Construction

Submitted: Integration Structural Mechanical Electrical Construction

350 Mission St.

ASCE Charles Pankow Foundation Architectural Engineering Student Competition

AEI Team 2-2014

Contents

Narrative

Appendices

Construction Highlights

Contract Type (Proposed):

Guaranteed Maximum Price (GMP)

Integrated Project Delivery Method (IPD)

Building Systems Summary

Biomethane-fueled Absorption Heat Pumps

Tambient Lighting

Concentrically-Braced Core Structure

Mat Slab Foundation

TOTAL COST: $131,213,200

TOTAL SCHEDULE: 19 months

Drawings

Executive Summary

In accordance with the project guidelines set by the ASCE Charles Pankow Annual Architectural Engineering Competition, AEI Team 2, henceforth also referred to as "the team", created a comprehensive building design and construction plan for a new office high rise building at the site of 350 Mission in San Francisco, California. Per the guidelines of the competition, the team considered the following in the construction design process:

1) **Building Design.** Construction impacted the way design progressed over the course of the project. Decisions were made regarding design practicality and how specific building systems would impact construction. The team was also conscientious about how construction impacted the community, through public building statistics and specific system display. Additionally design decisions, including the choice to prefabricate multiple building system elements, helped decrease waste created by the building's construction.

2) **Sustainability & Energy Efficiency.** Building design was driven by impact. How the building interacted with the community during and after construction was important to fully integrating unique ideas into the fabric of the architecture. In construction, the team sought ways to reduce waste on site. This included an integrated process to keeping the site clean and educating the public via publications during the construction process. Additionally, this included cutting back on construction waste materials, per the process of prefabrication.

   Furthermore, the team made a decision to bring vital units of the building's mechanical system onsite early. It was decided that a biomethane digester will serve as the primary source of building power. This system also reduces the negative impact from the community's sewage system.

3) **Integration & Collaboration.** Multidisciplinary teamwork was at the core of the building progress. Construction shaped design and design also shaped construction. By innovating through construction, the team was able to bring many of the building concepts to life in our plan for 350 Mission.

4) **Building Reoccupation.** One of the principle goals of the overall project was alleviating building downtime following a seismic event in San Francisco. Recommendations were made by the construction team in regards to material and system selection to ensure that the design evaded significant damage in the long run. Quality control during construction and in manufacturing of building elements was essential to creating a building which will last many years.

5) **Building Budget.** A building budget is included within the submission, which not only details short-term construction costs of the building, but also long-term life cycle costs.

   The building has a base construction budget of $131,213,200. The project has a total duration of 19 months. Work is scheduled to begin in January of 2013 and completion is expected early in July of 2014.

The team has created a cyclical phasing plan for the erection of 350 Mission which best interacts with the surrounding area, while keeping in mind the seismic potential in the region. Short Interval Production Scheduling (SIPS) was utilized not only to shorten the construction schedule, but to also keep productivity of trades at a maximum. In summary, the construction plan was designed to be an efficient, practical approach to the conception of the office building.

350 Mission Street will serve as a focal point in the financial district south of Market Street in San Francisco. Community, sustainability, building performance, practicality, and architectural prowess have shaped the team's comprehensive design. AEI Team 2 has created a building design which performs cohesively, engages the community, enhances occupant usability, and considers the unique qualities of the San Francisco bay area.

Introduction

350 Mission. Located just south of Market Street, at the corners of Fremont Street and Mission Street, 30 stories rise above street level to form 350 Mission. Primarily, the building will serve as an office space, featuring just short of 25 floors of open floor space. Additionally, a double-story lobby space will serve as the not only as the entrance for building occupants, but also a public space.

350 Mission is located in a region which is primarily populated by residential and business traffic. It is surrounded by office buildings: 45 Fremont, 50 Fremont, and 50 Beale. Furthermore, the Millennium Tower is located across Mission Street from the site. This tower primarily consists of residential properties, but also maintains several restaurants and recreation spaces. In the future, the Transbay Tower will be located cattycorner to 350 Mission. "Transbay" will be the tallest building in the city upon completion and will feature additional office space. Gathering information about the surrounding buildings helped drive the design and construction plan for 350 Mission.

Team Mission Statement:

Team 2 is dedicated to connecting communities, and enriching society through integrative high performance solutions and enduring principles.

Core Team Values & Goals. The team's design for 350 Mission set out to create a building scheme which fully embraced the goals of the ASCE Charles Pankow Foundation Annual Student Competition, while ensuring cohesiveness in collaboration. During design, the team developed a set of system-specific goals for the project. Over the course of the design development, we strove to reach particular design goalposts, amongst which included ensuring the building operated at near Net Zero conditions, reduced waste, educated the public on sustainability, practicality in its material composure, and would withstand incredible seismic stresses.

The goals of the project are all driven by a set of team values. These values became the cornerstones of project integration and design: **Performance, Endurance, and Connectivity.** The construction principles and approaches utilized throughout this project were outlined by these three values.

Performance. Efficiency in building construction drove integrated design. The team strove to create a building which could be erected in an efficient and effective approach. Furthermore, the team made decisions to ensure a level of quality in the final product. Construction goals driven by performance included:

- *High Performance Construction*: Construction was phased in what we define as "Pseudo-SIPS." SIPS, or Short Interval Production Scheduling, describes a schedule composed of cyclical and repetitive series of construction activities, ensuring constant motion and activity on site, while shortening the construction schedule. The open floor design of the building and structural steel skeleton made for a principally phased construction process.

- *Time & Environmentally Aware*: While utilizing prefabrication and repetitive construction activities, the team created a construction flow with schedule as a core principle. Efficiency was critical, but never placed before quality.

  The flow of site work identifies site constraints and the movement of pedestrian and vehicular traffic around the building. Considering the building's confined site, flow of building materials from offsite manufacturing locations was critical to the completion of construction.

- *Cost Practicality*: Design components were required essentials to the overall goals of the project. If proposed ideas did not mesh with total building design, decisions were made to either alter plans or remove the components from the overall design.

Endurance. Quality in the process of construction is essential to the life cycle of the building. During the planning process, a proposal was devised to ensure quality results in building construction. Construction goals driven by endurance included:

- *High Performance Construction*: Ensuring the building was erected in a manner which ensured a long life was a primary goal of the team. We designed, and the design should enable high quality construction.

Connectivity. Building design and construction were driven by how 350 Mission would be approached by tenants and the community. The team stressed education in sustainability, and integrated building performance into the daily lives of the building users. Construction goals driven by **Connectivity** included:

- *Time & Environmentally Aware*: Construction of 350 Mission will impact the surrounding area in terms of accessibility. Considering the confined space on site, permitting to use additional areas around the site was taken advantage of. However, the project team created a plan to minimize detrimental impact on flow of traffic and in regards to pedestrian safety.

- *Education & Safety*: Sustainability and building life cycle were at the forefront of design. The team made efforts to integrate education of building systems and performance. The building itself uses waste created by building tenants and the surrounding community. A goal was to highlight these features and illustrate the impact tenants had to the performance of the building. The lobby space, treated as an open, public space, will be completed at the earliest point possible in order to educate passersby on 350 Mission. The biomethane digestion system, specifically, will be showcased outside the lobby restrooms.

As identified, these three values of **Performance, Endurance, and Connectivity,** shaped decision making in design and construction. Overall, the primary construction goals included:

- **Developing a construction budget which is practical short-term and long-term.**
- **Developing a construction sequence which embraces the challenging constraints of the project site.**
- **Ensuring minimal impact to the surrounding environment, and**
- **Educating in sustainability through construction processes.**

1.0 Integration

The integrated project team was comprised of four discipline groups: electrical, construction, structural and mechanical. This integrated project team used Building Information Modeling tools and workflows among all four disciplines in order to design and deliver a fully integrated high-rise building design. These tools and workflows enabled the team to optimize the design around major points of integration, while working toward project goals (reference the integration report for a more in-depth analysis of these points). The team worked to achieve their project goals in each of these areas. Over the duration of the project, evidence suggested that it was this integration that led to innovation.

1.1 Computer Programs

To foster this collaboration, and design 350 Mission in the best manor possible, the construction team used the following software:

Autocad: Computer drafting software was used to create drawing details and lay out site development schemes in the construction process.

Revit: Revit was used to model specific building systems. Material quantities could be compiled through utilizing Revit.

Navisworks: 4D modeling software interacted with **Revit Architecture.** This was used to identify key construction sequences.

Microsoft Project: This tool was used in the basic scheduling of project activities. This data could then interact with **Navisworks.**

RS Means: Basic square foot estimates were used in establishing most cost comparisons between difference building systems.

ICE MC2: Computer based estimating software was used to develop the cost of specific building systems, especially in estimating structural elements.

SOM Environmental Analysis Tool: The team utilized the provided analysis tool which calculated the carbon footprint created by the construction process.

Further details in software integration may be found in the **Integration Report.**

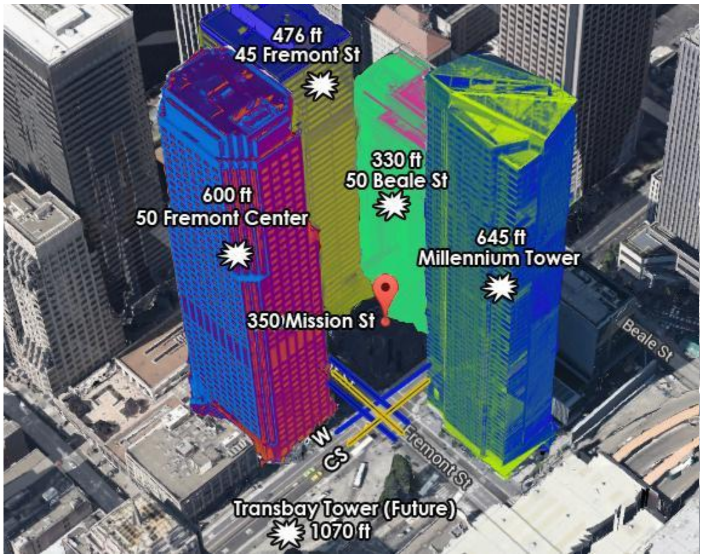


Figure 1: Surrounding conditions at 350 Mission Street. Primary water and sewage lines have been highlighted. These lines are critical to some of the building's signature performance features. Just to the south of the site, note the placement of the future Transbay Tower.[1]

2.0 Site

Site Orientation. 350 Mission will be constructed in the financial district just south of Market Street. The largest throughways which permit access to the area are Route 80 via the Oakland Bay Bridge, Route 101 which runs north-south just to the east of 350 Mission, and Market Street.

Located at the corners of Fremont Street and Mission Sreet, 350 Mission resides in an area which maintains consistent business and residential traffic. Construction activity and site setup took several cues from this condition. 45 Fremont Street, 50 Fremont Center, and 50 Beale Street operate as office buildings. The Millennium Tower across the street houses condominiums, restaurants, and recreational spaces. In the future, The Transbay Tower, diagonally adjacent to 350 Mission will stand as the tallest building in San Francisco.

3.0 Construction Conditions

The construction planning of 350 Mission posed considerable challenges. As already mentioned, the team sought to devise a plan which minimally impacted the surrounding area, which included accelerating construction by impacting design decisions.

In terms of project relations, the project team was constructed of an architect, engineer, general contractor, and various subcontractors. The Integrated Project Delivery (IPD) method allowed the team to consider how design decisions would impact construction early in the design process. The Architect-Engineer-General Contractor will work as the primary project lead, taking direction from the Owner/Developer. The team will confer the plan for construction with the subcontractors, who will provide design input, and complete project scope. The project has been developed by Kilroy Realty, while Salesforce, a cloud-based computing company, will occupy the entire building upon completion. The contract hierarchy diagram can be shown in figure 2 below.

The plan includes using a Guaranteed Maximum Price contract. Under this type of contract, the owner and contractor agreed on a maximum price the owner will be liable for paying. Additional costs will be covered by the contractor unless negotiated by both parties. If the total cost of construction is less than that of the total contract amount, the parties will have had an agreement established to reallocate the expenses.[12]

The team believes this type of contract will be most beneficial between all involved parties. The notion of potential cost savings for everyone included ensures a goal-oriented construction schedule. Developing a accurate project estimate is essential to the utilization of a Guaranteed Maximum Price contract.

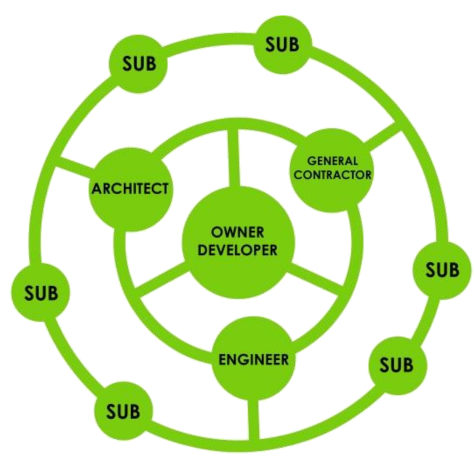


Figure 2: The diagram above breaks down the relationship between the parties involved in the construction of 350 Mission. Note the circular flow of project relations. All parties involved provide design input and complete work on the project. The architect-engineer-general contractor team take the lead.

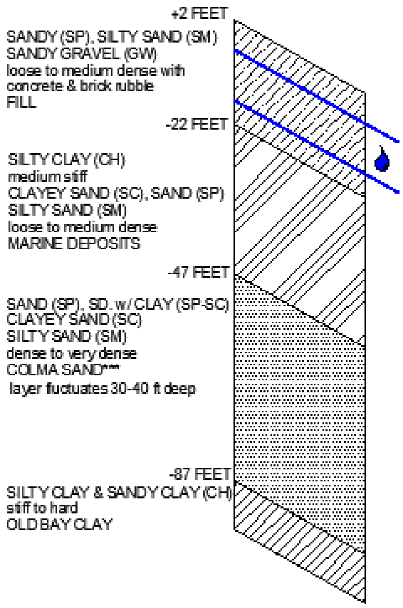


Figure 3: Idealized subsoil layers. The building will be supported by the "Colma Sand" layer which, as illustrated, exists at approximately 50 feet below sea level.[2] The area marked by the water drop illustrates where the groundwater level fluctuates between (-3 to -17 feet). Detailed soil information can be found in Appendix E.

3.1 Construction Challenges

1. **Poor Site Conditions**: The soil on-site prompted additional care taken in excavation. Primary building loads will be, supported by the Colma Sand layer, which is present approximately 50 feet below street level. Mixed fill, marine deposits, Old Bay clay, and sand, compose the subterranean levels below the surface.[2] In Figure 3, we have illustrated an "idealized" subsoil layer diagram. This diagram is representative of the information provided by the geotechnical report by Treadwell & Rollo. The soil boring logs were taken by Dames & Moore and were taken from the northwest corner of the site along Fremont Street and at the southeast corner of site along Mission Street.

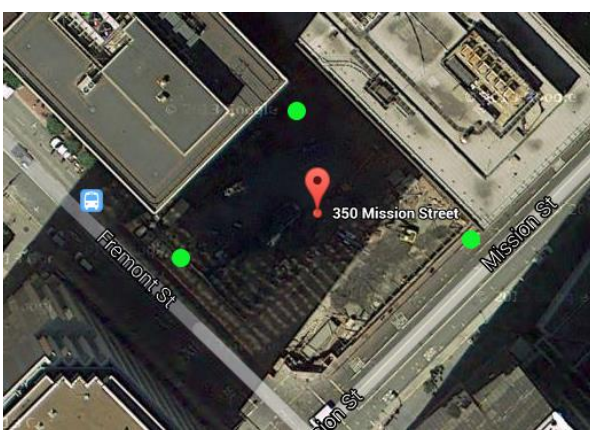


Figure 4: In the image above, the locations of soil borings have been illustrated, as provided by Dames & Moore. The former ITT Building stood where the new 350 Mission office building will be constructed.[2]

2. **Constrained Site**: The site is restricted to the general footprint of approximately 135 by 135 feet. Additional permits will be required to close and build on surrounding public space on the site. This includes our plan to use portions of Fremont Street and Mission Street during construction which will directly impact traffic.

   Furthermore, vertical construction became complex due to site limitations. The team decided to use a scheme for construction, which revolved around a centralized form of construction.

   Located in **Drawing C5**, a site constraint proposal can be found. Based on this plan, we have identified that approximately 25 feet of public space is available for use along Mission and Fremont Street. Additionally, the 17 foot corridors along 45 Fremont office building and 50 Beale Street will be confined within the construction site.

3. **Efficient Project Schedule**: The team made decisions in design which directly impacted the fluidity of project phasing. Because space onsite is constrained, decisions were made to prefabricate as many possible building systems throughout construction of the building. **Section 4** identifies areas where we made decisions in our phased plan for construction.

4. **Sustainable Site:** Carefully planned steps were taken to reduce waste on site. Reduction of waste was essential to utilizing the confined space available for construction. Taking steps to moderate unused materials was also an integral step in sustainability education through construction, as well achieving our **LEED PLATINUM** certification. Further LEED information is related in **Appendix B.**

LEED PROGRAM		
CATEGORY	POINTS POSSIBLE	POINTS EARNED
SUSTAINABLE SITES	26	21
WATER EFFICIENCY	10	10
ENERGY & ATMOSPHERE	35	33
MATERIALS & RESOURCES	14	5
INDOOR AIR QUALITY	15	12
INNOVATIVE DESIGN	6	4
REGIONAL PRIORITY	4	3
TOTAL: 88		

Figure 5: LEED point breakdown for 350 Mission.

4.0 Sequencing

Site Utilization. As discussed, the site at 350 Mission posed several challenges in construction. Following the demolition of the existing building on-site, a plan was created to utilize space on the building site.

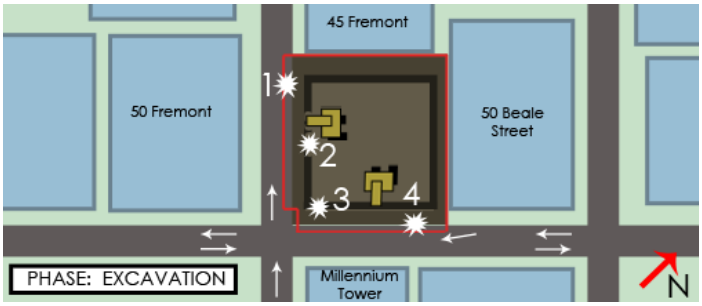


Figure 6: Shoring became a major concern in the construction process. Based on recommendations present in Treadwell & Rollo's geotechnical report, the team decided to utilize a soil-cement-mixed wall system in shoring the excavated site.

As illustrated in Figure 6, a method of shoring was used in construction which best suited the wet conditions of the site. Utilizing soil-cement-mixed walls however costly and requiring space for initiation, was one of only a handful of possible ways to successfully shore the excavated site.[8] The following factors are called out in Figure 6:

1- Because the site lacks available space for construction staging and utilization, a permit will be submitted through the San Francisco Department of Building Inspection for approval to use public space. Our intent is to allow traffic to continue along Mission and Fremont Streets. A bus lane along Mission Street (east-west) will be impacted by construction. Fremont is a one way street heading north. We utilized a parking lane and single lane of traffic in our construction sequence on Fremont.

