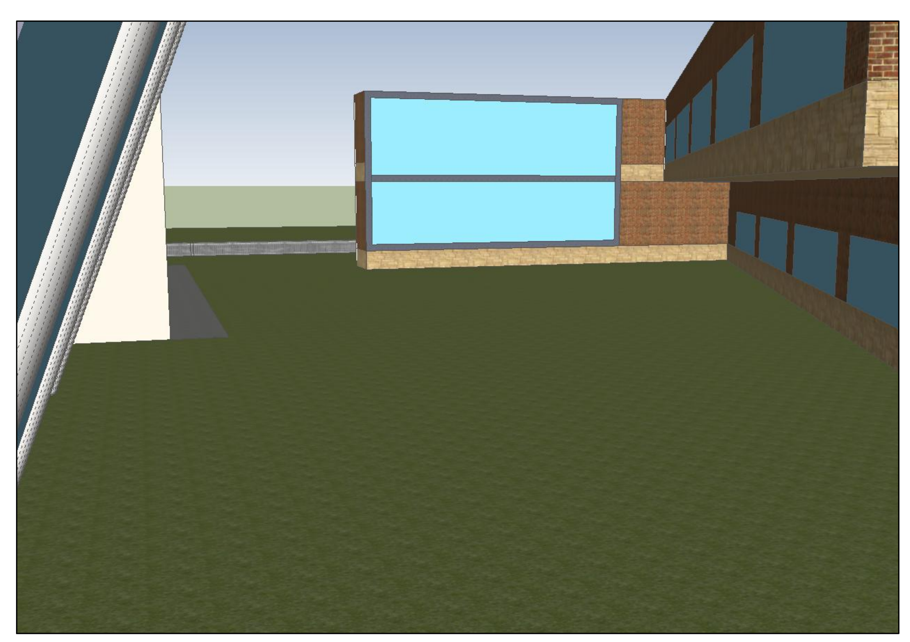




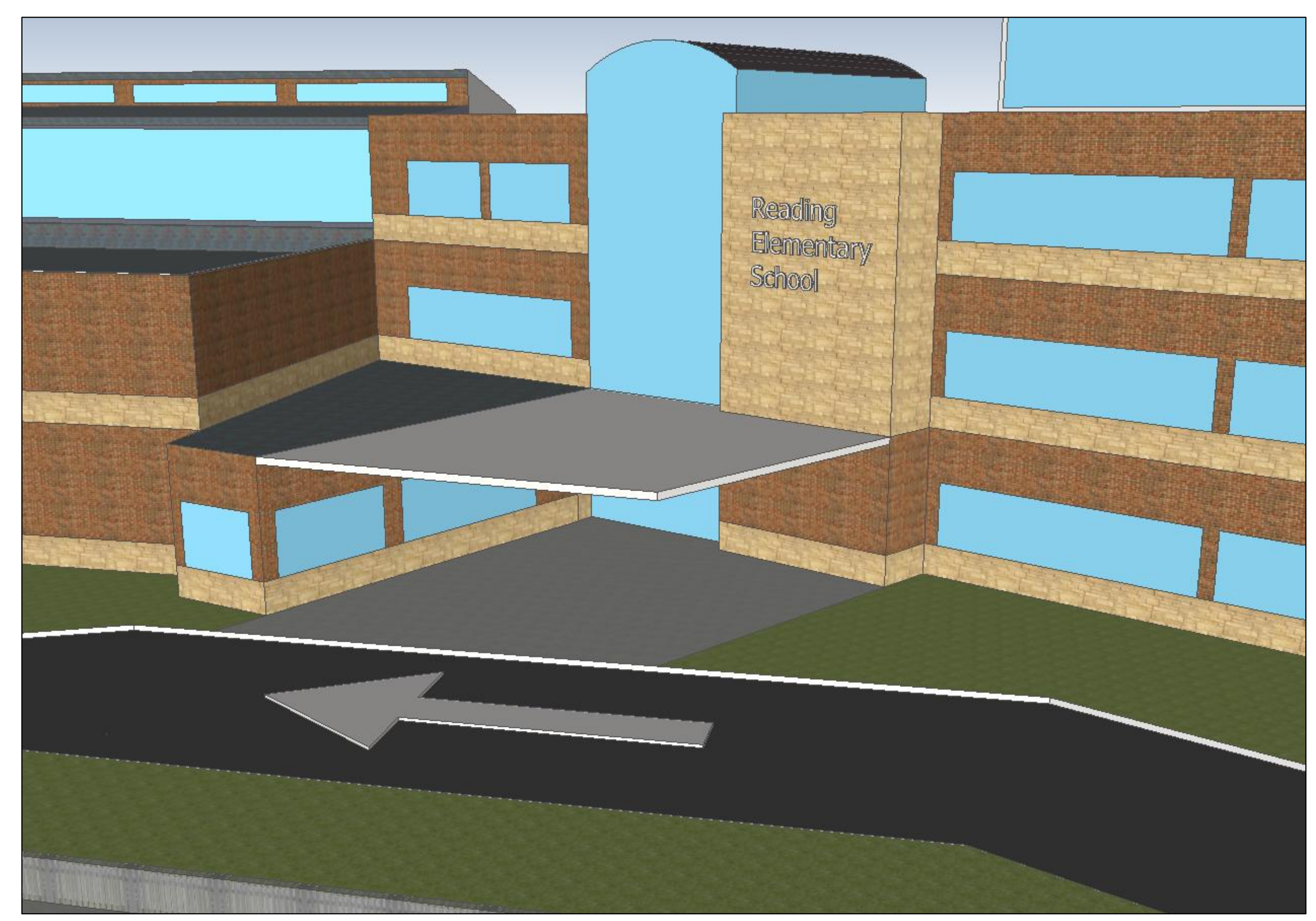
Snapshot E



Snapshot F



Snapshot G



Snapshot H

Autodesk Revit

www.autodesk.com/revit

No.	Description	Date

AEI Team #04-2013

Reading Elementary School

3D Project Overview

Project Number	04-2013
Date	22 February 2013
Drawn By	Author
Checked By	Checker

Drawing iv

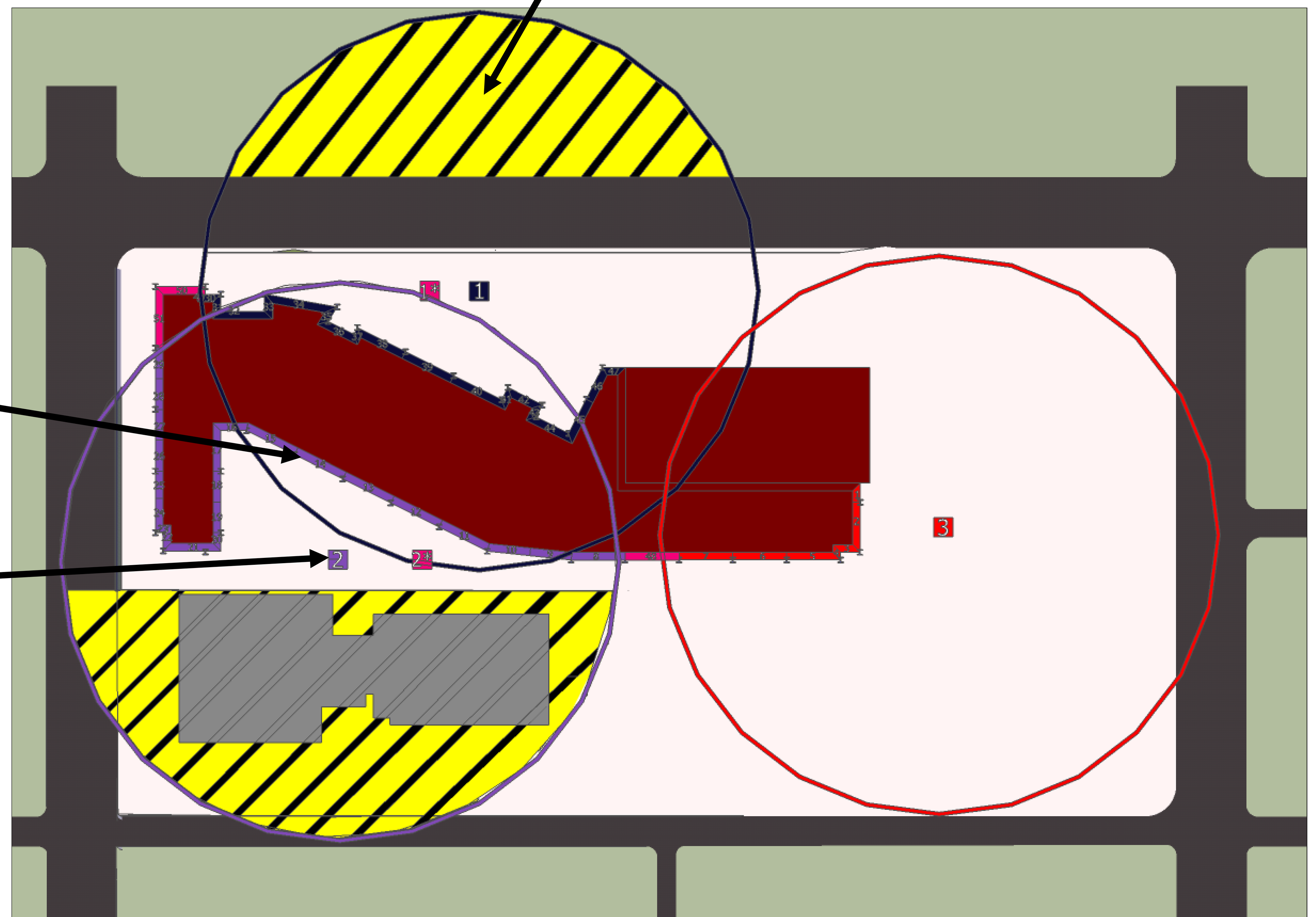
Scale

2/20/2013 3:25:43 PM

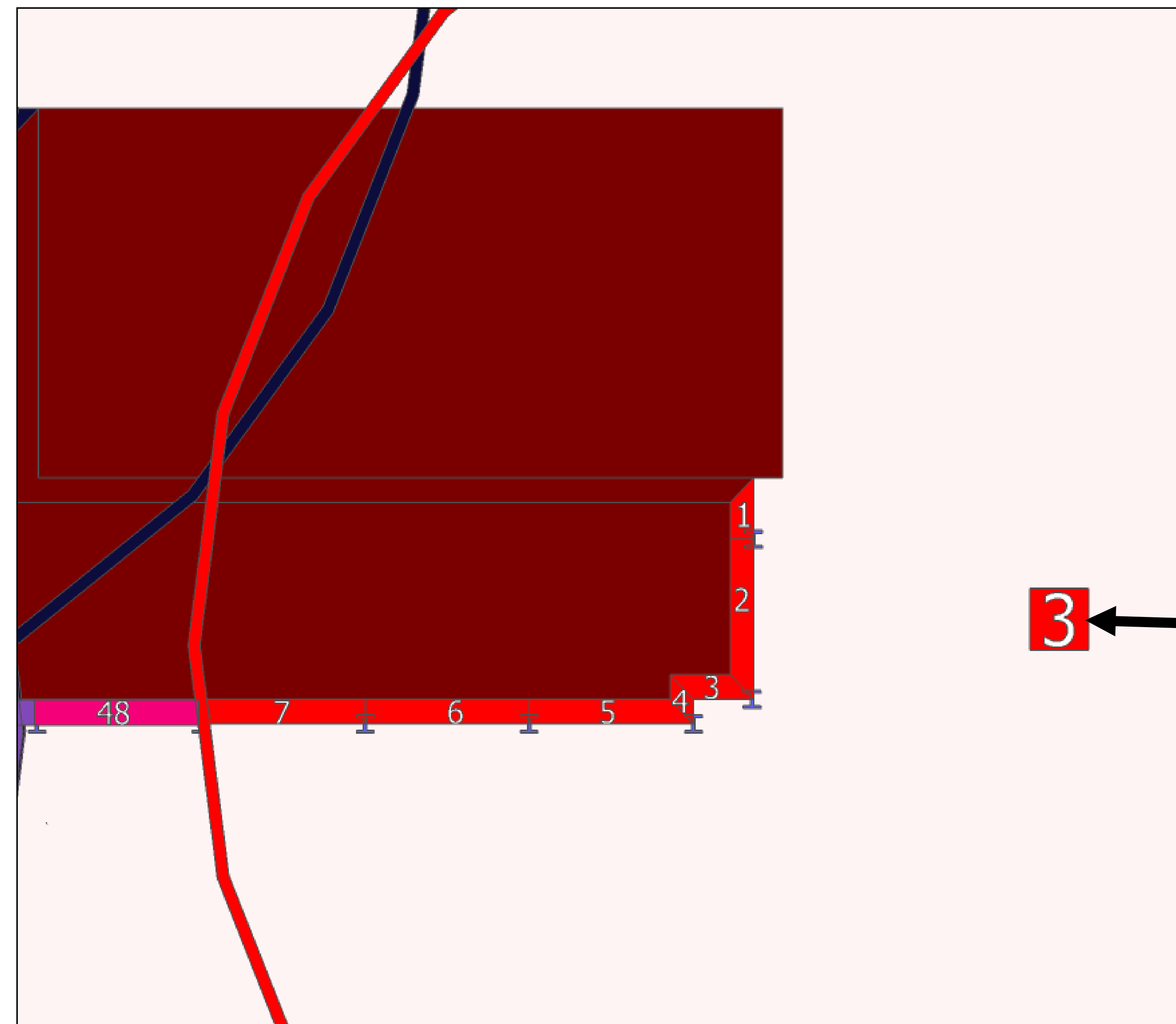