2- Hollow-stem augers will be used to simultaneously drill concentric borings, mixing cement slurry along the way. The soil-cement-walls will be reinforced appropriately by steel rods to add an additional level of rigidity to the shored layer. This layer of soil-cement will also help in keeping water out of the site as excavation continues.[10]

3- Temporary access to the site will be located at the southwest corner. Supplies during the

Figure 7: Considering the foundation systems of the surrounding buildings, we utilized a cement-soil wall in shoring soil during excavation. Additional supports must be installed as shown above to further support the soil loads until the foundation system is put in place.[13]

establishment of the shoring system will be delivered via this entrance. Additionally, excess materials will be removed via this entrance.

4- Because of the small space available, permits need to be acquired in order to close the sidewalks surrounding the construction site.[7] A fence will span the perimeter of the site which will be 8 feet tall. Sections of fencing adjacent to the barrier will be protected by a lighted, covered walkway, as called for by the 2013 California Building Code.[7]

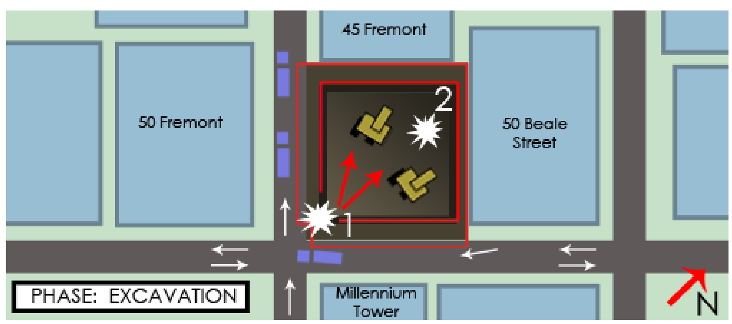


Figure 8: Soil will be removed from the site in similar fashion to how materials were transported during the establishment of the shoring system.

Following the establishment of the soil-cement walls, earth movers will begin removing soil from the site, down to an elevation of 48 feet below street level. The site will be dewatered to a level of no more than -52 feet until structural experts have ensured appropriate foundation conditions.[8] The following is highlighted in Figure 8:

1- The entrance at the southwest corner of the construction site will serve as the primary access for removing soil during excavation. It is noted that the trucks, marked in blue, have access to the site along Mission or Fremont streets.
2- The site will be sloped as noted by the arrows in red in Figure 8. An additional fence will be installed along the perimeter of the shoring system to prevent personnel accidents. Once excavation has reached a certain level, trucks equipped with clam attachments, as well as excavators, will continue to excavate to the remaining depth. Access shafts will be installed along the perimeter of the excavated, following reinforcement of the shoring conditions. A mobile crane will be moved on site to aid in the placement of materials to prepare for foundation development. Additional foundation development can be found on **Drawing C6.** Dewatering information can be found in **Appendix G.**

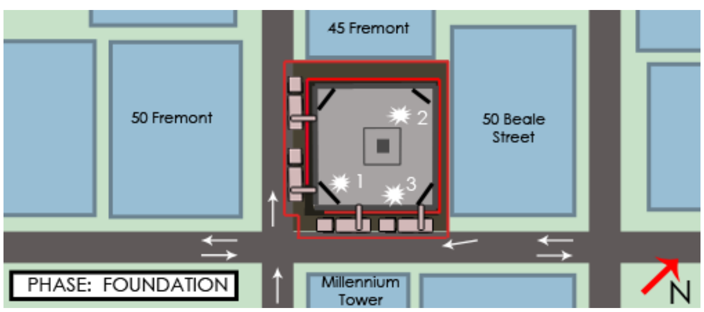


Figure 9: The building's foundation is composed primarily of a mat slab, which spans the base of the building and is 5 feet deep.

Mat Slab Construction. Due to the poor conditions of the soil at the site of 350 Mission, and the considerable building mass set to be constructed above, we decided that a mat slab would prove the more efficient and effective solution.

Earlier we discussed the condition of the soil below the site. The most suitable soils in which to develop the foundation system reside approximately 50 feet below street level in the "Colma" sand level. The layers above are not suitable for the construction of a foundation system, especially our intended mat slab.

The mat slab was developed at an elevation of 47 feet below street level. The plan to extend work into the ground coincides with our decision to slightly expand the space within the lowest subterranean level in the building. This space will be used to house pieces of our mechanical system.

With pouring a mat slab, there are significant concerns regarding the construction which reside in the properties and tendencies of concrete. Firstly, pumping the concrete will take place in one sitting and over the course of 22 hours. The slab must be prepared in that the already poured concrete does not set prematurely, affecting the structural integrity of the slab. Admixtures, such as fly ash, must be introduced, which will increase the workability of the concrete.

Additionally, the curing temperature could adversely affect the concrete slab. If temperatures in the center of the mass are permitted to reach a temperature too high, it is possible that dangerous cracking could occur within the slab. Air entrainment will be used to address this issue.4 In Figure 9:

1- Additional corner bracing will be installed during excavation. This bracing, pictured in Figure 7, is essential to ensuring the integrity of the soil-cement walls. The foundation walls will be constructed in front of the soil-cement layer, while the soil cement walls are placed within a 3 foot layer past the boundary of the property line. A permit from the city is required in order to temporarily infringe on this strip of public property.[7] Utility ports were established during the development of the excavated site, and were protected during foundation development.
2- Eight concrete trucks, which each carry 9 cubic yards of concrete, will be used in pouring the mat slab. The eight, working in shifts of four, will take 22 hours to complete the mat slab. Connections to the foundation wall system, as well as the building's structural core, will be established at this point. The crane will also begin installation. Additional crane staging can be found in **Drawing C8**.
3- It is critical that site operations are mindful of site conditions, including distance from the intersection. By California Building Code, all construction activity should take place 20 feet from any intersection, or fire protection equipment (i.e. hydrant).[7]

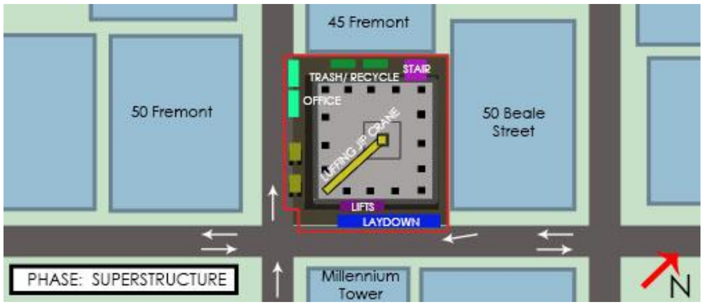


Figure 10: A schedule composed of short interval sequences will be used to complete the floors above the parking garage. As work moves upward, additional work on the floors below will be completed.

As illustrated in the picture above, we utilized a central crane in the construction of 350 Mission. This was installed 4 months into the building's development and structural measures were taken to accommodate for the crane's load via the foundation system.

By utilizing a **central crane**, additional space surrounding the worksite was opened up for construction staging and utilization. Two additional mobile cranes were installed during construction following the completion of the eighth floor. These cranes were placed along the south and western sides of the building. Both were critical in façade installation. The central crane was removed via these two mobile cranes. A single mobile crane remained following deconstruction of the central crane.

While the construction plan for the subterranean levels of 350 Mission used a diversified approach, the plan for the "super-terranean" levels of the building included a scheduling plan dubbed "**Pseudo-SIPS**." SIPS, or *short interval production scheduling,* is a method scheduling in construction which utilizes a series of repetitive activities to complete work efficiently. "Pseudo" is simply suggestive of the slight breaks in our short interval schedule, where certain construction activities momentarily slowed or altered the construction process.

Furthermore, sequencing was divided into series of floors during construction. This created numerous checkpoints during the construction process, with materials being allocated per phase. This division is illustrated in Figure 11.

Figure 12 illustrates the progression of vertical construction using simplistic forms. At the base level, just above the parking garage, Steel beams were erected into place every 2 stories.

As each floor's beams were set into place, floor decking and slabs will then be placed. These activities were repeated for each of the typical office floors until arriving at the mechanical floors above.

The core of the building will be composed of concentrically braced steel frames. The building will be built outward from the core, meaning the core will rise vertically at a pace slightly quicker than that of the surrounding floor structure and exterior columns. The exterior columns and steel core will fully support the loads imposed the floors and MEP systems. The central crane on site will be built on a thickened slab integrated into the mat slab, and will eventually be the location of the elevator core. As the height of the central luffing jib crane is raised to accommodate the erection of the structure, voids left in order to accommodate the crane were filled and completed, keeping up with the building's construction progression. The concentrically braced frames will rise around the central crane.

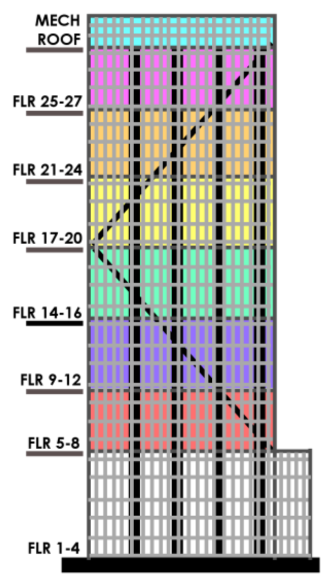


Figure 11: Construction sequences were divided by series of floors. Above, the floor division is presented and distinguished by color.

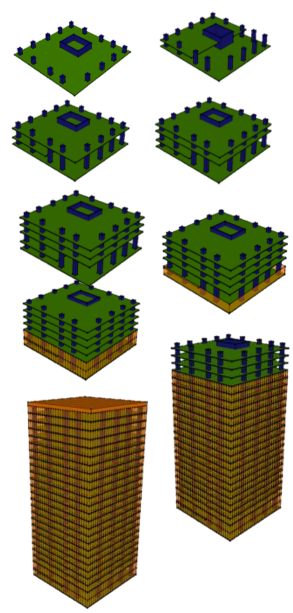


Figure 12: The progression of the general schedule of building construction is illustrated in simple forms. As the building moves vertically upward, additional work would take place below.

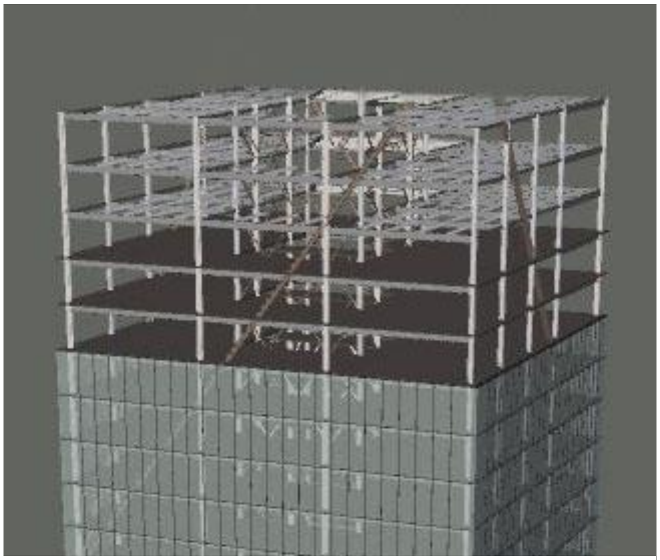


Figure 13: Lateral beam construction. Note the installation of the lateral beams is dependent on the placement of the floors each supports.

To minimize schedule impact due to connections, the team considered prefabricating pieces of the concentrically braced frame core. This decision also identifies the minimal space available for staging on site. Prefabricated pieces could be hoisted into place at a quicker rate than individual pieces.

The team consulted with a steel manufacturer, out of San Mateo California. This company, which resided only 20 miles from the site of 350 Mission, ensured team members that concentrically braced frames are often prefabricated at their facilities. Working with this idea of core prefabrication, a detailed plan was created to construct the building core.

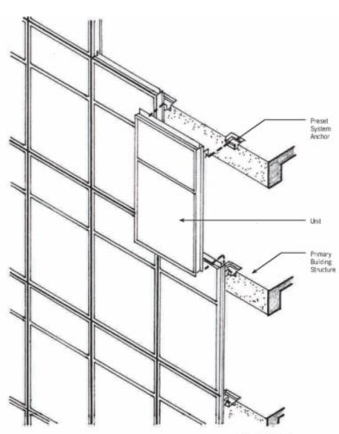


Figure 14: The unitized façade system will be integrated into the overall phasing plan for the upper floors of the building.[5]

The building also features lateral beams, which are illustrated in the Figure 13 above. These beams provided additional support for the building. They were installed once both connection levels were completed and braced accordingly.

Façade Construction. The building enclosure of 350 Mission will be composed of PPG Solarban 60™ glass. This low-e glass is engineered to control heat gain through the building's façade. The particular product used in the team's design blocks 66% of solar energy, while permitting 70% of solar light into the building spaces. For additional information on the façade, please reference the **Integration Report.**

The glass curtain wall will follow a format of construction similar to a unitized system[5]. Glass infill pieces will be supported by the building's structure. Particular focus must be taken into account with system joints.

As mentioned, to aid installation of the enclosure system, 2 additional mobile cranes will be installed at the base of the building while construction continues on the superstructure above. These cranes will aid in the disassembly of the centrally placed crane. The building schedule has been phased so that closing in the building follows not long after the structure is set in place. A scheme illustrating impact of the California Building Code is located on **Drawing C5.**

4.1 Schedule Impacts

The total schedule for the project spans **19 months**. The biggest time impacts associated with the construction schedule stemmed from the following activities:

1. Site Excavation & Shoring: Hollow stem augers were utilized to drill concentric borings, while also establishing a cement-soil wall in the process. The process of digging these adjacent borings, ensuring stability in the cement-soil wall, and then further reinforcing the foundation wall required a total of 7 weeks. Excavation will then commence to a total depth of -47 feet below street level. However adding time and money to the project, the team utilized the cement-soil shoring because of constraints on the site.

Figure 15: Hollow stemmed augers will be used to drill concentric borings around the perimeter of the site. Furthermore, this process will be used to establish the cement-soil shoring wall.[14]

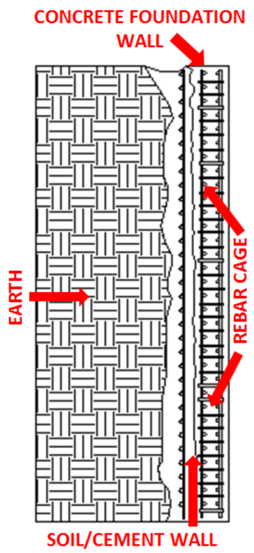


Figure 16: The above wall section shows the relationship between the soil-cement shoring wall and the building's foundation wall.

Soldier piles were recommended against by the soils report because of the high water content of the site. Additionally, we opted against utilizing a system which would serve as both shoring during excavation and the final foundation wall. Due to seismic conditions on-site, the reinforcement required for the building's foundation wall is incredibly complicated. To ensure quality and care in forming the foundation wall, we believed it necessary to utilize a method which gave the construction team better control.

The end result required us to seek a permit to utilize public space surrounding the site, requiring additional diligence in monitoring existing utility connections. However, this was necessary in ensuring the integrity of 350 Mission's foundation walls.

2. Mat Slab Construction: The mat slab serves as the primary mass associated with the foundation. Measuring **5 feet thick**, and approximately 18,500 square feet in area, it will be composed of **3,375 cubic yards of concrete**. Curing time was critical to the success of the mat slab. The mat slab will be monitored as it cures to ensure the heat of the curing process does not detrimentally affect the mat slab's composition.
3. Prefabrication: Two major building components were prefabricated in the manufacturing process to alleviate the time impact these items had on the building schedule. Those two items were the **concentrically braced structural core** and **foundation wall rebar cages.**

The core of the building serves as the structural backbone of the design. The concentrically braced frames feature a number of unique structural connections. These connections would pose considerable time delays in building production. Therefore, prefabrication of the structure was beneficial to our short interval production schedule.

Whole faces of the structural core were prefabricated and then set in place on-site. The goal was to cut back on the number of moving pieces in the equation. By prefabricating the pieces of the core, we believe the schedule, per every four floors of concentrically braced frames, will be reduced to by a **week on average**, for a **total schedule savings of seven weeks**.

Secondly, seismic site conditions required an over-designed foundation wall. A reinforcement case consisting of two interwoven mats of rebar was utilized in the foundation walls. These cages could be preassembled and set in place on-site. Due to the symmetry of the design, the cages could be installed with either face positioned towards the inside of the building, alleviated confusions in executing the design work. We anticipate that work associated with the foundation mats will occur during non-peak traffic hours, as the cages will be considerably large in size.

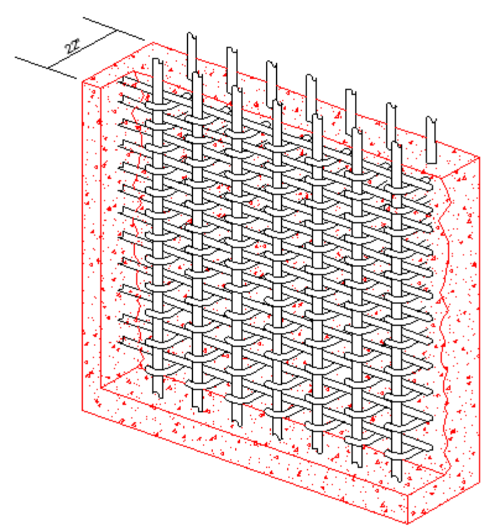


Figure 17: Foundation wall rebar cage. The rebar cage embedded in the foundation wall will feature two interlocking mats. The design loads of each face of the cage are identical. The ties connecting the two mats aid in combating seismic loads.

5.0 Environmental Impact

In addition to a focus on construction sequencing affecting the **Performance** of 350 Mission's development, the team ensured the construction process was initiated with the surrounding environment in mind.

Construction equipment, material manufacturing, and site deliveries all impact the surrounding environment. We investigated how our plan for design and construction consumed fossil fuels, and created air pollution. In total, we found our final design for 350 Mission would produce **14,087 tons** of carbon during the construction process.

Utilizing the Environmental Analysis Tool provided by Skidmore, Owings & Merrill, the team investigated how our design and construction decisions impacted the building's total carbon footprint and compared these values to a baseline structural concrete design of 350 Mission. Many of the discrepancies stemmed from budget differences. Our design was a reflection of a budget with practical considerations but without limits.

PRIMARY BUILDING DIFFERENCES		
SYSTEM	BASELINE	AEI TEAM 2
STRUCTURAL	CONCRETE	STEEL
ELECTRICAL	-	INT. COMBST. ENG.
MECHANICAL	-	BIOMETHANE
SERVICE LIFE	50 YEARS	100 YEARS
SEISMIC LOSS	ANNUALIZED	100-YEAR EVENT
MATERIALS TRANSPORT	SPREAD	LOCAL IDEALIZED

Figure 19: Major discrepancies between the original plan for 350 Mission, and our team's plan represent differences in major building systems & construction decisions.

The design and construction process was intended to be reflective of a commitment to quality and to positive environmental impacts. Because of this, we recognized that a significant portion of our carbon was integrated into the building's materials. However, we took the opportunity to cut back carbon emissions through utilizing local materials and subcontractors.

By cutting back the number of miles between the jobsite, and off-site offices and manufacturing sites,

350 MISSION CARBON FOOTPRINT			
	BASELINE	AEI TEAM 2	DIFFERENCE
MATERIAL (TONS CO2)			
STEEL	0	4162	4162
CONCRETE	6250	2550	-3700
REBAR	6556	2956	-3600
MISC	274	1410	1136
TOTAL	13080	11078	-2002
CONSTRUCTION (TONS C02)			0
TRANSPORTATION	333	247	-86
ELECTRIC POWER (GRID)	440	372	-68
DIESEL POWER	2418	1394	-1024
TOTAL	3191	2013	-1178
SEISMIC IMPACT (TONS C02)			0
DEMOLITION	36	40	4
MATERIAL MANUF. & TRANS.	1447	809	-638
RECONSTRUCTION	353	147	-206
TOTAL	1836	996	-840
BUILDING TOTAL	18107	14087	-4020
CARBON EQUIVALENTS	POWER: 1,640 HOUSEHOLDS FOR ONE MONTH FUEL: 3,680 CARS ON THE ROAD FOR A YEAR	POWER: 1,540 HOUSEHOLDS FOR ONE MONTH FUEL: 3,470 CARS ON THE ROAD FOR A YEAR	

Figure 18: Comparison between carbon production on the hypothetic original construction of 350 Mission, and that of our design based on figures from SOM's Environmental Analysis Tool.

ENVIRONMENTAL ANALYSIS - MATERIAL MANUFACTURING INPUTS		
MATERIAL TYPE	VESSEL	DISTANCE (MI)
STEEL	TRUCK (DIESEL)	13
WOOD	TRUCK (DIESEL)	490
CONCRETE	TRUCK (DIESEL)	3.65
CMU	TRUCK (DIESEL)	4
REBAR	TRUCK (DIESEL)	31
COLD-FORMED STEEL	TRUCK (DIESEL)	10
METAL DECKING	TRUCK (DIESEL)	20

Figure 20: The table above is representative of the considerations used in the Environmental Analysis Tool scenario for the delivery of manufactured project materials.

we could eliminate the total quantity of fuel consumed by the project's personnel. Utilzing a pool of twenty San Francisco based subcontractors, we analyzed how much, on average, project personnel would use in travel time to the 350 Mission jobsite. This analysis strictly considered personnel from subcontracted companies who would be associated with making design decisions. By traveling an average distance from the site, and utilzing companies from the western coast of the United States, we believe **4.65 gallons** of diesel fuel will be used per trip to the site. This amount of diesel fuel will produce approximately **0.05 tons** of carbon per trip. Additional insight and data can be found in Appendix A.

Additionally, we assumed a workforce of approximately 100 people during peak project activities. If staff members, on average, lived approximately **20 miles** from the site, our workforce would be producing approximately **2.64 tons** roundtrip of carbon a day. If we consider our project schedule will be **395 work days**, the the workforce would produce as much as **1,050 tons** of carbon during the construction of 350 Mission.

To summarize, the biggest carbon concerns in constructing 350 Mission stemmed from the materials used in the manufacturing process. It was important to ensure we reduced carbon emissions in all ways possible. We attempted to reduce the carbon outputs in two major ways:

1. **Material Production**: The biggest reductions, from a material standpoint, came from utililizing local manufacturers, and tracking specifics about the production of our concrete. Based on technology out of the San Francisco area, it is possible to reduce the carbon output associated with the production of concrete by **23%.** This is conceivable by using a method of recycling aggregate for the concrete in 350 Mission. When we factor in this reduction, we can reduce the amount of carbon produced by manufacturing to **1,950 tons.**
2. **Regional Personnel**: Similarly to utilizing local materials, we wanted to utilize a local workforce to cut down on carbon output created by transportation. By analyzing a hypothetic scenario which utilized a workforce within a 500 miles radius, we were able to reduce the carbon output of project associates to **247 tons**.

Considering the **14,087 tons** of carbon expected to be produced by the building's construction, and the **1,050 tons** produced by a commuting workforce, the total amount of carbon produced by the construction of 350 Mission equates to **15,137 tons**.

6.0 Connectivity

One of the project teams primary values of connecting with the community through the construction of 350 Mission, was highlighting the performance of the building through publicly issued publications and workforce education

Signage was used in instilling sustainable values and concepts, as well as notifying construction personnel of proper safety protocol or of project hazards.

A site specific safety plan was developed to ensure proper safety measures were taken for the duration of the project. The safety plan is built around the following factors:

- **Personnel Safety**. Ensuring safe work conditions starts by education personnel on site. Proper safety-wear will be required and monitored on the site. Furthermore, daily project activities will be summarized at the start of each day to identify potential risks.
- **Public Safety.** Two office buildings will remain occupied during construction of 350 Mission. Traffic will be diverted around construction activities. Steps will be taken to separate the

Figure 21: Personal safety requirements per California Occupational Safety & Health Administration.[9]

public from the construction activities. Details of how the California Building Code impacted the discussion can be found in **Drawings D.**

- **Site Safety & Security.** In working with a high rise, additional matters were taken to secure building materials and in securing the site. This kept not only the site safe, but also the area surrounding the site.

Signage was additionally used as an education tool. Firstly, we identified the carbon impact of having a large workforce communting to the site. We believed it important to recommend carpooling and alternative methods of transportation to get to the building site.

Additionally, we wanted to use our biomethane digester as an educational tool. In the final building product, human waste, as well as compost, will be used to power building systems. This system will also come online during the building process. We'd like to educate not only building occupants, but construction personnel, in the inner workings on this system. Daily construction and building activities will impact the performance of the biomethane digester.

A public restroom will be featured in the lobby space of the building. Publications will compliment the restroom, educating passersby of how they interact with the building system.

Additional signage will be provided around the permiter of the building, specificially the areas coordined off around 45 Fremont and 50 Beale, where we will highlight the complete building. In these publications, we want to illustrate the composition of 350 Mission and how both both the public and building occupants will interact with the building space.

Additional safety and sustainability plans can be found in **Appendix E.** Information regarding Construction Air Quality and Waste Management can be found in **Appendices C** and **D**.

7.0 Life Cycle Payback

As already mentioned, our building is composed of several state of the art systems designed ot reach our goal of Net zero operations. Because of this, additional costs were incured in the original construction of the building. However, our building's operating systems went beyond typical building design.

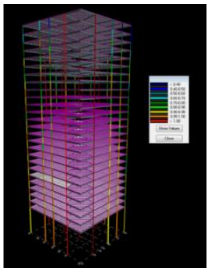
Utilzing the basic 350 Mission model from our carbon comparison, the team was able to analyze basic lifetime cost impacts of investing in luxury building systems.

Using our numbers, representative of a 20 million dollar luxury cost increase and 100-year service life, we arrived at an Equivalent Benefit / Cost Ratio of **0.2** utilzing SOM's Estimated Cost-Benefit Analysis Tool.

By investing an additional **20 million dollars** to the base building's systems, we can expect as much as a **3.35 million dollar** benefit over 100 years of building life.

This is considering our enhanced system will net an annual loss of **$110,000,** verses **$1,240,000** a conventionally designed building would lose in maintance. We expect then, that over 100 years of building life, 350 Mission will maintain a **6% return on investment,** purely from a material standpoint. Additionally, we must consider the energy produced by the building. For additional information on energy consumption and production, please reference our **Mechanical Report.** Additional Estimated Cost-Benefit information may be found in **Appendix A.**

8.0 Budget Breakdown



Structural System

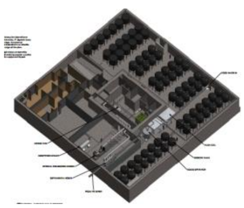
Total Cost: $35,322,500

The foundation of 350 Mission will be primarily composed of a **mat slab** with a thickness of 5' in depth. The building's primary columns along the perimeter of the building, as well as the foundation walls, tie into this slab. A **lightweight gravity system**, paired with a **concentrically braced core** and **external lateral bracing** compose the upper structure. The core and lateral bracing are designed to serve as the primary load paths above.

Electrical System

Total Cost: $20,295,400

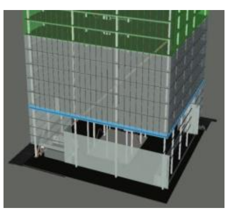
The building is powered **50% by waste**. Electricity is generated by an **Internal Combustion Engine**, and fueled by the bio-methane digester. **Virtual Desktop infrastructure** is used to reduce data demand loads. **LED task lighting** is mounted at individual workstations to reduce overall lighting loads. The lobby space will feature an interactive lighting design.



Mechanical System

Total Cost: $23,240,400

Biomethane generation and a**n Internal Combustion Engine** serve as the primary energy sources in 350 Mission. A **free radiant space cooling** system is used in cooling. A **wastewater heat pump** and **gas-fired boiler** will serve as the primary heat generators. Ventilation is maintained by a **DOAS air handler** and **absorption chiller**.



Exterior Façade

Total Cost: $2,409,800

The exterior façade will be composed of a **flat, glass curtain** wall system. **Solarban 60TM** will be utilized in this system, as it provides ample natural light, but also prevents unnecessary fluctuations in environmental temperatures. Additionally, this system is unitized in a way which integrates into our short interval production schedule, as illustrated on **Drawings C.**

Basic Office Floor

Total Cost: $2,300,800

The design utilizes an open office floor layout. Virtual desktop units will be strategically placed based on mechanical and electrical floor layout. The open floor design allows natural light to penetrate the majority of the floor space and permits maximum flexible space.

Lobby Design

Total Cost: $252,690

The lobby is an interactive space, where lighting and educational publications will highlight the architectural and technical features of 350 Mission. Furthermore, the lobby features a café and public restroom. The restroom interacts with the biomethane digester.

TOTAL BUILDING COST: $131,213,180

*Additional estimation can be found on **Appendix H.**

9.0 Conclusion

Based on project guidelines, and the team construction goals, the team collectively believes we have achieved what we set out to accomplish:

1) **Building Design.** During the design process for 350 Mission, team members discussed how the overall design would impact the construction process. Decisions were made in design which affected both the final cost, schedule, and carbon output of the building's construction

   Decisions were made to prefabricate specific pieces of the structure to alleviate delays in the project schedule. The **concentrically braced core** of the building structure will be pre-assembled in pieces to reduce the number of in-field connections that must be made.

   Furthermore, the **foundation reinforcement** systems will be manufactured such that they can be installed once arriving on-site. This reinforcement includes the layers of reinforcement composed the **mat slab** and the enhanced, reinforced cages of the **foundation walls.**

2) **Sustainability & Energy Efficiency.** The team's design for 350 Mission features top notch building systems. Because significant carbon output was expected from the materialization of building components, the team developed an **idealized construction plan** which featured a local workforce. By utilizing local materials and local subcontractors, the goal was to reduce the carbon footprint created by the construction process.

   Additionally, our goal was **educate** both building occupants and construction personnel on methods of sustainability. During construction, we wanted to instill personal impact on carbon output, encouraging alternative methods of transportation to commute to work.

   Furthermore, the team made a decision to bring vital units of the building's mechanical system onsite early. It was decided that a biomethane digester will serve as the primary source of building power. This system also receives significant impact from the community's sewage system.

   Utilizing a **unitized building façade** added efficiency to our "Psuedo-SIPS" phased construction. The repetitive, simple system was easily integrated into the construction process.

3) **Integration & Collaboration.** The final product is the best solution of different building systems working in tandem to achieve the project's goals. Notable integration occurred in creating an effective **office environment** and in executing the complicated foundation system. Critical mechanical equipment resides at the base of our building- and a plan to ensure its installment is the result of integration between construction, structural, and mechanical plans.

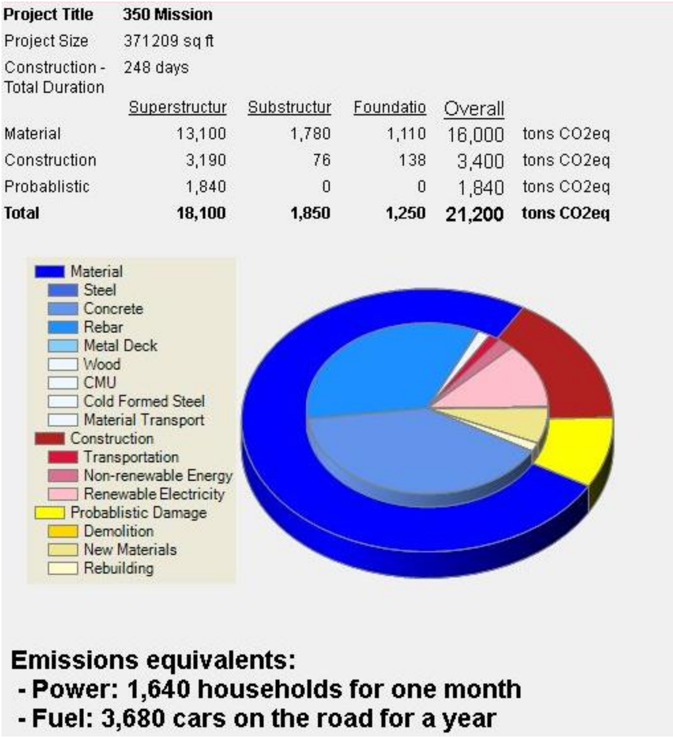
Looking at the primary construction goals:

- **Developing a construction budget which is practical short-term and long-term (Page 13).**
- **Developing a construction sequence which embraces the challenging constraints of the project site (Page 5).**
- **Ensuring minimal impact to the surrounding environment (Page 10), and**
- **Educating in sustainability through construction processes (Page 11)**

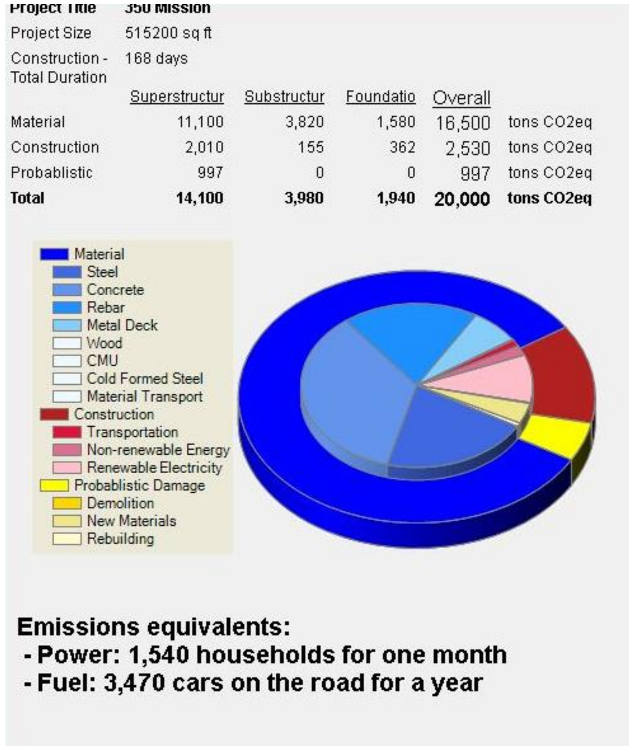
Figure 21: Rendering of final building; taken from Autodesk Navisworks.

APPENDIX A: ENVIRONMENTAL IMPACT

1. SOM ENVIRONMENTAL ANALYSIS TOOL

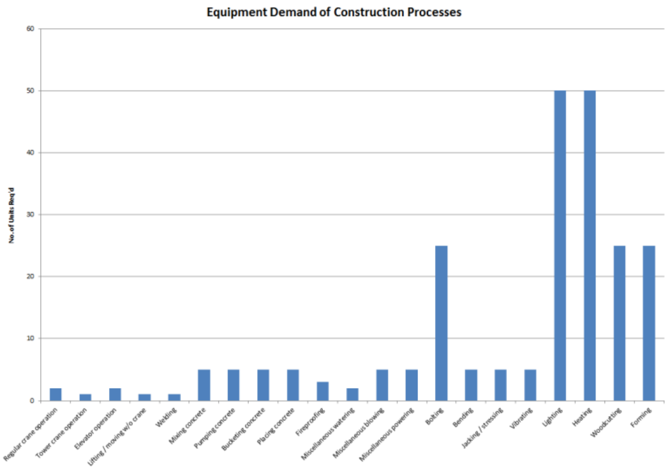


Appendix Figure 1: Carbon breakdown figures representing a hypothetic "base" 350 Mission design.

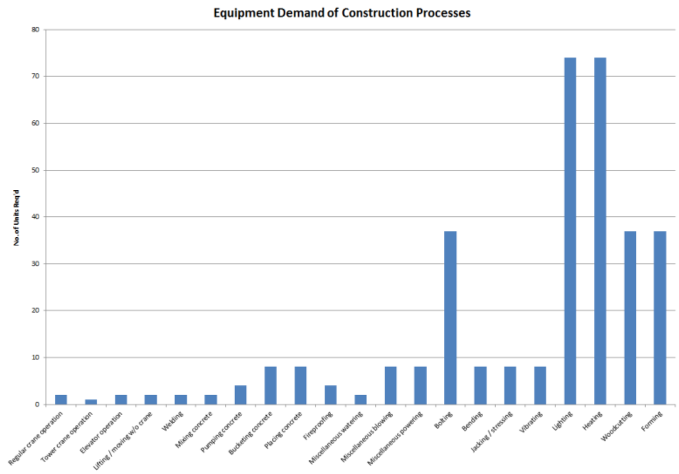


Appendix Figure 2: Carbon breakdown figures representing our team's design for 350 Mission.

The above diagrams breakdown the carbon outputs associated with the construction for each of two 350 Mission designs. Note that additional carbon was attributed to concrete in the baseline, structural concrete design, as the structure was primarily composed on concrete. Furthermore, more carbon is attributed to transportation for the baseline design. Our numbers for material transportation are idealistic, as they represent a hypothetical scenario where majority local business complete work on the project.



Appendix Figure 3: Equipment Utilization during the construction process; "base design" for 350 Mission.



Appendix Figure 4: Equipment Utilization during the construction process; our plan for 350 Mission.

SOM - Environmental Analysis Tool	
Material Quantities	
Steel, psf	7.04
Steel Fabrication Level	Average
Concrete, cf/sf	0.5
Percentage flyash, %	0
Percentage slag, %	0
Percent medium-strength concrete	
Rebar, psf	5
Metal deck, psf	2
Misc incl bolts, shear studs, etc.	0
Material Transportation Values	
Steel Distances, mi	
Ocean freighter, diesel	0
Barge, diesel	0
Train freighter, diesel	0
Truck, diesel	12.93
Concrete Distances, mi	
Ocean freighter, diesel	0
Barge, diesel	0
Train freighter, diesel	0
Truck, diesel	3.65
Rebar Distances, mi	
Ocean freighter, diesel	0
Barge, diesel	0
Train freighter, diesel	0
Truck, diesel	31
Metal Deck Distances, mi	
Ocean freighter, diesel	0
Barge, diesel	0
Train freighter, diesel	0
Truck, diesel	20

Appendix Figure 5: Material impact of construction; our plan for 350 Mission.

Process	No. of units	Time on site /in use (days)
Regular crane operation	2	40
Tower crane operation	1	415
Elevator operation	2	400
Lifting / moving w/o crane	2	124
Welding	2	124
Mixing concrete	2	110
Pumping concrete	4	89
Bucketing concrete	8	38
Placing concrete	8	38
Fireproofing	4	9
Miscellaneous watering	2	38
Miscellaneous blowing	8	124
Miscellaneous powering	8	124
Bolting	37	124
Bending	8	38
Jacking / stressing	8	38
Vibrating	8	38
Lighting	74	13
Heating	74	5
Woodcutting	37	38
Forming	37	38

Appendix Figure 6: Equipment figures; our plan for 350 Mission.

The numbers used for material transportation are representative of an idealistic scenario. Utilizing a pool of local subcontractors and material manufacturers, we hoped to offset the carbon and costs associated with transportation. We were able to cut back on the carbon produced from transportation associated with the construction process.