Cranes cannot swing onto existing property or above existing occupied structures. These spaces are depicted with black and yellow pattern seen below.

Precast wall panels are coordinated to match the color of the crane location for each panel lift.

Crane locations are depicted by numbered squares. The surrounding circles with corresponding colors represent each crane location's swing radius.



Above is our Crane Pick Strategy Overview. This image depicts all planned crane locations and their corresponding picks. This image provides a possible solution for the issue of erecting massive precast panels on such a tight site. The erection of each panel has been evaluated and ensured to fall within the crane radius and load capacity. Refer to captions for more explanation of the developed visual and calculations.

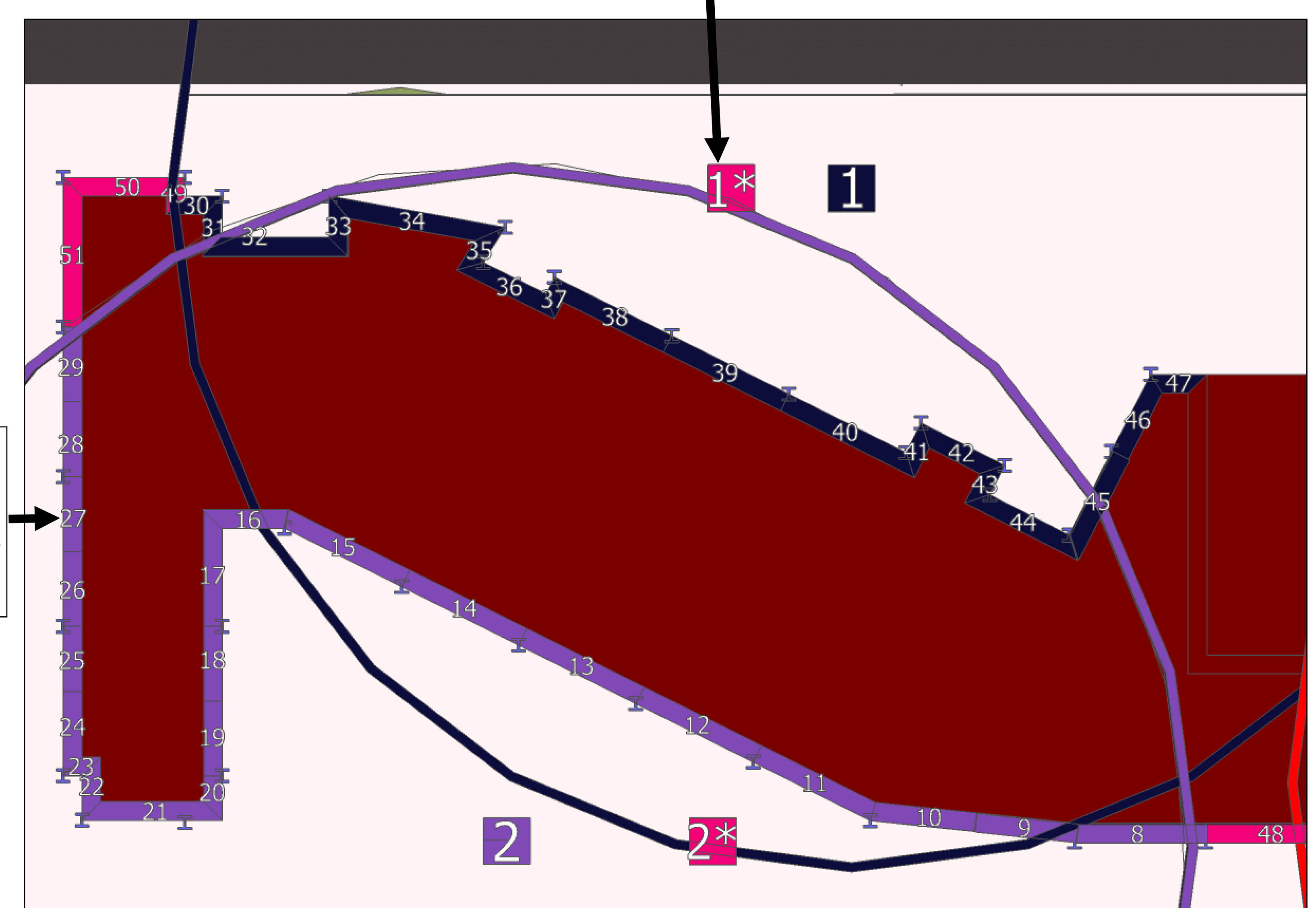


Above is a detailed view of crane location 3. Panels which will be erected with specific crane locations are color coordinated. Each panel is numbered as well. Panel's respective calculations can be found in the Panel Erection Calculations below.

To the left is a detailed view of the third crane location. You can see clearly the precast panels numbered 1 through 7 which will be erected while the crane is in 'Position 3'. Notice that all of these panels fall within the radius of the proposed crane. Although this is a two dimensional plan, three stories of panels will be erected in these locations. As described in the Construction Management report, panel heights will be 14', the floor to floor height of the building.

Crane Locations 1* and 2* have been proposed in order to safely erect precast panels at four locations which are just slightly out of the reach or the original three locations. Precast panel numbers 48 and 51 are especially important in that they are very near to the maximum load and swing radius. The precast panel subcontractor is to take specific not to ensuring that the crane location is within the swing radius prior to erecting panels in crane locations 1* and

Each panel location was designated a specific panel number, shown here. Peach panel was measured in length and multiplied by the panel height and weight of approximately 90 PSF. Panel weights were calculated to ensure that each panel was safe to erect with our suggested crane and within its proposed radius. NO panels were to exceed 35,000 pounds. Additionally, distances were measured to ensure that each panel was within the calculated 150 foot radius. Refer to Panel Erection Calculations to the



Above is a detailed view of crane locations 1, 1*, 2 and 2*. Panels which will be erected with specific crane locations are color coordinated. Each panel is numbered as well. Theis respective calculations can be found in the Panel Erection Calculations to the right.

Panel Erection Calculations

Crane Location	Panel Number	Panel Length [FT]	Panel Weight [LB]	Pick Distance [FT]
3	1	8	9968	43
3	2	25	31150	40.5
3	3	10	12460	46
3	4	3	3738	52
3	5	26	32396	65
3	6	28	34888	92
3	7	28	34888	120
2	8	28	34888	130
2	9	22	27412	106
2	10	22	27412	85
2	11	28	34888	62
2	12	28	34888	40
2	13	28	34888	37
2	14	28	34888	46
2	15	28	34888	66
2	16	16	19936	83
2	17	23	28658	78
2	18	16	19936	67
2	19	16	19936	61
2	20	8	9968	59
2	21	26	32396	71
2	22	10	12460	85
2	23	5	6230	87
2	24	16	19936	91
2	25	14	17444	96

Crane Location	Panel Number	Panel Length [FT]	Panel Weight [LB]	Pick Distance [FT]
2	27	16	19936	109
2	28	16	19936	120
2	29	16	19936	130
1	30	8	9968	135
1	31	9	11214	131
1	32	27	33642	119
1	33	8	9968	105
1	34	32	39872	89
1	35	7	8722	76
1	36	19.5	24297	72
1	37	4	4984	63
1	38	28	34888	53
1	39	28	34888	42
1	40	28	34888	47
1	41	7	8722	53
1	42	16	19936	56
1	43	7	8722	65
1	44	23.5	29281	76
1	45	22	27412	81
1	46	17	21182	75
1	47	10	12460	75
2*	48	28	34888	113
1*	49	4	4984	114
1*	50	22	27412	125
1*	51	28	34888	136