The number of construction days associated with each piece of equipment was coordinated with the building schedule. Even though the construction takes place over a period of 395 days, some of these figures are higher. These numbers were padded specifically to consider additional hours of work, or additional pieces of equipment. Additional analysis can be found in the **Integration Report.**

2. ESTIMATED COST-BENEFIT

SOM'S Environmental Analysis Tool also allowed the team to look at basic Cost-Benefit information associated with 350 Mission's design. The Cost-Benefit Analysis tool compared figures associated with a conventional building system verses an enhanced building system. The enhanced building system figures represented the team's official design for 350 Mission.

We estimated that a conventional design for 350 Mission would cost approximately **110 million dollars.** Our building cost a total of **133 million dollars.** The Cost-Benefit Analysis tool was representative of the **20 million dollar** difference of potential buildings. Furthermore, the tool considered a total building life of 100 years.

	Conventional System	Enhanced System
Building	$3,810,000	$457,000
Structure	$1,650,000	$265,000
Nonstructural Components	$2,160,000	$193,000
Business Interruption	$0	$0
Total	$3,810,000	$457,000
Net Expected Benefit	$3,350,000	
Net Additional First Cost	$20,000,000	
Equivalent Benefit/Cost Ratio	0.2	

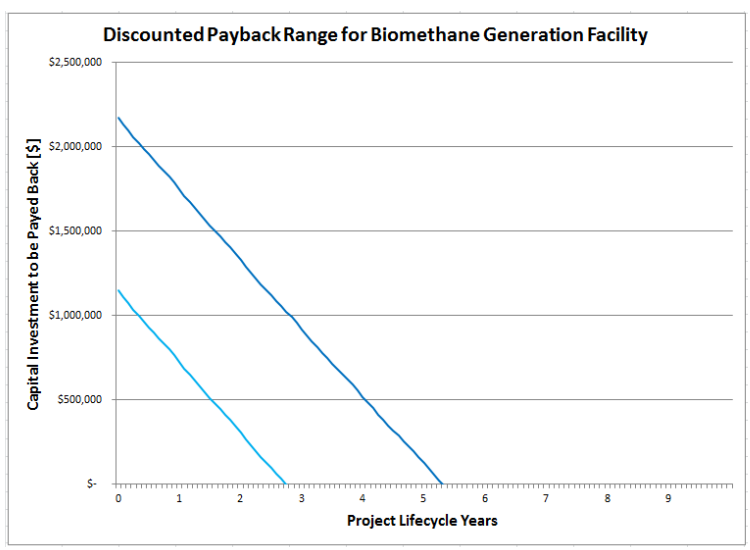
Appendix Figure 7: Data produced by SOM's Environmental Analysis Tool. This data was produced using inputs generated by team members.

In total, we expected a total net benefit of an enhanced system to be around **3.35 million dollars.** This means that over the 100-year lifecycle of the building, 3.35 million dollars would be saved from installing the enhanced building systems. When that number is compared to our net additional first cost of **20 million dollars,** we arrive at a benefit-to-cost ratio of **0.2.** Any ratio <1 is considered a loss based on material considerations. It was still important to maintain a positive annual benefit, which we did achieve. Additionally, our design for 350 Mission was able to reach our goal of a Net zero building. It will produce its own energy via biomethane digestion, amongst other buildings systems.

The biomethane digester has a base cost of **$2,170,000.** The system, which will be powered by compost and both building and city sewage will produce enough energy to power the building's operations *and* sell some electricity back to the grid. Over the first **10 years of building service,** the operation and maintenance costs associated with the biomethane digester will amount to **$484,773.** Additionally, we expect to incur a total of **$3,481,690** in payback dollars from digester operations.

We expect the digester to pay for itself within **six years of operations.**

Over a 100-year lifespan, we expect a 6% return on investment on building materials, based on general project costs. Overall, this includes a net expected annual benefit of **1.13 million dollars.**



Appendix Figure 8: Payback associated with the biomethane digester.

3. SUBCONTRACTOR LOG

In considering the travel impact of the workforce involved on the job, the team identified a group of twenty local and semi-local subcontractors as a pool of potential associates. The companies identified in our compilation represent actual organizations. These twenty were used to develop an analysis on average distance from the project facilities and average gas consumption based on those figures.

Our goal was to work with a local workforce who was licensed to work in San Francisco, employed both a union and independent workforce, and resided closely to 350 Mission Street. Additionally, we accounted for the potential to work with companies which were located further from the site, but along the west coast of the United States.

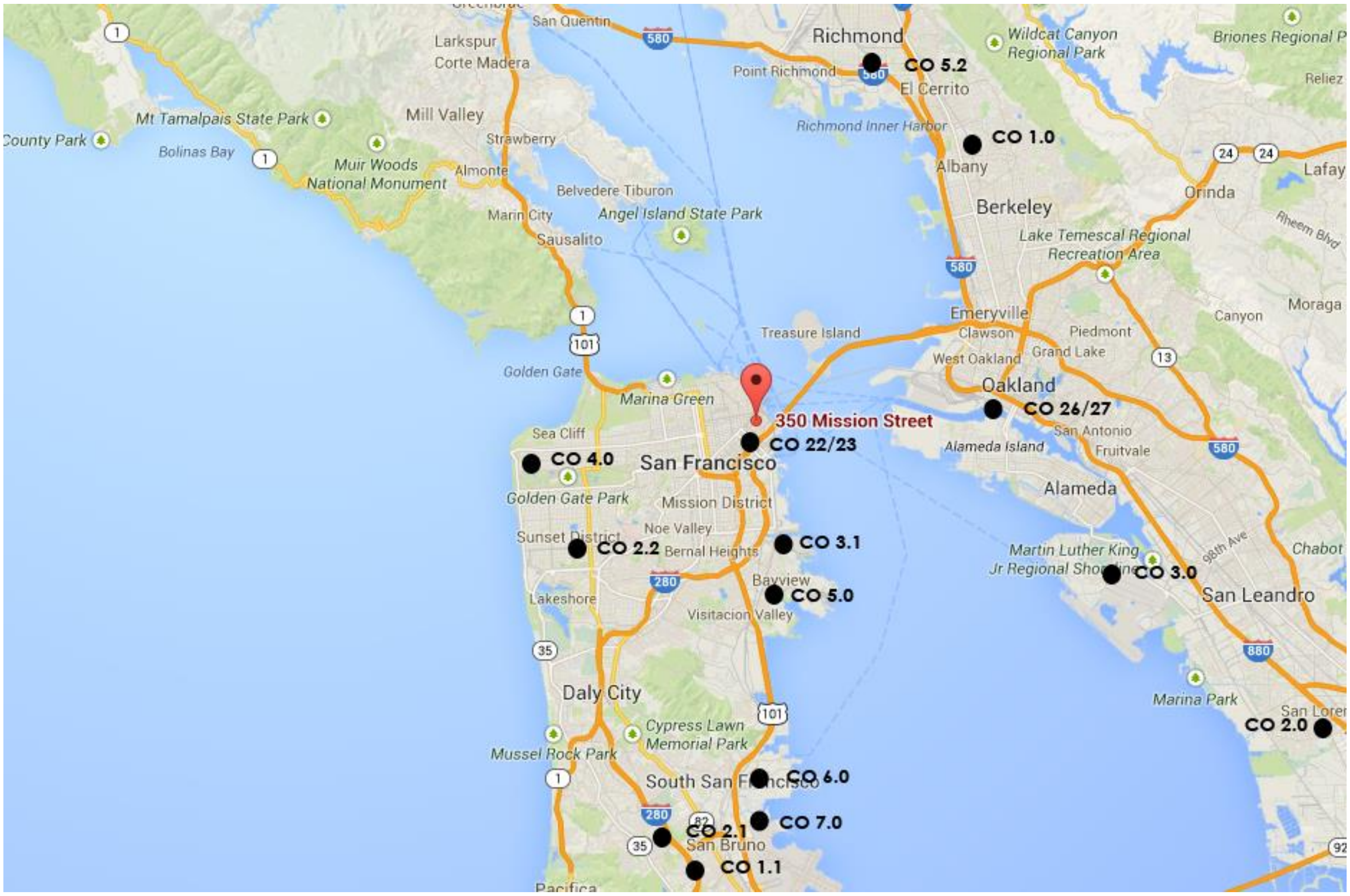
The data represents the total amount of diesel fuel consumed by an industrial vehicle from each of these locations- an overestimate of the total amount of fuel consumed. The total amount of carbon dioxide produced by consuming a gallon of diesel fuel is equivalent to 10,180 grams[6]. If we consider our experimental pool of associates, the average trip to the jobsite utilizes 4.65 gallons of diesel fuel. In total that equates to 47,433 grams of carbon dioxide produced per trip to the site.

COMPANY	CSI	LOCATION	DISTANCE	COST OF FUEL*	GAL
CO 1.0 – SITE FACILITIES	**01**	**Gardena, CA 90248-3735**	**25 MILES**	**$9.75**	**2.62**
CO 1.1 – SITE SECURITY & SETUP	**01**	**San Bruno, CA 94066-3905**	**16 MILES**	**$7.06**	**1.90**
CO 2.0 – UTILITY ACCESS	**02**	**Davis, CA 95616-4653**	**72 MILES**	**$27.82**	**7.48**
CO 2.1 – EXCAVATION	**02**	**San Bruno, CA 94066-1851**	**16 MILES**	**$6.87**	**1.84**
CO 2.2 – FLOODING & RUNOFF	**02**	**San Francisco, CA 94116-2422**	**8 MILES**	**$4.89**	**1.31**
CO 3.0 – CONCRETE INSTALLATION	**03**	**Burlingame, CA 94010**	**19 MILES**	**$7.62**	**2.05**
CO 3.1 – ADDT'L CONCRETE MAT'L	**03**	**San Francisco, CA 94124**	**4 MILES**	**$2.43**	**0.65**
CO 4.0 – MASONRY	**04**	**San Francisco, CA 94121**	**7 MILES**	**$4.77**	**1.28**
CO 5.0 – STEEL ERECTOR	**05**	**San Francisco, CA 94124**	**5 MILES**	**$3.23**	**0.87**
CO 5.1 – STEEL FABRICATOR	**05**	**Salinas, CA 93912**	**108 MILES**	**$40.22**	**10.81**
CO 5.2 – STEEL FABRICATOR	**05**	**Richmond, CA 94804**	**15 MILES**	**$6.15**	**1.65**
CO 6.0 – PLASTICS	**06**	**S. San Francisco, CA 94080-4813**	**12 MILES**	**$5.06**	**1.36**
CO 6.1 – TIMBER	**06**	**Bend, OR 97701-8930**	**500 MILES**	**$181.33**	**48.74**
CO 7.0 – WATERPROOFING	**07**	**S. San Francisco, CA 94080-6911**	**12 MILES**	**$5.36**	**1.44**
CO 7.1 – THERMAL MATERIALS	**07**	**Campbell, CA 95008-6602**	**16 MILES**	**$8.21**	**2.21**
CO 8.0 – CURTAIN WALL	**08**	**Livermore, CA 94550**	**45 MILES**	**$17.40**	**4.68**
CO 8.1 – COMMERCIAL DOORS	**08**	**Woodland, CA 95696**	**7 MILES**	**$4.58**	**1.23**
CO 9.0 – INTERIOR MATERIALS	**09**	**Daly City, CA 94015-25323**	**3 MILES**	**$2.12**	**0.57**
CO 22/23 – MECH/PLUMBING	**22/23**	**San Francisco, CA 94107**	**1 MILE**	**$1.04**	**0.28**
CO 26/27 ELECTL/TELECOM/SEC	**26/27**	**San Francisco, CA 94111**	**1 MILE**	**$0.83**	**0.22**

Appendix Figure 9: Hypothetical contractor pool with address & fuel information.

1: Considers highway & city miles at 10 miles per gallon
2: Experimental cost of fuels = $3.72 per gallon

The following maps identifies group of companies listed in the table above and illustrates their relative distance to 350 Mission Street.



Appendix Figure 10: Companies within approximately fifteen miles of the site have been illustrated in the map above. As stated early, it is estimated that about 48,000 grams of carbon dioxide will be released into the atmosphere by one industrial truck's trip to the site. This is overestimate considering that personal vehicles will also likely be used to travel between locations. One gallon of regular unleaded gasoline releases 8,700 grams of carbon dioxide into the air[6].

APPENDIX B: LEED CONSTRUCTION IMPACT

The following chart breaks down LEED credits associated with the construction process. Related information regarding Construction Air Quality can be found in **Appendix C.** Additional, related content regarding Waste Management can be found in **Appendix D.**

CREDIT	IMPACT	+ / -
SS P1	Construction Activity Pollution Prevention (reduced pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation; REQ: Create & implement an erosion and sedimentation control plan for all construction activities associated with the project	+
SS 1	Site Selection (avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site; REQ:avoid farmlands, undeveloped land, environmental sanctuaries, etc.)	+
SS 2	Development Density and Community Connectivity (to channel development to urban areas with existing infrastructure, protect greenfields, preserve habitat and natural resources)	-
SS 5.1	Site Development-Protect or Restore Habitat (to conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity)	-
SS 6.1	Storm water Design- Quantity Control (to limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from storm water runoff and eliminating contaminants)	+
SS 7.1	Heat Island Effect- Non-roof (to reduce heat islands to minimize impacts on microclimates and human wildlife habitats)	-
MR 1.1	Building Reuse- Maintain Existing Walls, Floors and Roof (extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste, and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport)	-
MR 1.2	Building Reuse- Maintain Interior Nonstructural Elements (extend lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport)	-
MR 2	Construction Waste Management (divert construction and demolition debris from disposal in landfills and incineration facilities. Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites)	+
MR 3	Materials Reuse (reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources)	-
MR 4	Recycled Content (increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials)	+
MR 5	Regional Materials (increase demand for bu8ilding materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation)	+
IEQ 3.1	Construction Indoor Air Quality Management Plan- During Construction (reduce indoor air quality problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants)	+
IEQ 3.2	Construction Indoor Air Quality Management Plan- Before Occupancy (reduce indoor air quality problems resulting from construction or renovation to promote the comfort and well-being of construction workers and building occupants)	+
IEQ 4.1	Low-Emitting Materials- Adhesives and Sealants (to reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants)	+
IEQ 4.2	Low-Emitting Materials- Paints and Coatings (to reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants)	+

Appendix Figure 11: LEED credits associated with the construction process. Anything denoted by a "+" was integrated into the project plan. This follows LEED 2009.

APPENDIX C: CONSTRUCTION INDOOR AIR QUALITY[18]

Goal: The goal of this plan is to define the minimum practices on the jobsite to meet LEED Certification IEQ credits for Construction Indoor Air Quality Management Planning. It will be utilized during construction to ensure a healthy environment for the construction workforce and building occupants.

LEED Requirements:

1. This plan must meet or exceed the recommended control measurements the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Indoor Air Quality (IAQ) guidelines for occupied buildings under construction.
2. Materials that are prone to moisture damage and that are stored onsite should be protected.
3. Filtration Media with a Minimum Efficiency Reporting Value (MERV) of 8 must be used at each return air grill, for all air handlers to be permanently utilized.

Key Indoor Air Quality Initiatives

- **HVAC Protection (During Construction)**
  - Avoid using permanently installed HVAC systems during construction if possible.
  - Materials should be delivered to the jobsite using an "on-time" delivery method, so that it can be ready for installation as soon as possible.
  - Seal all duct work, piping, conduit systems, and other equipment openings with protective shrink wrap from dust and odors.
- **Source Control**
  - Recover, isolate, and ventilate containers housing toxic materials.
    - Storage of these toxic materials must be carefully coordinated in order to avoid any unwanted incidents.
  - Fumes from idling vehicles, gasoline, and diesel fueled tools must be either contained or exhausted.
- **Pathway Interruption**
  - All project equipment and material staging will be located away from critical air flow pathways.
  - Certain areas of work must be isolated in order to prevent contamination of clean or occupied spaces.
    - Utilize temporary barriers (tarps, plastic wrap, etc.)
  - Walk off mats will also be used to isolate finished spaces from construction activity, such as stairwells.
- **Housekeeping**
  - Use vacuum cleaners with high efficiency particle filters.
  - Use wetting agents for dust and debris remnants.
- **Scheduling**
  - Conduct activities with high pollution potential during off hours to allow time for new materials to air out.
  - Allow adequate time for flush-out and IAQ test procedures prior to building occupancy.

Final Cleaning/Testing Requirements

- **Option 1:**
  - **Flush-Out Path 1:** Subsequent to construction completion, prior to building occupancy and with all interior finishes installed, new filtration media must be installed and a flush-out must be performed of the system. 14,000 cubic feet of outdoor are per square foot must be supplied to the system, while maintaining an internal temperature of at least 60 ^{0}F, and a relative humidity of no higher than 60%.
  - **Flush-Out Path 2:** If occupancy is desired prior to completion of the flush-out, the space may be occupied following delivery of a minimum of 3500 cubic feet of outdoor air per square foot of floor area. Once the space is occupied, it must be ventilated at a minimum rate of 0.30 cubic feet per minute per square foot of outside air or the design minimum outside air rate, whichever is greater. During each day of the flush-out period ventilation must begin a minimum of 3 hours prior to occupancy and continue during occupancy. These conditions must be maintained until a total of 14,000 cubic feet of outdoor air per square foot of floor area has been delivered to the space.
- **Option 2:**
  - **Air Testing:** Conduct baseline IAQ testing after construction ends and prior to occupancy. Demonstrate that maximum allowable concentrations of contaminates are not exceeded. These procedures comply with OSHA requirements and allow for the cleanings and safest indoor air quality required for building occupation.

APPENDIX D: WASTE MANAGEMENT[19]

Goal: In order to reach a near net-zero level for 350 Mission, waste management needed to become a key player during the construction process, not only to achieve LEED points, but to also ensure project productivity and environment sensitivity. A minimum of 75% by weight of construction waste generated on-site will be salvaged r recycled to the highest extent possible, rather than ending up in a landfill.

Responsibilities

- Lead waste reduction efforts will be led by the General Contractor and then work is either performed by GC labor, or supplemented to subcontractors responsible for their own trade waste.
- Local waste management company, Recology, will provide a wide range of waste reduction services including:
    - Robust recycling and sorting
    - Composting
    - Trash collection
    - Providing debris boxes ranging from 9-30 cubic yards
- Recycled materials will include, but are not limited to:
    - Metals: Scrap iron, steel, copper, brass, and aluminum
    - Concrete excess
    - Masonry: Brick, rock, broken up asphalt pavement containing no aggregates
    - Gypsum Board: Excess drywall construction materials including cuttings, other scrap and excess materials
    - Carpet: carpet tile and pad scraps
    - Packaging: Cardboard, boxes, plastic, polystyrene, pallets, crates, paint cans, and plastic pails
    - Wood: Wood forms, waste chutes, and excess trim.