Drawing vi

Innovative Construction and Construction Methods

Crane Utilization Strategy

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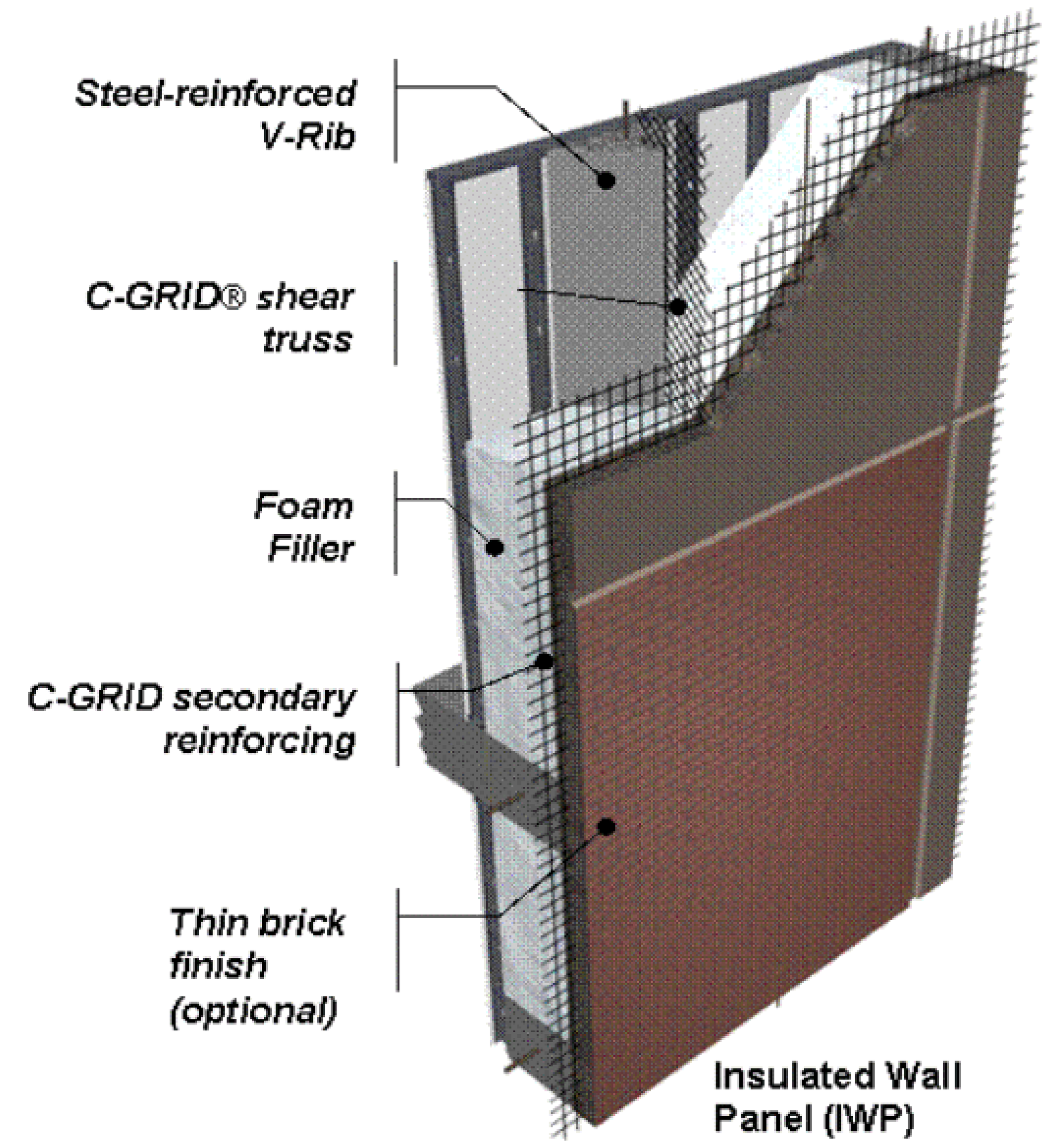
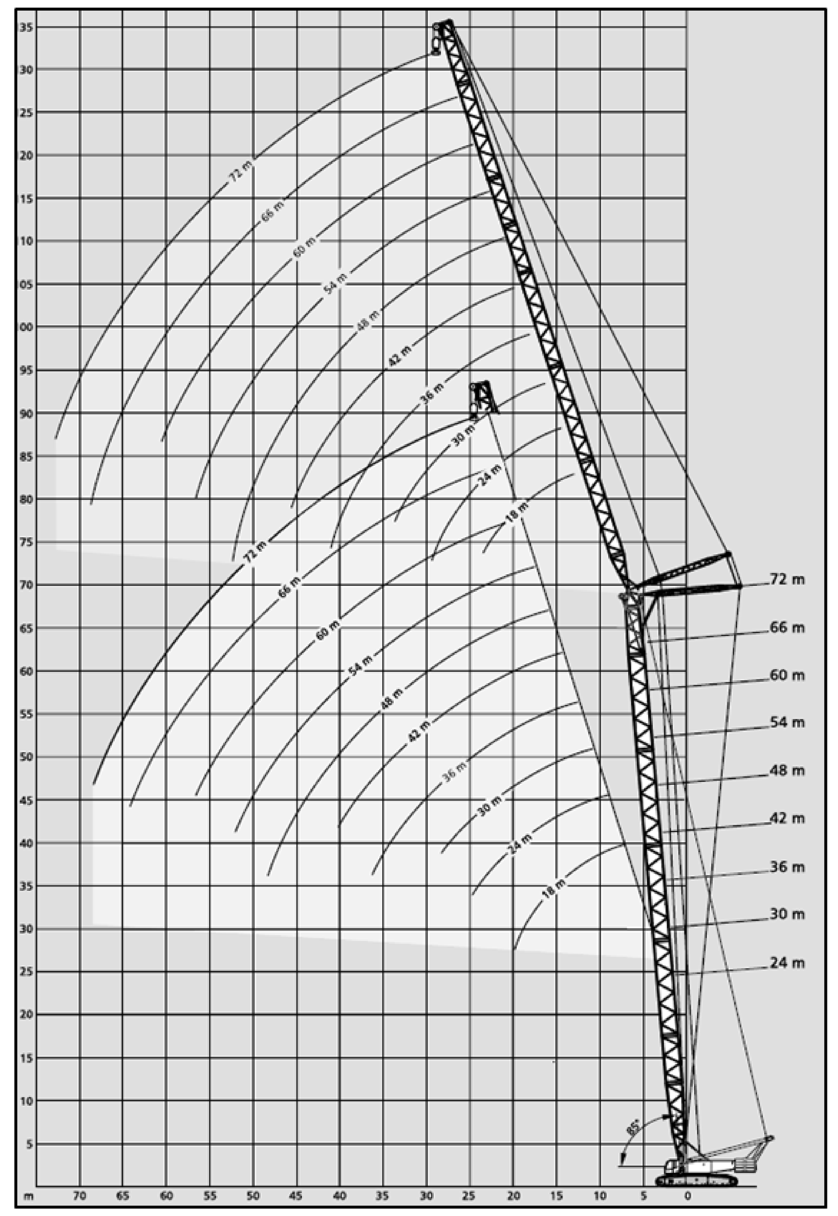




54 m	Main boom · Hauptausleger · Flèche principale						
	Radius Ausladung Portée		Fly jib · Hilfsausleger · Fléchette				
		m	18,0	24,0	30,0	36,0	42,0
	15		53,3	-	-	-	-
	16		51,3	-	-	-	-
	17		49,5	44,5	-	-	-
	18		47,7	42,8	-	-	-
	19		46,1	41,4	37,0	-	-
	20		44,6	40,0	35,7	-	-
	21		43,4	39,1	34,8	31,3	-
	22		42,2	38,2	33,9	30,4	-
SW	23		41,1	37,3	33,2	29,8	26,0
	24		40,1	36,4	32,5	29,1	25,5
	26		-	34,8	31,2	28,1	24,5
	28		-	33,3	29,9	27,1	23,7
	30		-	31,8	28,7	26,1	23,0
	34		-	-	26,5	24,2	21,5
	38		-	-	-	22,6	20,1
	42		-	-	-	21,0	18,8
	46		-	-	-	-	17,5
	50		-	-	-	-	-

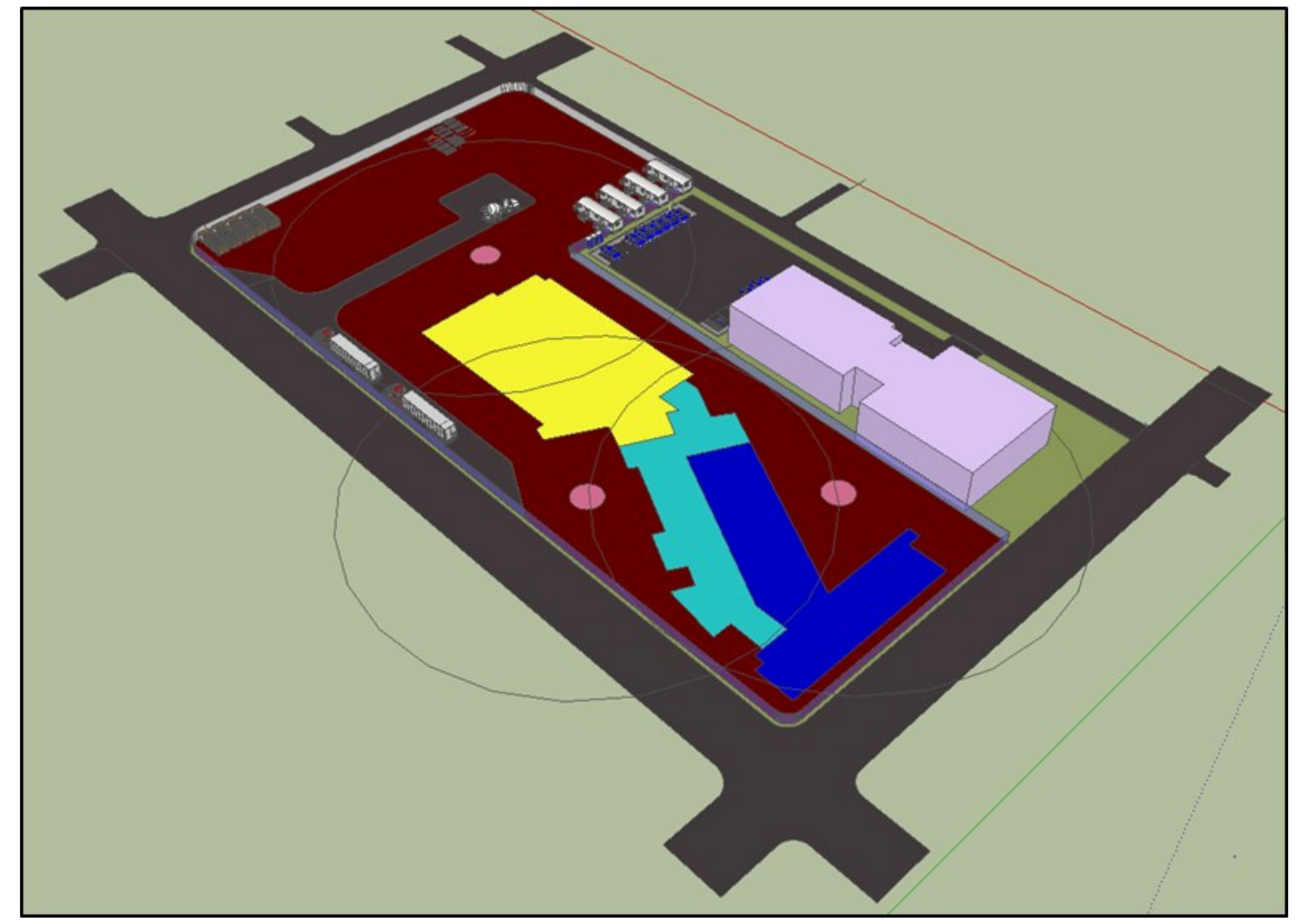
Radius:

46 m = 150.9 ft.

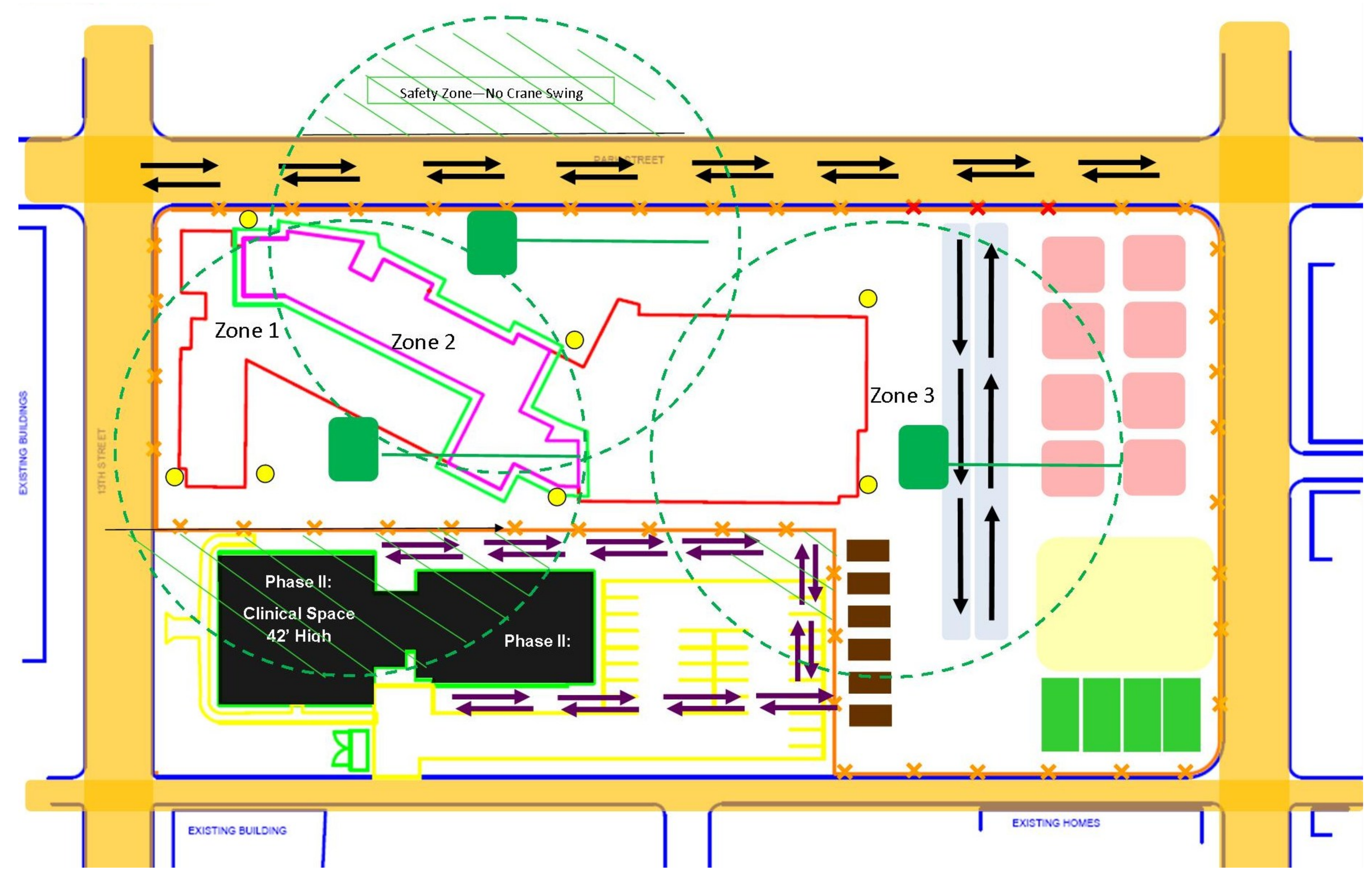
Capacity:

17.5 tons (46m) = 35,000 lb.

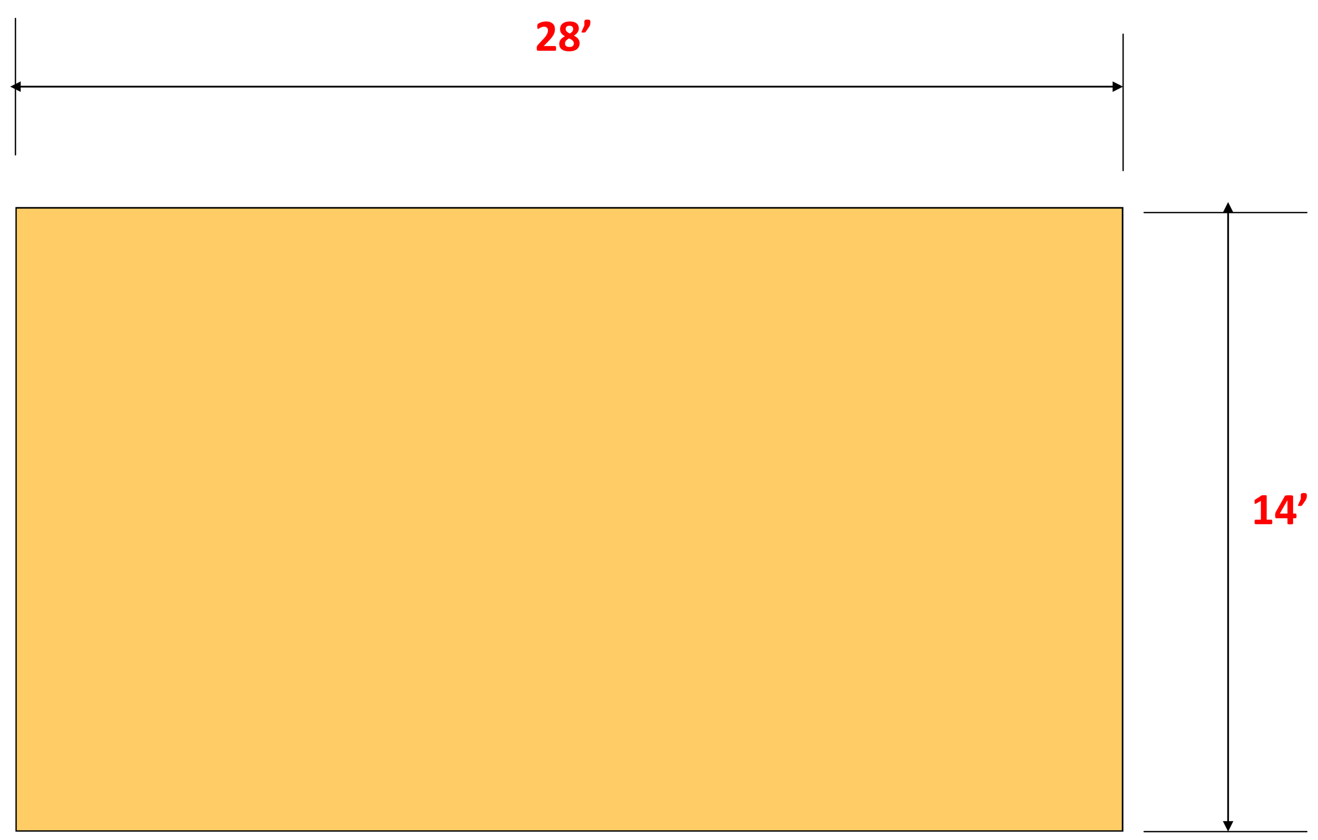
Therefore, a 46 meter boom with 42 meter jib would be appropriate to make the most critical pick of 35,000 lb at 140 feet. It is extremely imperative that the precast panel contractor place the crane as specified in order to assure no picks exceed the 140' radius, as extending the crane to its maximum radius would lower the crane capacity to 35,000 pounds, which is exactly the minimum capacity required for precast panels.