Waste Reduction Plan

- A single container of waste will be transported to Recology and accounted for in cubic yards and weight of recycling matter. Spreadsheets of this recorded material will be noted every time a dumpster goes out, in order to properly record the efficiency of this recycling process.
- Logistics of the waste entering and exiting the construction site, will be coordinated by the General Contractor, who will be responsible for dumpster delivery and pick-up, sorting, recycling, and hauling. The waste will go to this address to be processed:

    1. Recology
       900 7th Street.
       San Francisco, Ca 94111

- Sorting will be categorized by the following materials:
    - Metals, concrete, cardboard, wood, and drywall

Plan Implementation

- Waste management will be a regular topic during all owner and subcontractor meetings had onsite. LEED coordinator for the General Contractor will be managing the construction waste management process.
- Preconstruction meetings will be held before work is produced on site including the following topics:
    - Appropriate handling and recycling, salvage, reuse, and return methods
- Subcontractor requirements include the following:
    - Provide any additional recycling input on materials not listed above
    - Food or waste disposal will need to be disposed off-site
    - Daily clean-ups will be monitored and if not properly separated, then it will be at the expense of the subcontractor.

APPENDIX E: SAFETY & SIGNAGE PLAN

1. CALIFORNIA / OSHA GUIDELINES

The California Building Code and **San Francisco Building Code** served as the primary foundation for setting up a proper, safe construction site. Conditions outlined by **Title 8** were also considered. To further ensure project safety and efficient working conditions, we recognized **Californian OSHA Guidelines**. Below, the team has illustrated major OSHA impacts to how 350 Mission was constructed and how decisions were made to meet OSHA requirements.

STANDARDS	PROJECT RESPONSE
3642 Elevating work platform equipment, such as vertical tower, scissor lift, and mast-climbing work platform may be used to position employees, and materials. 1. Platform deck shall be equipped with a guardrail or other structure around its upper periphery. Where guardrail is less than 39 inches high, a personal fall protection system is required. 2. The platform shall have toe boards at sides and ends. 3. Nothing may ride on elevating platform.	Lifts used in accordance with OSHA California standard 3642. Lifts will be primarily utilized in the subterranean levels and lobby.
1720 Placement of Concrete. Pumping plan will follow Title 8 Safety Orders. Equipment shall be inspected by a qualified operator prior to daily use and the inspection must be documented.	Title 8 was considered in phasing the construction sequences. Primary concrete pumping takes place in the placement of the mat slab, and in the construction of the foundation walls. Local concrete supplies were considered.
1712 Rebar & other impalement hazards. Employees working at grade or at the same surface level as exposed protruding rebar or similar projects shall be protected against impalement by guarding exposed ends that extend up to 6 feet above grade or other work surface, with approved protective coverings.	Primary instances involving exposed rebar will occur during the setting of the massive mat slab. Rebar connections will extend along the perimeter of the mat slab, and at its center. Protective, inverted troughs will cover series of exposed rebar, while manufactured 4" by 4" coverings will cover individual pieces of rebar.
1615 Crane safety. Safety devices such as crane level indicator, horn, jib stops, boom stops, etc. are required on all equipment unless otherwise specified. Operational aids such as boom hoist limiting device, boom angle, boom length indicator, load weighing devices, are all required.	The primary tower crane involved in lifting on-site will be centrally located. A key will be integrated into the mat slab, as well as a designed pad, to handle loads imposed by the crane. The segmentally constructed luffing jib crane is detailed in **Drawing C8.**
2510 Grounding. Each electrical receptacle must have a grounding contract that is connected to an equipment grounding conductor. Temporary wiring *must* be grounded.	On-site generators will be used to power some site equipment. Temporary electric power will be provided by permit, as noted in **Drawing C5.**
1636 Elevators. An elevator is required for structures or buildings 60 ft. or more above ground level or 48 ft. below ground level.	Building lifts will be installed along the south of the building footprint. Additionally, the interior service elevator will be utilized as interior fit-out occurs.
1604 Hoists. For hoists located outside of a structure, the hoist way enclosures must be 8 ft. high on the building side or the scaffold side at each floor landing and 8 ft. high on all sides of the pit.	As mentioned, hoists will be installed along the south of the building. These hoists will be used to move materials from the laydown/staging area, and to move project personnel.
1512 Medical Care. A first aid kit must be provided by each employer on all job sites and must contain the minimum or supplies as determined by an authorized licensed physician. The employer shall	Medical equipment will be located in the on-site project facilities, located at the northwestern corner of the site. Emergency services will enter the site from the northwestern corner, and will be able to

have a written plan to provide emergency medical services.	leave from the western perimeter or northwestern corner of the jobsite.
1709 Trusses & beams. Trusses & beams must be braced laterally and progressively during construction to prevent buckling or overturning.	Building columns will be first be installed, spanning every two floors. Beams and trusses will be installed following the installation of each layer of columns.
1710 Connections. A load shall not be released from its hoisting line until the slid web structural members are secured at each connection with at least two bolts and drawn wrench tight.	In addition to in-field connections, all pre-manufactured connections of the core system will be monitored. Additionally, care must be taken in installing the external lateral beams, as they span many additional stories.
1716 Fall protection. Required when workers are connecting beams where the fall distance is greater than two stories or 30 ft. whichever is less	Netting will be installed surrounding the perimeter of the building as construction moves vertically. Workers will be tied off twice above each netting.
1632 Open floor. Shall be guarded by either temporary railings or toe boards or by covers. Covers shall be capable of safely supporting the greater of 400 pounds or twice the weight of the employees, equipment, and materials.	The building schedule is phased such that floor decking is installed shortly after the completion of each structural floor. Until decking is installed, temporary, structurally capable boards will be placed on each occupied floor.
1710 Permanent Floors. There shall be not more than eight stories between the erection floor and the uppermost permanent floor. There shall not be more than four floors or 48 ft, whichever is less, of unfinished bolting or welding above the foundation or uppermost permanently secured floor.	Based on the schedule of the building, there will be no more than six floors between vertical erection, and placement of permanent flooring system. Stairwell access will rise with each finished level.
1541 Underground utilities. The exact locations of the underground utilities must be determined by safe and acceptable means. While the excavation is open, the underground utilities must be protected, supported, or removed as necessary.	We have utilized drawings provided by the SOM design team, and geotechnical report by Treadwell & Rollo. Utility locations were considered in site logistics, as well as early excavation development.
1541 Bracing. Protective systems for excavations deeper than 20 ft. shall be designed by a registered engineer. Excavations must be inspected as needed after every rainstorm or earthquake.	As illustrated within the report, and on **Drawings C5,** lateral bracing will be installed during excavation to complement the cement-soil walls which primarily hold back layers of soil around the site.
1541 Barriers. Must be erected around excavations in remote locations. All wells, pits, shafts, and caissons must be covered or barricaded.	During excavation, an additional layer of fencing will surround the excavation surface to protect personnel at street level.
1670 Fall protection. Guard rails are required to guard the open sides of all work surfaces that are 7.5’ or higher or workers must be protected by other means.	As mentioned, each finished floor which has not been enclosed will be temporarily closed in a layer of netting and tarping. This will remain in place until the installation of the enclosure system.
1921 Fire protection. A water supply that is adequate to operate fire-fighting equipment must be made available as soon as combustible material arrives on-site.	Location of temporary water supply has been noted within the **Sequencing** pages of the report, as well as on page **Drawings C5.**
1599 Site access controls. Flaggers must be placed in locations so as to give effective warning. Signage must be visible noting site conditions.	Two trained flaggers will be utilized at either of two construction site gates. Proper signage will alert surrounding traffic of the site conditions.
1513 Site cleaning. Ground areas within 6 ft. of buildings under construction shall be kept reasonably free of irregularities. Piled or stacked material shall be placed in stable stacks to prevent it from falling, slipping, or collapsing. Material on balconies or in other similar elevated areas shall be secured to prevent falling.	Site disposal and recycling will take place at the north end of the site. Daily clean-ups will take place following the completion of major work activities.
1523 Lighting. Construction areas shall be lighted to	Lighting will be installed in all active construction

not less than minimum required illumination activities. (3 footcandles in areas of low activity, 5 in outdoor active construction areas, 30 in first-aid)	areas. Subterranean levels will feature 10 footcandles of light. Above ground levels will utilize the program outlined at left.
1730 Roof work. For multi-unit roofs with slopes 0:12, employees shall be protected by a) roof jack system, b) minimum 24 inch high parapet	A temporary 4 foot tall parapet will be installed during the installation of roof features for added protection.
1637 Scaffolds. Scaffolds must be provided for work that cannot be done safely by employees standing on ladders or on solid construction that is at least 20 in. wide. Each scaffold must be designed to support its own weight and 4 times the maximum load.	Scaffolding will be utilized with work surrounding the structural core of the building. Additionally, scaffolding will be used in outfitting the lobby space on the ground floor of 350 Mission.
1629 Stairways. Required in buildings of up to 3 stories or 36 ft. in height. In steel frame buildings, a stairway must be installed leading up to each planked floor.	Stairwells will rise in the core of the building with each finished floor. Two separate stairwells will provide access to each finished floor, and provide means of egress. An additional temporary staircase will be installed at the northwest corner of the building, with access to the bottom 5 floors.
1526 Toilet facilities. Toilet facilities are required on the jobsite. One washing station must be provided for each 20 employees or fraction thereof.	Temporary toilet facilities will be placed at the northwestern corner of the jobsite. Following the installation of the methane digestion equipment, personnel will be encouraged to use restroom facilities at the southeast corner of the building to aid digester initiation.

Appendix Figure 12: OSHA California standards & their impact on our construction plan for 350 Mission.

Appendix Figure 13: Placement of safety publications.

In making personnel on-site aware of potential site hazards & educating all of proper safety habits, the construction crew will utilize daily meetings and publications in instilling values.

1. Daily Meetings / Facilities: Morning meetings will be used to identify potential work hazards, and ensure proper personal safety equipment is being utilized. Signage will illustrate appropriate required safety equipment. Hazards will be marked appropriately.
2. Safety publications will be posted at all entrances to the building site.

2. SUSTAINABILITY

As part of creating an interactive design, the team sought ways to connect with the surrounding public and building occupants. Utilizing varying methods of communication, the team was able to illustrate the impact 350 Mission would have on the site and the surrounding area.

Appendix Figure 14: 350 Mission promotional publication.

Firstly, advertising the completed 350 Mission will be important to gauge the interest of the public. The team wanted to publicize that the construction of 350 Mission will be an environmentally healthy addition to the surrounding community. Furthermore, we wanted to illustrate that 350 Mission would be more than just a typical, close-to-the-public, office building. The lobby space will be used primarily as a public space, featuring a café and public restroom.

The restroom will be a fundamental component of the biomethane digester powering the building. The team wanted to use this restroom area as a way to educate the user on how compost and sewage are impacting the daily activities at 350 Mission.

Additionally the intent was to advertise the flexibility of the building spaces. The open floor plans and public lobby were designed to be adaptable. The space was meant to be easily reconfigured based on current building occupants.

Appendix Figure 15: 350 Mission construction personnel publication.

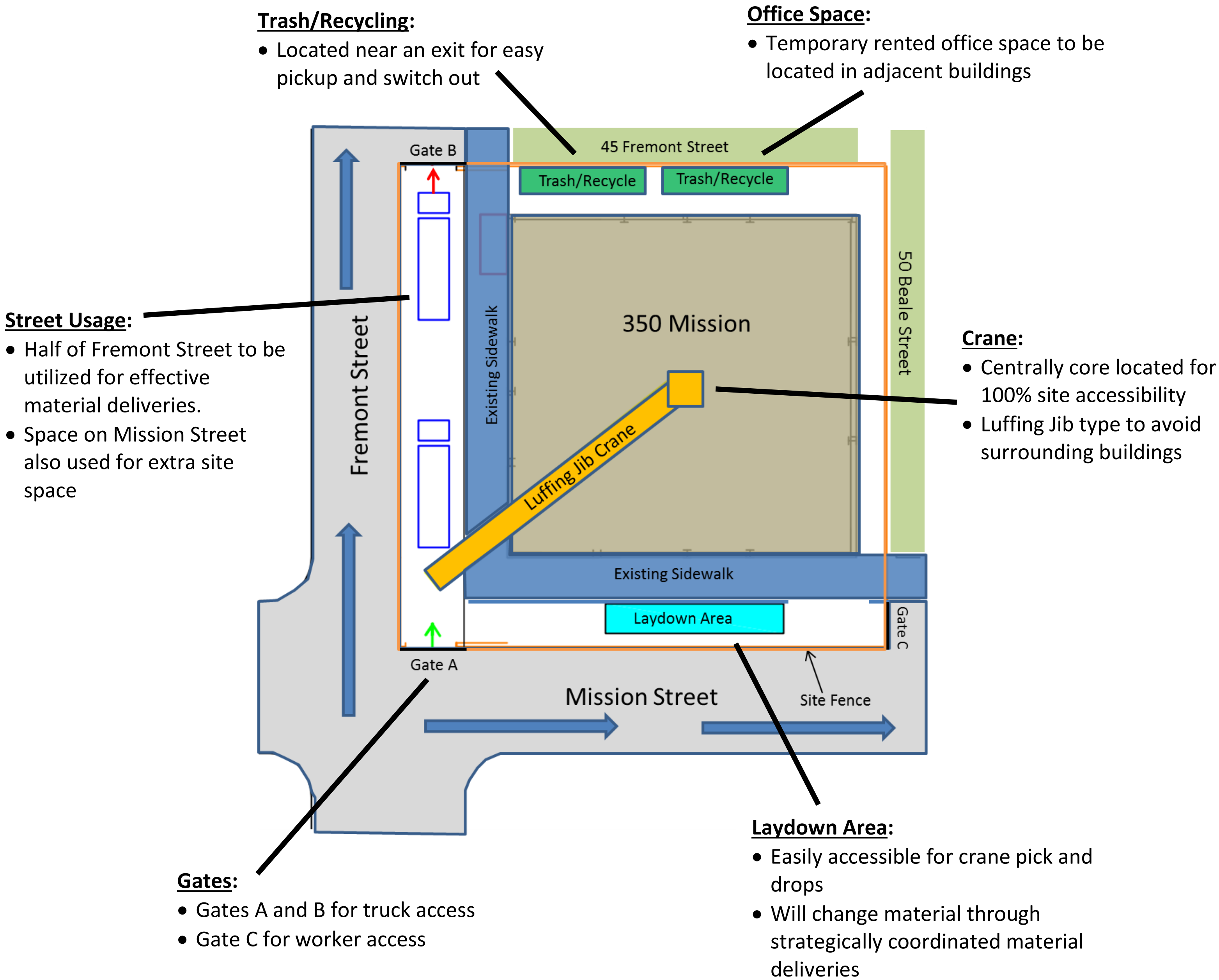
Secondly, communication was centered on instilling sustainable concepts in construction personnel and building occupants. The campaign centered around being a "Team Player," highlights ways to keep the community clean, cut back on building waste, and recycle waste materials.

Furthermore, construction personnel will be encouraged to carpool or used alternate methods of transportation to the site to cut back on the carbon produced from construction activities. Our goal is to limit construction waste and carbon footprint.

APPENDIX F: BASIC SITE DIAGRAM

1. SITE UTILIZATION

Below, a basic map of the site during peak construction has been illustrated. The construction team is requesting a permit to utilize bus lanes on both Mission Street and Fremont Street. Further details of the site setup, based on the California Building Code, can be found on **Drawing C5.**



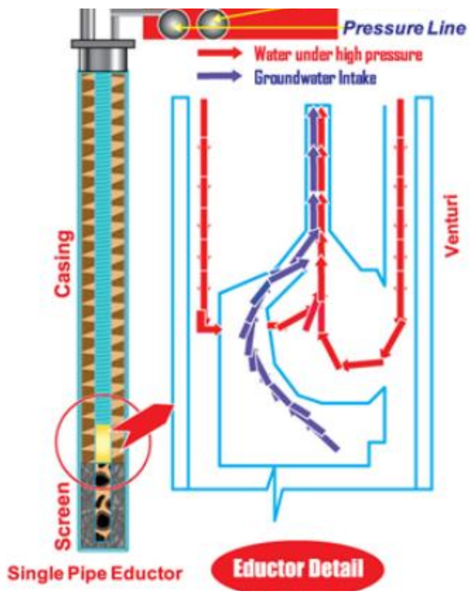
Appendix Figure 16: Basic site setup.

APPENDIX G: DEWATERING SCHEME[17]

Based off of the Geotechnical Investigation Report, performed by Treadwell & Rollo, the design groundwater level should be taken as an elevation of -3 feet. The desired excavation level is 54', or 51' below design groundwater.

Eductor Dewatering was chosen as a method that is most effective for deep excavations with lower permeable soils, such as the Colma soil layer encountered at an elevation of -7 and -8 feet.

Appendix Figure 17: A storm water drain on Fremont street was chosen to discharge groundwater after being removed from the excavation site.



Appendix Figure 18: The Venturi process allows groundwater to be discharged from the wells, while high pressure water is applied at the same time.

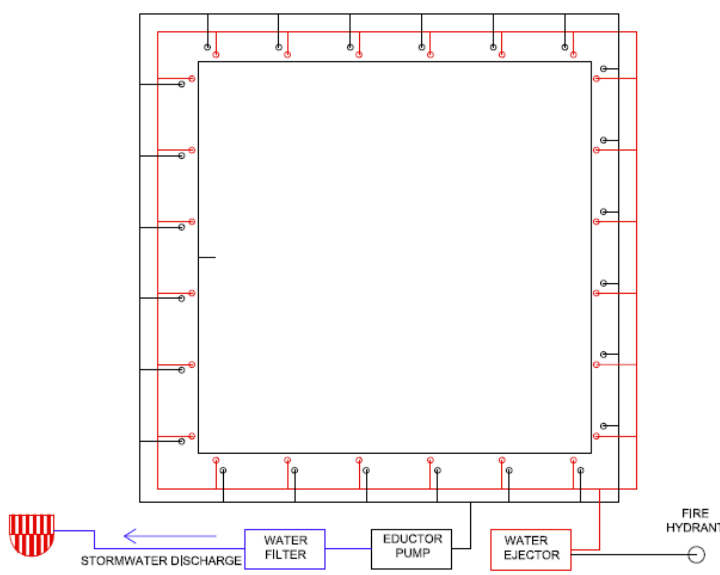
Special permitting m ... ge groundwater in the San Francisco storm drain system, per the Regional Water Quality Control Board. The following steps must be followed.

1. Provide RWQCB with any water **quality assessment or discharge information**
2. **Apply** for a permit from RWQCB
3. **Region 2** – Apply under site-specific Dewatering Permit
4. **Test** Water per RWQCB requirements
5. Receive Waste discharge **authorization** from RWQCB
6. **Monitor** compliance with monitoring program
7. **Report** in compliance with reporting program

Eductor dewatering includes a series of wells, spaced evenly surrounding the excavation site. In this case, wells were spaced every 25 ft. Each unit consists of a well, a submersible pump, and discharge piping.

High pressure water is fed near each well, causing a Venturi effect. This process uses this high pressure water (marked in red) to draw the ground water through a well screen and push it to the surface through a return pipe (marked in black).

The water is then run through a filtration system, taking into account that the groundwater is most likely contaminated. Lastly, the water is released into the storm drain system.



Appendix Figure 19: A schematic is represented to show the Eductor dewatering process.

APPENDIX H: DETAILED ESTIMATE

1. BASELINE DESIGN ESTIMATE

TOTAL BASE	99,472,534
CONTRACTOR	12,931,429
ARCHITECT	4,973,627
TOTAL	117,377,590

350 MISSION STREET								
BASELINE DESIGN ESTIMATE								
GARAGE, UNDERGROUND PARKING								
CODE	SECTION	INFORMATION	UNIT	UNIT COST	COST PER S.F.	% OF SUB-TOTAL	TOTAL UNITS	TOTAL COST
A. SUBSTRUCTURE								
1010	Standard Foundations	Mat slab*(2) - 10 foot thick*(7)	-	-	-		-	1,100,000
1030	Slab on Grade	5 in. reinforced concrete with vapor barrier & granular ba	SQFT SLAB	6.93	3.47		18496	128,177
2010	Basement excavation	Excavation 24 feet deep	SQFT GROUND	10.85	5.43		18496	200,682
2020	Basement Walls	Concrete Walls*(1)*(5)	LNFT WALL	82	0.4	22%	710	58,220
B. SHELL								
B10 Superstructure								
1010	Floor Construction	Cast-in-Place Concrete Beam & Slab, Concrete columns	SQFT FLOOR	27.66	13.83	44.90%	73984	2,046,397
B20 Exterior Enclosure								
2010	Exterior Walls	Cast-in-Place Concrete Beam & Slab, Concrete columns	SQFT WALL	22.22	4	7.10%	21760	483,507
C. INTERIORS								
1010	Partitions	Concrete block*(3)	SQFT PARTITION	43.16	0.83		3600	155,376
1020	Interior Doors	Hollow metal	EACH	9216	0.09		28	258,048
2010	Stair Construction	Concrete	FLIGHT	66.25	34	2.30%	14	928
D. SERVICES								
D20 Plumbing								
2010	Plumbing Fixtures	Drainage in parking areas, toilets, & service fixtures*(4)	EACH	0.06	0.06		43	3
2020	Domestic Water Distribution	Electric water heater	SQFT FLOOR	0.11	0.11		73984	8,138
2040	Rainwater drainage		SQFT GROUND	2.52	1.26	2.40%	18496	46,610
D30 HVAC								
3010	Terminal Package Units	Exhaust fans	SQFT FLOOR	0.17	0.17	0.30%	73984	12,577
D40 Fire Protection								
4010	Sprinklers	Dry pipe sprinkler system	SQFT FLOOR	4.12	4.12		73984	304,814
4020	Standpipes	Dry standpipe system	SQFT FLOOR	0.15	0.15	7.20%	73984	11,098
D50 Electrical								
5010	Electrical Service & Dist	200 ampere service, panelboard & feeders	SQFT FLOOR	0.14	0.14		73984	10,358
5020	Lighting & Brance Wiring	T8 fluorescent fixtures, receptacles, switches, & misc	SQFT FLOOR	3.23	3.23		73984	238,968
5030	Communications & Security	Addressable alarm systems & emergency lighting	SQFT FLOOR	0.18	0.18		73984	13,317
5090	Other Elec	Emergency generator, 11.5 kilowatts	SQFT FLOOR	0.06	0.06	6.10%	73984	4,439
E. EQUIPMENT & FURNISHINGS								
1030	Vehicular Equipment	Ticket dispenser, booths, automatci gates	SQFT FLOOR	0.41	0.41	0.70%	18496	7,583
OFFICE, 30 STORY								
CODE	SECTION	INFORMATION	UNIT	UNIT COST	COST PER S.F.	% OF SUB-TOTAL	TOTAL UNITS	
A. SUBSTRUCTURE								
2020	Basement Walls	4 ft foundation wall	LNFT WALL	82	0.4	3.9%	710	116,440
B. SHELL								
B10 Superstructure								
1010	Floor Construction	Concrete slab, metal deck, beams	SQFT FLOOR	20	26.49		554880	22,195,200
1020	Roof Construction	Metal deck, open web steel joist, beams, columns	SQFT ROOF	8.64	0.54	20.40%	18496	319,611
B20 Exterior Enclosure								
2020	Exterior Windows	Doubled glazed, heat absorbing, tinted plate glass wall	EACH	75	24.29	18.80%	12000	1,800,000
2030	Exterior Doors	Double aluminum & glass doors	EACH	6311	0.67		10	126,220
B30 Roofing								
3010	Roof Coverings	Single-ply membrane fully adhered	SQFT ROOF	5.76	0.36	0.30%	18496	213,074
C. INTERIORS								
1010	Partitions	Gypsum board on metal studs	SQFT PARTITION	5.5	2.96		100000	1,100,000
1020	Interior Doors	Single-leaf hollow metal	EACH	1152	2.89		910	2,096,640
1030	Fittings	Toilet partitions	SQFT FLOOR	0.39	0.39		554880	432,806
2010	Stair Construction	Concrete filled metal pan*(6)	FLIGHT	1.52	0.81		130	395
3010	Wall Finishes	60% vinyl wall covering, 40% paint	SQFT SURFACE	1.52	0.81		100000	304,000
3020	Floor Finishes	60% carpet tile, 30% vinyl composition tile, 10% ceramic	SQFT FLOOR	5.23	5.23		554880	5,804,045
3030	Ceiling Finishes	Mineral fiber tile on concealed Z bars	SQFT CEILING	5.11	5.11	16.20%	554880	5,670,874
D. SERVICES								
D10 Conveying								
1010	Elevators & Lifts	Four-geared passenger elevators	EACH	200,000	7.68	5.80%	7	2,800,000
D20 Plumbing								
2010	Plumbing Fixtures	Toilet & service fixtures, supply & drainage	EACH	5622	4.18		470	5,284,680
2020	Domestic Water Distribution	Oil-fired water heater	SQFT FLOOR	0.35	0.35		554880	388,416
2040	Rainwater drainage	Roof drains	SQFT ROOF	2.88	0.18	3.60%	18496	106,537
D30 HVAC								
3020	Heat Generation Systems	Boiler, heat exchanger, & fans	EACH	486175	2.57		6	5,834,100
3030	Cooling Generation Systems	Chilled water, fan coil units	SQFT FLOOR	14.2	14.2	14.60%	554800	15,756,320
D40 Fire Protection								
4010	Sprinklers	Sprinkler system, light hazard	SQFT FLOOR	2.78	2.78		554800	3,084,688
4020	Standpipes	Standpipes & hose system	SQFT FLOOR	0.54	0.54	2.50%	554800	599,184
D50 Electrical								
5010	Electrical Service & Dist	2400 ampere service, panelboard, & feeders	SQFT FLOOR	0.89	0.89		554800	987,544
5020	Lighting & Brance Wiring	High-efficiency fluorescent fixtures, receptacles, switche:	SQFT FLOOR	11.51	11.51		554800	12,771,496
5030	Communications & Security	Addressable alarm systems, internet, phone wiring, & en	SQFT FLOOR	5.4	5.4		554800	5,991,840
5090	Other Elec	Emergency generator, 200 kilowatts, uninteruptable pow	SQFT FLOOR	0.54	0.54	13.80%	554800	599,184

The baseline estimate illustrates a basic building design, structurally concrete in nature. We used this theoretical "baseline" as a way of comparing potential design options.

2. AEI TEAM 2 DESIGN ESTIMATE

TOTAL BASE	100,933,216
CONTRACTOR	23,214,640
ARCHITECT	7,065,325
TOTAL	131,213,181

350 MISSION STREET

AEI TEAM 2 DESIGN ESTIMATE

GARAGE, UNDERGROUND PARKING

CODE	SECTION	INFORMATION	UNIT	UNIT COS'	COST PER S.F.	% OF SUB-TOTAL	TOTAL UNITS	TOTAL COST
A. SUBSTRUCTURE								
1010	Standard Foundations	Mat slab*(2) - 5 foot thick*(7)	-	-	-		-	425,000
1030	Slab on Grade	5 in. reinforced concrete with vapor barrier & granular base	SQFT SLAB	6.93	3.47		18496	128,177
2010	Basement excavation	Excavation 24 feet deep	SQFT GROUND	10.85	5.43		18496	200,682
2020	Basement Walls	Concrete Walls*(1)*(5)	LNFT WALL	82	0.4	22%	710	58,220
B. SHELL								
B10 Superstructure								
1010	Floor Construction	Cast-in-Place Concrete Slab, Steel Columns and Beams	SQFT FLOOR	23.45	13.83	44.90%	73984	1,734,925
B20 Exterior Enclosure								
2010	Exterior Walls	Cast-in-Place Concrete Slab, Steel Columns and Beams	SQFT WALL	25.65	4	7.10%	21760	558,144
C. INTERIORS								
1010	Partitions	Concrete block*(3)	SQFT PARTITION	43.16	0.83		3600	155,376
1020	Interior Doors	Hollow metal	EACH	9216	0.09		28	258,048
2010	Stair Construction	Concrete	FLIGHT	66.25	34	2.30%	14	928
D. SERVICES								
D20 Plumbing								
2010	Plumbing Fixtures	Drainage in parking areas, toilets, & service fixtures*(4)	EACH	0.06	0.06		43	3
2020	Domestic Water Distributic	Electric water heater	SQFT FLOOR	0.11	0.11		73984	8,138
2040	Rainwater drainage		SQFT GROUND	2.52	1.26	2.40%	18496	46,610
D30 HVAC								
3010	Terminal Package Units	Exhaust fans	SQFT FLOOR	0.17	0.17	0.30%	73984	12,577
D40 Fire Protection								
4010	Sprinklers	Dry pipe sprinkler system	SQFT FLOOR	4.12	4.12		73984	304,814
4020	Standpipes	Dry standpipe system	SQFT FLOOR	0.15	0.15	7.20%	73984	11,098
D50 Electrical								
5010	Electrical Service & Dist	200 ampere service, panelboard & feeders	SQFT FLOOR	0.14	0.14		73984	10,358
5020	Lighting & Brance Wiring	T8 fluorescent fixtures, receptacles, switches, & misc	SQFT FLOOR	3.23	3.23		73984	238,968
5030	Communications & Security	Addressable alarm systems & emergency lighting	SQFT FLOOR	0.18	0.18		73984	13,317
5090	Other Elec	Emergency generator, 11.5 kilowatts	SQFT FLOOR	0.06	0.06	6.10%	73984	4,439
E. EQUIPMENT & FURNISHINGS								
1030	Vehicular Equipment	Ticket dispenser, booths, automatci gates	SQFT FLOOR	0.41	0.41	0.70%	18496	7,583
OFFICE, 30 STORY								
CODE	SECTION	INFORMATION	UNIT	UNIT COS'	COST PER S.F.	% OF SUB-TOTAL	TOTAL UNITS	
A. SUBSTRUCTURE								
2020	Basement Walls	4 ft foundation wall	LNFT WALL	82	0.4	3.9%	710	116,440
B. SHELL								
B10 Superstructure								
1010	Floor Construction	Concrete slab, metal deck, beams, columns	SQFT FLOOR	28.26	26.49		554880	12,968,211
1020	Roof Construction	Metal deck, open web steel joist, beams	SQFT ROOF	9.54	0.54	20.40%	18496	352,904
1030	Core Construction	Steel members, hollow tubing	LF of members		-		27157.75	8,665,352
1040	Exterior Bracing	Steel lateral members	LF of members				2113.33	597,674
B20 Exterior Enclosure								
2020	Exterior Windows	Doubled glazed, heat absorbing, tinted plate glass wall panel	EACH	75	24.29	18.80%	12000	1,800,000
2030	Exterior Doors	Double aluminum & glass doors	EACH	6311	0.67		10	126,220
B30 Roofing								
3010	Roof Coverings	Single-ply membrane fully adhered	SQFT ROOF	5.76	0.36	0.30%	18496	213,074
C. INTERIORS								
1010	Partitions	Gypsum board on metal studs	SQFT PARTITION	5.5	2.96		100000	1,100,000
1020	Interior Doors	Single-leaf hollow metal	EACH	1152	2.89		910	2,096,640
1030	Fittings	Toilet partitions	SQFT FLOOR	0.39	0.39		554880	432,806
2010	Stair Construction	Concrete filled metal pan*(6)	FLIGHT	1.52	0.81		130	395
3010	Wall Finishes	60% vinyl wall covering, 40% paint	SQFT SURFACE	1.52	0.81		100000	304,000
3020	Floor Finishes	60% carpet tile, 30% vinyl composition tile, 10% ceramic	SQFT FLOOR	5.23	5.23		554880	5,804,045
3030	Ceiling Finishes	Mineral fiber tile on concealed Z bars	SQFT CEILING	5.11	5.11	16.20%	554880	5,670,874
D. SERVICES								
D10 Conveying								
1010	Elevators & Lifts	Four-geared passenger elevators	EACH	200,000	7.68	5.80%	7	2,800,000
D20 Plumbing								
2010	Plumbing Fixtures	Toilet & service fixtures, supply & drainage	EACH	5622	4.18		470	5,284,680
2020	Domestic Water Distributic	Oil-fired water heater	SQFT FLOOR	0.35	0.35		554880	388,416
2040	Rainwater drainage	Roof drains	SQFT ROOF	2.88	0.18	3.60%	18496	106,537
D30 HVAC								
3010	Biomethane Systems	Anaerobic Digester, Solid Seperator	EACH					1,374,000
3020	Combined Heat and Power	Packaged CHP unit	EACH					165,000
3030	Water	Evaporative Coolers, Absorption Heat Pump, Radient Panels, Boiler, Pump	EACH					7,918,800
3040	Air	AHU's, fans	EACH					120,000
3050	Distribution/Labor		SQFT	12.3			554880	13,650,048
D40 Fire Protection								
4010	Sprinklers	Sprinkler system, light hazard	SQFT FLOOR	2.78	2.78		554800	3,084,688
4020	Standpipes	Standpipes & hose system	SQFT FLOOR	0.54	0.54	2.50%	554800	599,184
D50 Electrical								
5010	Electrical Service & Dist	2400 ampere service, panelboard, & feeders	SQFT FLOOR	0.89	0.89		554800	987,544
5020	Lighting & Brance Wiring	High-efficiency fluorescent fixtures, receptacles, switches, AC, MISC	SQFT FLOOR	11.51	11.51		554800	12,771,496
5030	Communications & Security	Addressable alarm systems, internet, phone wiring, & emergency lighting	SQFT FLOOR	6	5.4		554800	6,657,600
5090	Other Elec	Emergency generator, 200 kilowatts, uninteruptable power supply	SQFT FLOOR	0.54	0.54	13.80%	554800	599,184

*(1)- Parking garage did not account for basement walls- utilized figures from office building estimate

*(2)- Mat slab is primary foundation of the building

*(3)- Assume total partition of 3600 sqft based on core partitions

*(4)- Additional draining equipment for every 5000 sqft

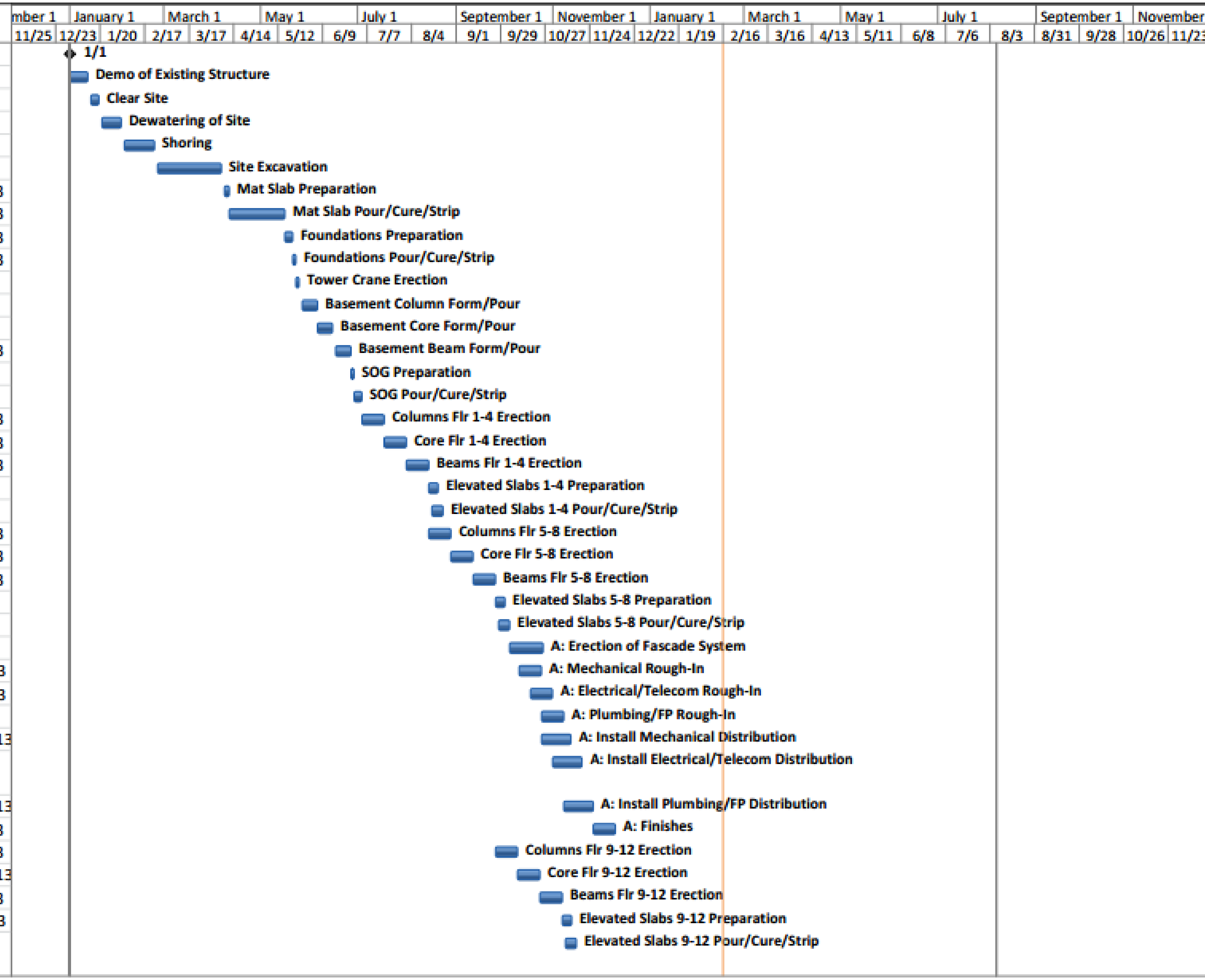
*(5)- Included core walls in this calculation