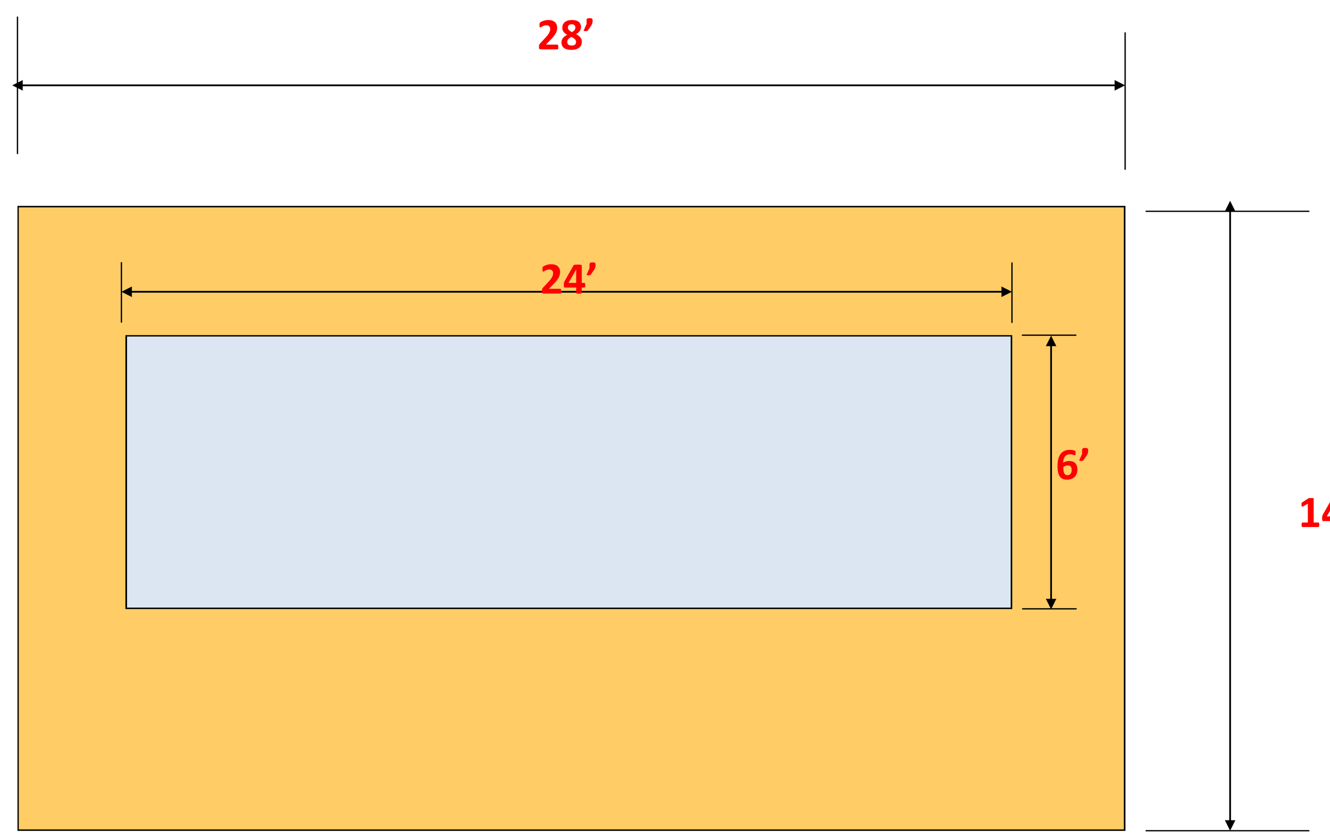
Above is a site logistics plan with proposed crane placements. The proposed crawler crane locations are depicted with pink circles. A 140' radius is shown at each location. The crane at each location is to be set back 35' from the building footprint. This setback is needed to minimize loads on surrounding buildings and foundations caused by the weight of the crane. The setback also allows enough room for the crane boom to clear 45' (42' height of the building + 3' clearance) at the face of the building while maintaining an angle at which the boom can clear the required 140' radius. However, with such a large jib selected, clearance is not a major issue. The selected crane is highlighted in yellow on the sizing chart, which is laid out in meters and tons. Refer to conversions and calculations



Case 1: Solid Panel



Case 2: Panel with Largest Glass Area



Panel Weight

14'*28' = 392 SF

392 SF * 90 lbs/ft2 = 35,000

Panel Weight

14'*28' = 392 SF

6'*24' = 144 SF Glass

392-144 = 248 SF Concrete

248 * 90 lbs/ft2 + 248 * 5 lbs/ft2 = 25,000

First Level:	**1170 LF**
Second Level:	**1235 LF**
Third Level:	**982 LF**
	3387 LF

⇒ **122 Panels**

Pick Schedule

3400 LF = 150 Picks

6 Panels a Day for 25 Days

- 3 axles on 6' spread with 385 65R 22.5 aluminum rims...meets US, Canadian and many other countries' DOT regulations
- 70,000 GVWR (3-25,000 lbs axles)
- Available in 48' or 53' designs with load bay extension
- Available in any length - fixed or extendable
- Hauls panels up to 57 feet in length
- Optional Rack System for hauling various size pipe
- Air ride suspension 6 independent wheels for a smooth ride = less damage to the panels
- 48' design gets in and out of tight job-sites
- No Permitting for over-width loads - "Run day or Night"
- No Escorts for over-width loads
- Vertical hauling up to 13 foot panels
- Vertical handling reduces damage
- Center "low" load bay for equal load distribution
- Folding stabilizing rack to convert to flat bed carrier
- Unload panels in any sequence
- Custom tail gate extension hauls a 40' panel heavy duty adjustable load pins and winches for securing load
- Durable tube steel construction for years of service
- Anti-corrosion paint
- Optional center rack for hauling various size panels
- Optional Double Tee rack available

Reference: http://www.loadlifter-solutions.com/pages/international_pcc/

Transportation Strategy—Just in Time Delivery

6 Panels a day, 6 Panels Placed

Drawing vi

Innovative Construction and Construction Methods

Precast Panel Erection Strategy

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