*(6)- Includes lobby stair

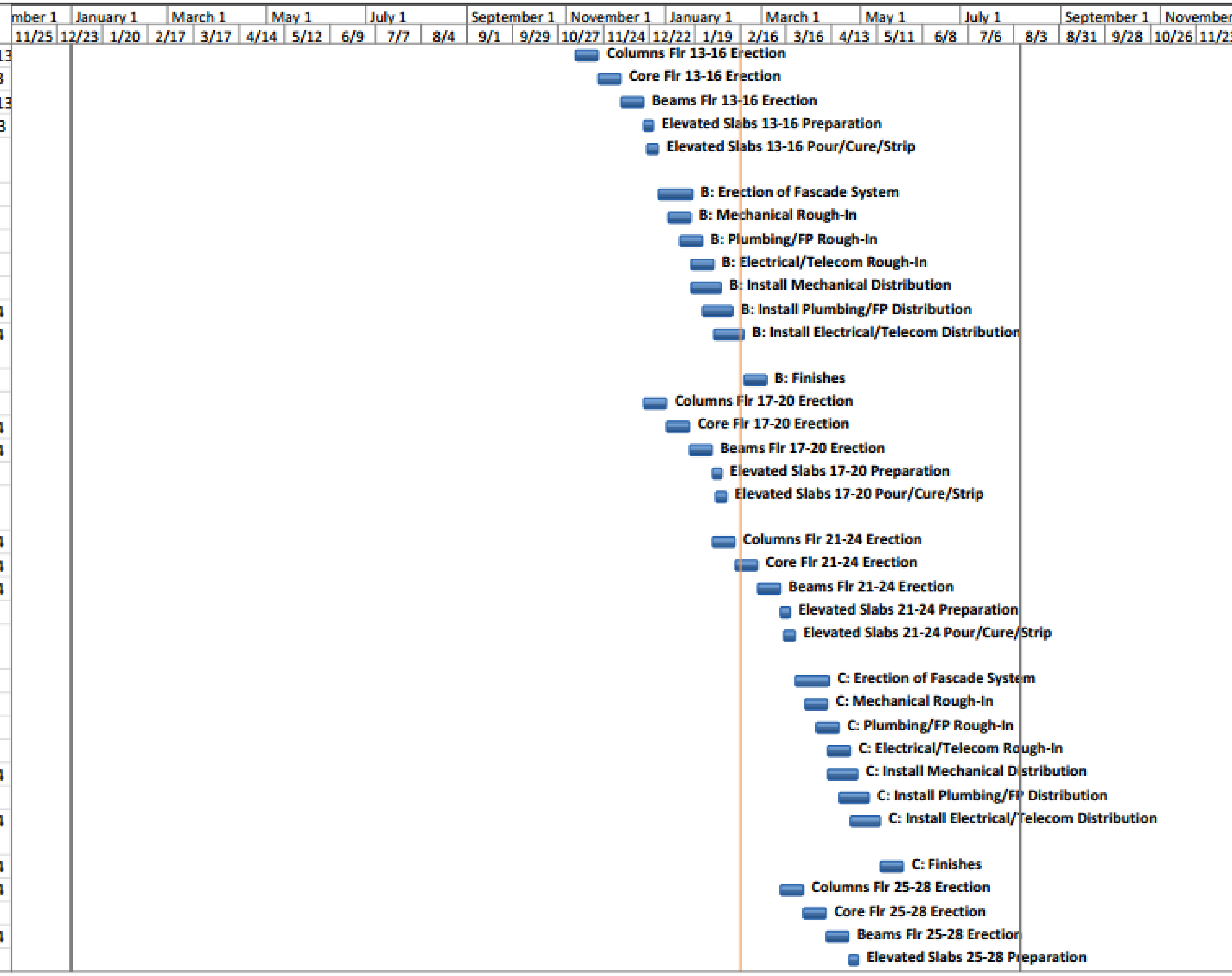
*(7)- Mat slab estimation usingt ICE MC2

APPENDIX I: PROJECT SCHEDULE

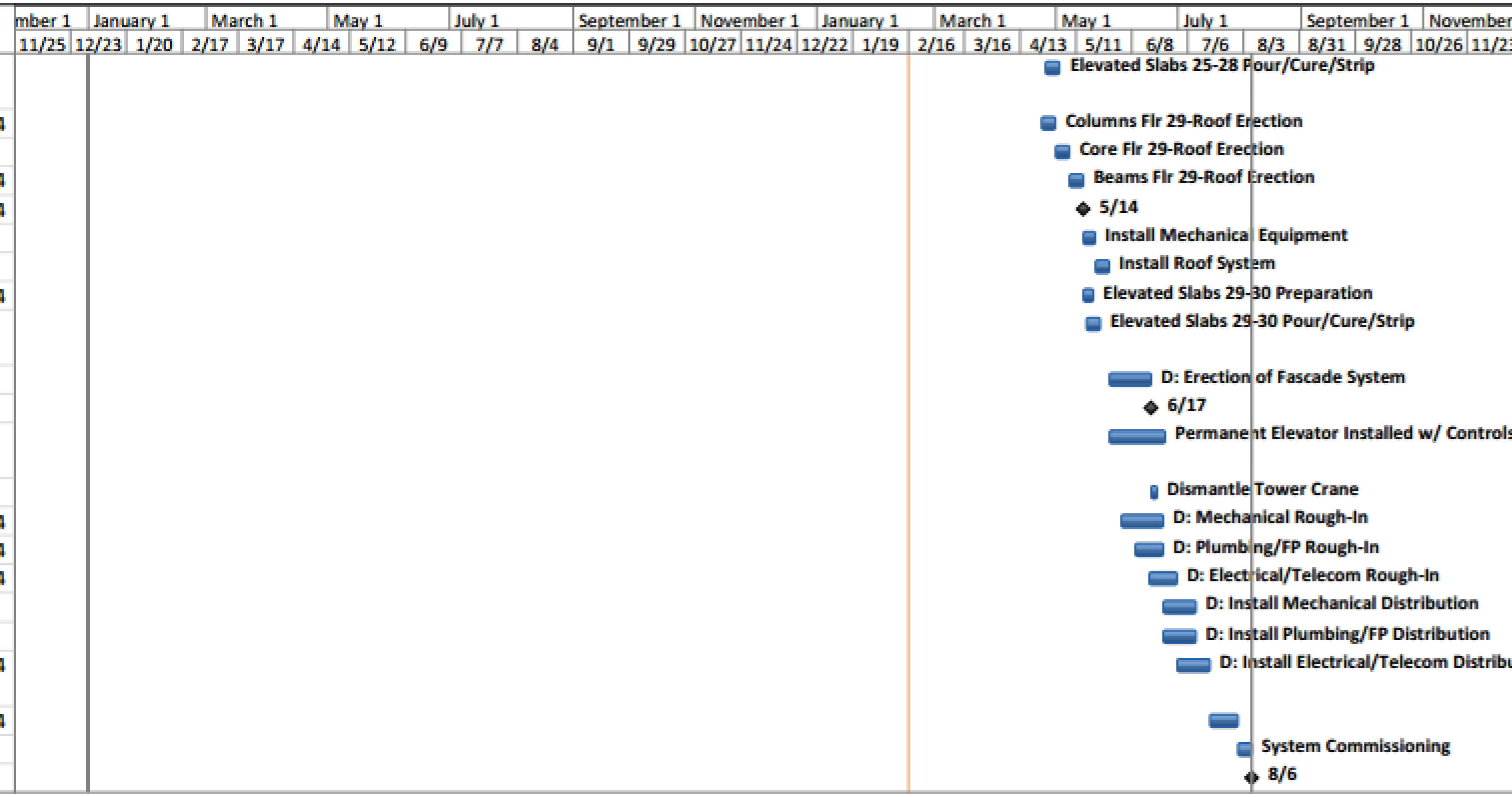
ID	Task Name	Duration	Start	Finish
1	Notice to Proceed	0 days	Tue 1/1/13	Tue 1/1/13
2	Demo of Existing Structure	1.8 wks	Tue 1/1/13	Fri 1/11/13
3	Clear Site	1 wk	Mon 1/14/13	Fri 1/18/13
4	Dewatering of Site	2 wks	Mon 1/21/13	Fri 2/1/13
5	Shoring	3 wks	Mon 2/4/13	Fri 2/22/13
6	Site Excavation	1.5 mons	Mon 2/25/13	Fri 4/5/13
7	Mat Slab Preparation	3 days	Mon 4/8/13	Wed 4/10/13
8	Mat Slab Pour/Cure/Strip	25 days	Thu 4/11/13	Wed 5/15/13
9	Foundations Preparation	3 days	Thu 5/16/13	Mon 5/20/13
10	Foundations Pour/Cure/Strip	2 days	Tue 5/21/13	Wed 5/22/13
11	Tower Crane Erection	2 days	Thu 5/23/13	Fri 5/24/13
12	Basement Column Form/Pour	1.5 wks	Mon 5/27/13	Wed 6/5/13
13	Basement Core Form/Pour	1.5 wks	Wed 6/5/13	Fri 6/14/13
14	Basement Beam Form/Pour	1.5 wks	Mon 6/17/13	Wed 6/26/13
15	SOG Preparation	2 days	Wed 6/26/13	Fri 6/28/13
16	SOG Pour/Cure/Strip	3 days	Fri 6/28/13	Wed 7/3/13
17	Columns Flr 1-4 Erection	2 wks	Wed 7/3/13	Wed 7/17/13
18	Core Flr 1-4 Erection	2 wks	Wed 7/17/13	Wed 7/31/13
19	Beams Flr 1-4 Erection	2 wks	Wed 7/31/13	Wed 8/14/13
20	Elevated Slabs 1-4 Preparation	4 days	Wed 8/14/13	Tue 8/20/13
21	Elevated Slabs 1-4 Pour/Cure/Strip	1 wk	Fri 8/16/13	Fri 8/23/13
22	Columns Flr 5-8 Erection	2 wks	Wed 8/14/13	Wed 8/28/13
23	Core Flr 5-8 Erection	2 wks	Wed 8/28/13	Wed 9/11/13
24	Beams Flr 5-8 Erection	2 wks	Wed 9/11/13	Wed 9/25/13
25	Elevated Slabs 5-8 Preparation	4 days	Wed 9/25/13	Tue 10/1/13
26	Elevated Slabs 5-8 Pour/Cure/Strip	1 wk	Fri 9/27/13	Fri 10/4/13
27	A: Erection of Fascade System	3 wks	Fri 10/4/13	Fri 10/25/13
28	A: Mechanical Rough-In	2 wks	Thu 10/10/13	Thu 10/24/13
29	A: Electrical/Telecom Rough-In	2 wks	Thu 10/17/13	Thu 10/31/13
30	A: Plumbing/FP Rough-In	2 wks	Thu 10/24/13	Thu 11/7/13
31	A: Install Mechanical Distribution	2.5 wks	Thu 10/24/13	Mon 11/11/13
32	A: Install Electrical/Telecom Distribution	2.5 wks	Thu 10/31/13	Mon 11/18/13
33	A: Install Plumbing/FP Distribution	2.5 wks	Thu 11/7/13	Mon 11/25/13
34	A: Finishes	2 wks	Tue 11/26/13	Mon 12/9/13
35	Columns Flr 9-12 Erection	2 wks	Wed 9/25/13	Wed 10/9/13
36	Core Flr 9-12 Erection	2 wks	Wed 10/9/13	Wed 10/23/13
37	Beams Flr 9-12 Erection	2 wks	Wed 10/23/13	Wed 11/6/13
38	Elevated Slabs 9-12 Preparation	4 days	Wed 11/6/13	Tue 11/12/13
39	Elevated Slabs 9-12 Pour/Cure/Strip	1 wk	Fri 11/8/13	Fri 11/15/13



ID	Task Name	Duration	Start	Finish
40	Columns Flr 13-16 Erection	2 wks	Wed 11/6/13	Wed 11/20/13
41	Core Flr 13-16 Erection	2 wks	Wed 11/20/13	Wed 12/4/13
42	Beams Flr 13-16 Erection	2 wks	Wed 12/4/13	Wed 12/18/13
43	Elevated Slabs 13-16 Preparation	4 days	Wed 12/18/13	Tue 12/24/13
44	Elevated Slabs 13-16 Pour/Cure/Strip	1 wk	Fri 12/20/13	Fri 12/27/13
45	B: Erection of Fascade System	3 wks	Fri 12/27/13	Fri 1/17/14
46	B: Mechanical Rough-In	2 wks	Thu 1/2/14	Thu 1/16/14
47	B: Plumbing/FP Rough-In	2 wks	Thu 1/9/14	Thu 1/23/14
48	B: Electrical/Telecom Rough-In	2 wks	Thu 1/16/14	Thu 1/30/14
49	B: Install Mechanical Distribution	2.5 wks	Thu 1/16/14	Mon 2/3/14
50	B: Install Plumbing/FP Distribution	2.5 wks	Thu 1/23/14	Mon 2/10/14
51	B: Install Electrical/Telecom Distribution	2.5 wks	Thu 1/30/14	Mon 2/17/14
52	B: Finishes	2 wks	Tue 2/18/14	Mon 3/3/14
53	Columns Flr 17-20 Erection	2 wks	Wed 12/18/13	Wed 1/1/14
54	Core Flr 17-20 Erection	2 wks	Wed 1/1/14	Wed 1/15/14
55	Beams Flr 17-20 Erection	2 wks	Wed 1/15/14	Wed 1/29/14
56	Elevated Slabs 17-20 Preparation	4 days	Wed 1/29/14	Tue 2/4/14
57	Elevated Slabs 17-20 Pour/Cure/Strip	1 wk	Fri 1/31/14	Fri 2/7/14
58	Columns Flr 21-24 Erection	2 wks	Wed 1/29/14	Wed 2/12/14
59	Core Flr 21-24 Erection	2 wks	Wed 2/12/14	Wed 2/26/14
60	Beams Flr 21-24 Erection	2 wks	Wed 2/26/14	Wed 3/12/14
61	Elevated Slabs 21-24 Preparation	4 days	Wed 3/12/14	Tue 3/18/14
62	Elevated Slabs 21-24 Pour/Cure/Strip	1 wk	Fri 3/14/14	Fri 3/21/14
63	C: Erection of Fascade System	3 wks	Fri 3/21/14	Fri 4/11/14
64	C: Mechanical Rough-In	2 wks	Thu 3/27/14	Thu 4/10/14
65	C: Plumbing/FP Rough-In	2 wks	Thu 4/3/14	Thu 4/17/14
66	C: Electrical/Telecom Rough-In	2 wks	Thu 4/10/14	Thu 4/24/14
67	C: Install Mechanical Distribution	2.5 wks	Thu 4/10/14	Mon 4/28/14
68	C: Install Plumbing/FP Distribution	2.5 wks	Thu 4/17/14	Mon 5/5/14
69	C: Install Electrical/Telecom Distribution	2.5 wks	Thu 4/24/14	Mon 5/12/14
70	C: Finishes	2 wks	Tue 5/13/14	Mon 5/26/14
71	Columns Flr 25-28 Erection	2 wks	Wed 3/12/14	Wed 3/26/14
72	Core Flr 25-28 Erection	2 wks	Wed 3/26/14	Wed 4/9/14
73	Beams Flr 25-28 Erection	2 wks	Wed 4/9/14	Wed 4/23/14
74	Elevated Slabs 25-28 Preparation	4 days	Wed 4/23/14	Tue 4/29/14



ID	Task Name	Duration	Start	Finish
75	Elevated Slabs 25-28 Pour/Cure/Strip	1 wk	Fri 4/25/14	Fri 5/2/14
76	Columns Flr 29-Roof Erection	1 wk	Wed 4/23/14	Wed 4/30/14
77	Core Flr 29-Roof Erection	1 wk	Wed 4/30/14	Wed 5/7/14
78	Beams Flr 29-Roof Erection	1 wk	Wed 5/7/14	Wed 5/14/14
79	Steel Topping Out	0 days	Wed 5/14/14	Wed 5/14/14
80	Install Mechanical Equipment	4 days	Wed 5/14/14	Tue 5/20/14
81	Install Roof System	1 wk	Tue 5/20/14	Tue 5/27/14
82	Elevated Slabs 29-30 Preparation	3 days	Wed 5/14/14	Mon 5/19/14
83	Elevated Slabs 29-30 Pour/Cure/Strip	5 days	Fri 5/16/14	Thu 5/22/14
84	D: Erection of Fascade System	3 wks	Tue 5/27/14	Tue 6/17/14
85	Building Enclosed	0 days	Tue 6/17/14	Tue 6/17/14
86	Permanent Elevator Installed w/ Controls	1 mon	Tue 5/27/14	Tue 6/24/14
87	Dismantle Tower Crane	3 days	Tue 6/17/14	Fri 6/20/14
88	D: Mechanical Rough-In	3 wks	Mon 6/2/14	Mon 6/23/14
89	D: Plumbing/FP Rough-In	2 wks	Mon 6/9/14	Mon 6/23/14
90	D: Electrical/Telecom Rough-In	2 wks	Mon 6/16/14	Mon 6/30/14
91	D: Install Mechanical Distribution	2.5 wks	Mon 6/23/14	Wed 7/9/14
92	D: Install Plumbing/FP Distribution	2.5 wks	Mon 6/23/14	Wed 7/9/14
93	D: Install Electrical/Telecom Distribution	2.5 wks	Mon 6/30/14	Wed 7/16/14
94	D: Finishes	2 wks	Thu 7/17/14	Wed 7/30/14
95	System Commissioning	1 wk	Thu 7/31/14	Wed 8/6/14
96	Substantial Completion	0 days	Wed 8/6/14	Wed 8/6/14



Major Building System Durations (* indicate milestones)			
System	**Duration**	**Start**	**Finish**
Demolition of Existing Structure	2 wks	1/1/13	1/11/13
Site Shoring/Excavation	9 wks	2/4/13	4/5/13
Mat Slab Prep/Pour	1 mon	4/8/13	5/15/13
Tower Crane Erection	2 days	5/23/13	5/24/13
Steel Erection/Topping Out*	45 wks	7/3/13	5/14/14
Façade Erection/Building Enclosed*	3 mon	10/4/13	6/17/14
Permanent Elevator Installation	1 mon	5/27/14	6/24/14

WORKS CITED

1 – Google Maps. 350 Mission St, San Francisco, 19405. Retrieved Dec. 15, 2013, from https://www.google.com/maps/preview/place/350+Mission+Street/@37.7291005,-122.5965349,10z/data=!4m2!3m1!1s0x8085806376568ab7:0xafdca467c1dcb052?hl=en

2 – Treadwell & Rollo. Jun. 28, 2012. *Geotechnical Investigation, 350 Mission Street, San Francisco, California.*

3 - Fraser Engineering (UK) Ltd. (2013). Radiant Panel in Grid Prior To Ceiling Finish. Retrieved Dec. 11, 2013, from http://feukltd.com/Radiant%20Panel%20Page.htm

4 - Integrated Publishing. Soldier Pile Systems. Retrieved Dec. 05, 2013, from http://constructionmanuals.tpub.com/14045/css/14045_250.htm

5 - Boswell, C. Keith (2013) Exterior Building Enclosures**.** ISBN 9781118332795

6 - U.S. Environmental Protection Agency, Office of Transportation and Air Quality. (2013). *Gas Emission from a Typical Passenger Vehicle*. Retrieved Jan. 10, 2014 from http://www.epa.gov/otaq/climate/documents/420f11041.pdf

7 – International Code Council. 2010 California Building Code. Retrieved Dec. 15, 2013, from http://publicecodes.cyberregs.com/st/ca/st/b200v10/

9 – Cal/OSHA. State of California. 2014. http://www.dir.ca.gov/DOSH/.

10 - ASTM 6151-08. Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Sampling. Nov. 28, 2013.

11 - Kilroy Realty Corporation. Dec. 8, 2012. *Construction Under Way for 2015 Delivery of the 27-Story Tower at 350 Mission Street.* Retrieved Nov. 08, 2013, from http://phx.corporate-ir.net/phoenix.zhtml?c=79637&p=irol-newsArticle&ID=1768409

12 – Peckar & Abramson, P.C. Understanding Contractual Pricing Arrangements – Fixed Price, Cost-Plus1, and Guaranteed Maximum Price. Retrieved Dec. 19, 2013, from http://www.pecklaw.com/images/uploads/communications/Client_Alert-Understanding_Contractual_Pricing_Arrangements.pdf

13 - Panoramio – Google Maps. *301 Mission Deep Excavation Shoring.* Retrieved Jan. 15, 2014, from http://www.panoramio.com/photo/18202635

14 – Hole Products. (2013) *Hollow Stem Augers, Cutterheads & Components.* Retrieved Dec. 15, 2013, from http://www.holeproducts.com/category/Hollow-Stem-Augers-Cutterheads--and--Components

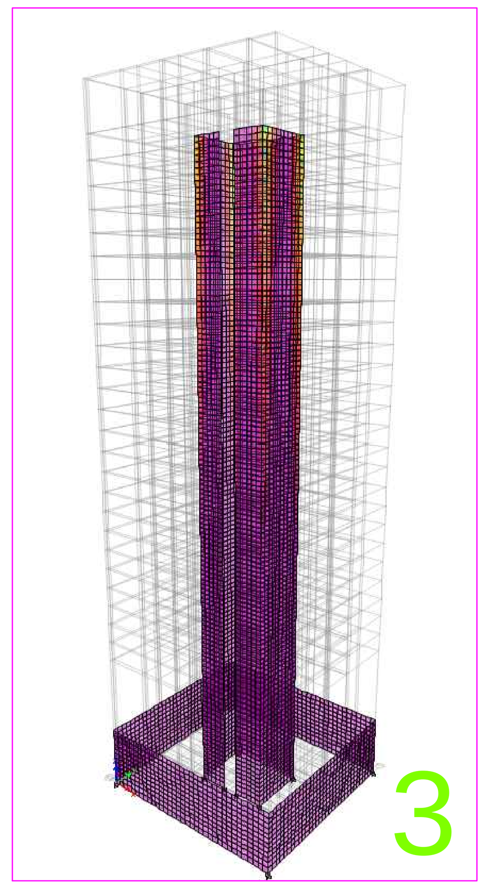
15 – The Concrete producer – Concrete Materials and Admixtures. (Mar. 7, 2011) *All in a Night's Work.* Retrieved Dec. 15, 2013, from http://www.theconcreteproducer.com/concrete-materials-and-admixtures/all-in-a-night-s-work1_2.aspx

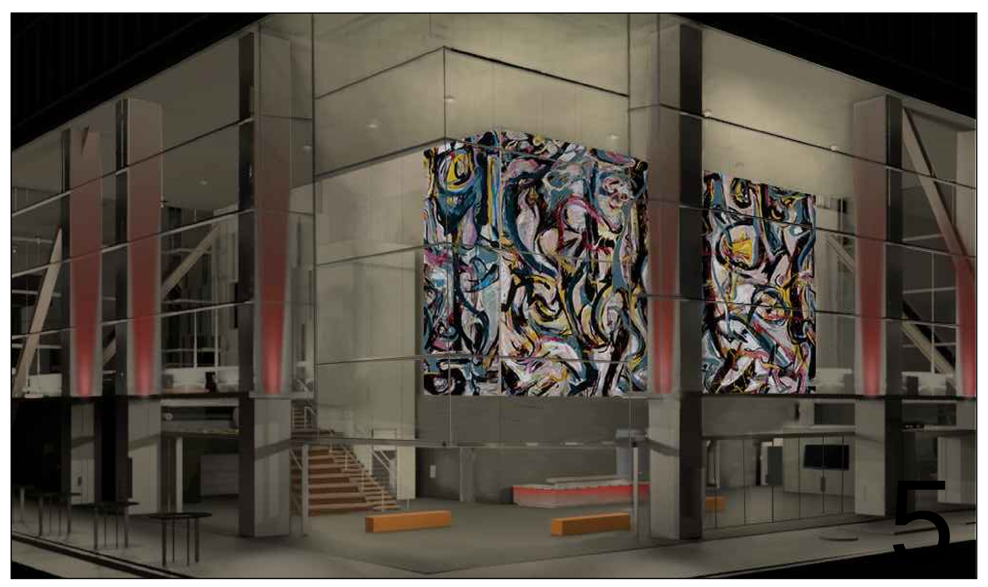
16 – Wickman, Forrest. May. 22, 2012. *Raising Crane, How do cranes get to the top of skyscrapers?* Retrieved Jan. 29, 2014, from http://www.slate.com/articles/life/explainer/2012/05/tower_crane_building_one_world_trade_center_how_do_cranes_get_on_top_of_skyscrapers_.html

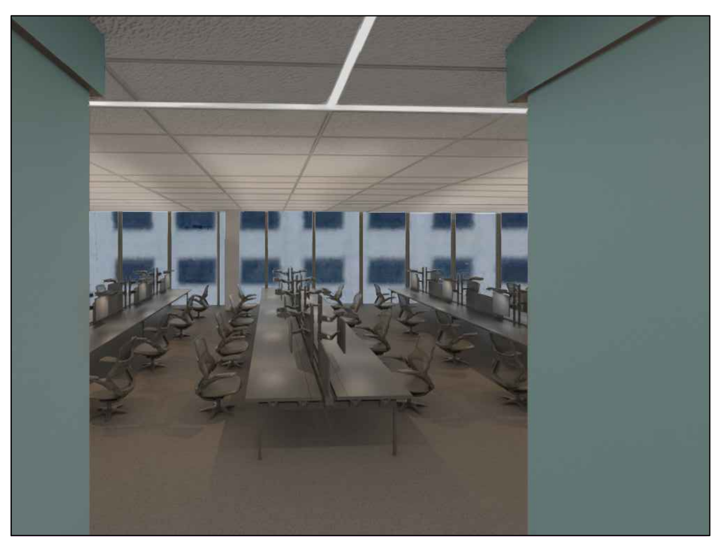
17 – Wellcore. Well Point Systems. Retrieved Jan. 29, 2014, from http://www.wellcore.co.za/downloads/Dewatering_Well_Points.pdf

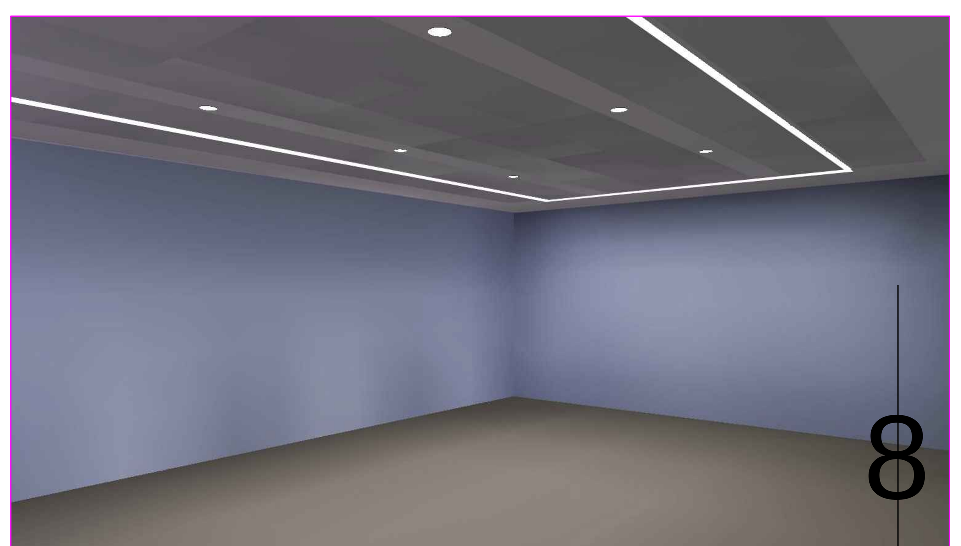
18 – IAQ Guidelines for Occupied Buildings Under Construction, 2nd Ed. 2007. Retrieved Jan. 30, 2014, from http://www.smacna.org/bookstore/index.cfm?fuseaction=search_results&keyword=IAQ%20Guidelines%20for%20Occupied%20Buildings%20Under%20Construction,%202nd%20Edition

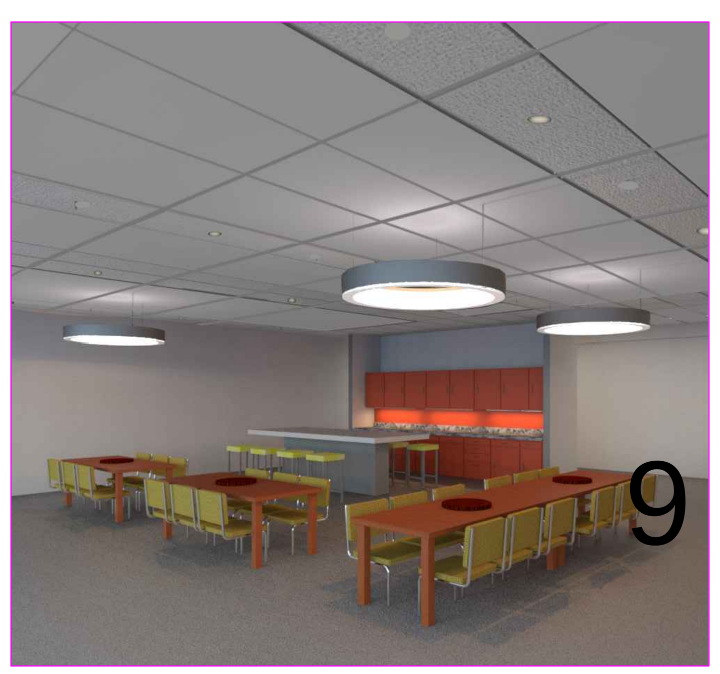
19 – USGBC – LEED MR Credits 2.1 &2.2. "Construction Waste Management Plan" Retrieved Jan. 30, 2014, from http://www.usgbc.org/home

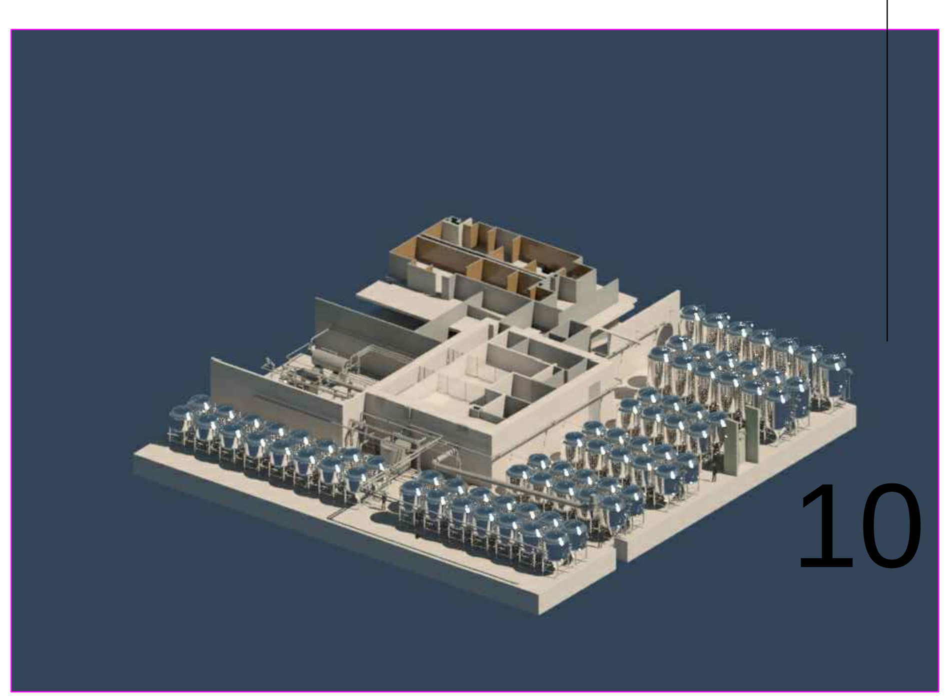












350 MISSION

SAN FRANCISCO, CALIFORNIA

AEI TEAM 2 - 2014
BUILDING OVERVIEW

BUILDING STRUCTURE: At the base, a mat slab resides as the primary piece to the building's foundation system. Foundation walls stem from the outer perimeter of the slab. The walls are formed against the cement-soil walls of the excavation shoring system. The building's structure is primarily composed of steel above.

The core is a concentrically based steel structure. The building's stairs and elevators are located in the centrally constructed core. Fifteen steel columns stand around the building's perimeter. The southwestern corner of the building features a cantilever; as in a column does not stand at the corner.

Additional lateral beams are present on the four exterior faces of the building. These structural elements will be accentuated by the building's facade.

MEP SYSTEMS: The flagship mechanical system of the team's design for 350 Mission is a biomethane digester. The digester utilizes sewage, and compost materials to produce building energy. The building's particular system produces energy to both power complementary building systems, and sell electricity to the grid of San Francisco.

A free radiant space cooling system is used to cool the building, and a wastewater heat pump and gas-fired boiler will serve as the primary heating system of the building. Ventilation is maintained by a DOAS air handler and absorption chiller.

The office floors will utilize a Virtual Desktop infrastructure to reduce data demand loads. LED task Tambient lighting will be mounted at individual workstation sto reduce overall lighting loads.

The lobby was designed as an interactive public space. Art and lighting features will highlight the lofty elements of the spacious lobby. A cafe and public restroom will be located at entry level. The restroom interacts directly with the biomethane digester. Lighting below the reception desk will distinguish how the building is performing mechanically. A restaurant will be featured on the floor above.

Images:

1 - The reception desk within the lobby. The desk will be drenched in different colors of light based on the how the building is performing. The restroom facility is located down the hallway in the center of the image.
2 - The open floor plan of the office floors. Note the available flex spaces available on each office floor, as well as the individual desk units.
3 - Analysis of structural core performance. The building's core will carry the primary building loads.
4 - Rendering of the building's structural system. Note the external lateral braces. These strucutral elements will be highlighted through the building's facade, creating a visual identity at 350 Mission.
5 - The lobby lit up at night.
6 - LED artwork will be installed behind the reception area within the lobby. The open lobby space will be the central community space within the building and house several artistic installations.
7 - View from the elevator corridor to an open office layout. Each desk is equipped with it's own Tambient unit.
8 - Office floor flex space.
9 - Office floor kitchen area
10 - Basement floor integration. The basement height was increased to accommodate the digester equipment. The reduced depth of the designed mat slab allotted addition space for the mechanical equipment.

PROJECT
AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE
ASCE STUDENT COMPETITION

DRAWING TITLE
CONSTRUCTION-
BUILDING
OVERVIEW

SCALE: N/A
JOB NUMBER: 350 MISSION
DATE: 02/17/2014
DRAWN BY: AEI 2 - 2014
SHEET NUMBER:
C1

Project Milestones

Preliminary Research	8/26/2013	9/4/2013	Presentation 1	Constr, Mech, Elect, Struct
Preliminary Planning	9/4/2013	9/18/2013	Presentation 2	Constr, Mech, Elect, Struct
Schematic Design	9/18/2013	10/9/2013	Presentation 3	Constr, Mech, Elect, Struct
Written Development	10/9/2013	11/18/2013	Disciplinary and Integration Report Submission	Constr, Mech, Elect, Struct
Design Development	11/18/2013	12/11/2013	Presentation 4	Constr, Mech, Elect, Struct
AEI Electronic Submission	1/31/2004	2/17/2014	Electronic Submission	Constr, Mech, Elect, Struct
Finalist Presentations	3/27/2014	3/29/2013	Final Presentation	Constr, Mech, Elect, Struct

These project milestones, dictated by professors and the ASCE Competition guidelines, were strictly followed in order to create a structured and organized project flow. As presentations and deadlines approached, project progress linearly followed and progressed accordingly until the date of the final submission. Maintaining an organized resource allocation plan, which mimicked these guidelines allowed for smooth deadline transitions.

Resource Allocation Plan

Model Development	Construction	2	6	8
	Electrical	2	6	8
	Mechanical	2	6	8
	Structural	2	6	8
Model Review	Construction	2	2	16
	Electrical	2	2	16
	Mechanical	2	2	16
	Structural	2	2	16
Structural Analysis & Design	Structural	2	10	8
Lighting/Electrical Analysis & Design	Electrical	2	10	8
Mechanical Analysis & Design	Mechanical	2	10	8
Schedule & Cost Analysis	Construction	2	8	4
LEED Certification / Net Zero Awareness	Collaborative	8	5	4

A considerable effort was made to drive the building development and make significant progress every week. This plan was constructed in order to track hours set aside every week to perform important tasks. This helped to keep a structured work plan and increase group member productivity, while sticking to project milestones and deadlines.

File Structure

Network Drive	00 Meeting Minutes	.pdf	Team
	01 Admin Docs	.pdf	Team
	02 Individual Research	Folder	Team
	03 Marketing Materials	Folder	Team
	04 3D-4D Models	Folder	Team
	AA - Energy Models	.exe	Electrical/Mechanical
	AB - Sketch-Up	.skp	Construction/Mechnaical
	AC - Revit	.rvt	Team
	AD - Navisworks	.nwc	Construction
	AE - AGI	.AGI	Electrical
	AF - AutoCAD	.dwg	Team
	05 Continuous Work	Folder	Team
	AA - Construction	Folder	Construction
	AB - Structural	Folder	Structural
	AC - Electrical	Folder	Electrical
	AD - Mechanical	Folder	Mechnical
	AE - Integration	Folder	Integration
	06 Presentation 1 (9/4/13)	Folder	Team
	AA - Disciplinary Development	Folder	Team
	AB - Graphic/Photos	.png	Team
	AC - Integration	Folder	Team
	AD - Final Presentation	.pdf	Team
	07 Presentation 2 (9/18/13)	Folder	Team
	08 Presentation 3 (10/9/13)	Folder	Team
	09 Presentation 4 (10/30/13)	Folder	Team
	10 Presentation 5 (12/11/13	Folder	Team
	11 Discipline/Integration Reports (12/18/13)	Folder	Team
	12 Discipline/Integration Reports (1/27/13)	Folder	Team
	13 Discipline/Integration Reports (2/10/13)	Folder	Team

The file structure provide to the left was developed based off AVANT's needs, and project requirements. The Main folders from 00-13 flow in a chronological manner from the beginning of the project, until the final submission. This file structure guaranteed the organization and thoroughness of the project guidelines and competition. A major goal was to make files, documents, and models as easily accessible as possible. This allowed the team to spend less time actually searching for the files to work on, and more time creating an integrated and sustainable building design, therefore proving a productive file structure.

BIM Usage

Integrated Schematic Model	Create and update a model of 350 Mission St. that not only encorperates systems from each option that are essential to the design process, but to also have a 3D representation of system collaboration.	All Members	Significant
Energy Analysis	Perform electrical, lighting, and mechanical studies and calculations in order to reduce building loads to further reach a goal of a near Net Zero building which directly correlates to a positive building life cycle.	Elect, Mech	Significant
Architectural Layout	Create owner importance in order to have the maximum possible rentable space .Choose building systems to not only reduce building loads, but also play to the benefit of the owner.	All Members	Significant
Site Logistics Planning	Create a plan to effectively stage materials on and off site, properly erect and install essential building systems, and complete the project safely and with minimal community impact.	Constr.	Significant

The use of Building Information Modeling drove the collaborative energy with AVANT in ways that incorperated the planning process, system design, construction, and the life cycle of the building. BIM was used not just for its technological benefits in coordination, but also as a planning process to construct a sustainable and evergy efficient building, and keep renewable paybacks realistic thoughout the life of the building.

Software Integration Key

- BIMx Plan
- DAYSIM Model
- ETABS Model
- Site Logistics Model
- Ecotect Model
- RAM Model
- Navisworks Model
- Revit Model
- AutoCAD
- AGI Model
- IES Model

The progression of AVANT's progress, starting from team preparation and preliminary research, all the way to running clash detection and creating a 4D model, can be found in the process flow diagram on the right. Each row of the diagram represents a separate "progress of work" milestone, which funnels into the middle, where process goals and integration maintains the dominate driving force of project development.

Different software utilized throughout the project are represented by colored dots, and placed next to their respective milestone process. Multiple dots on each process represent a push for software integration and compatability

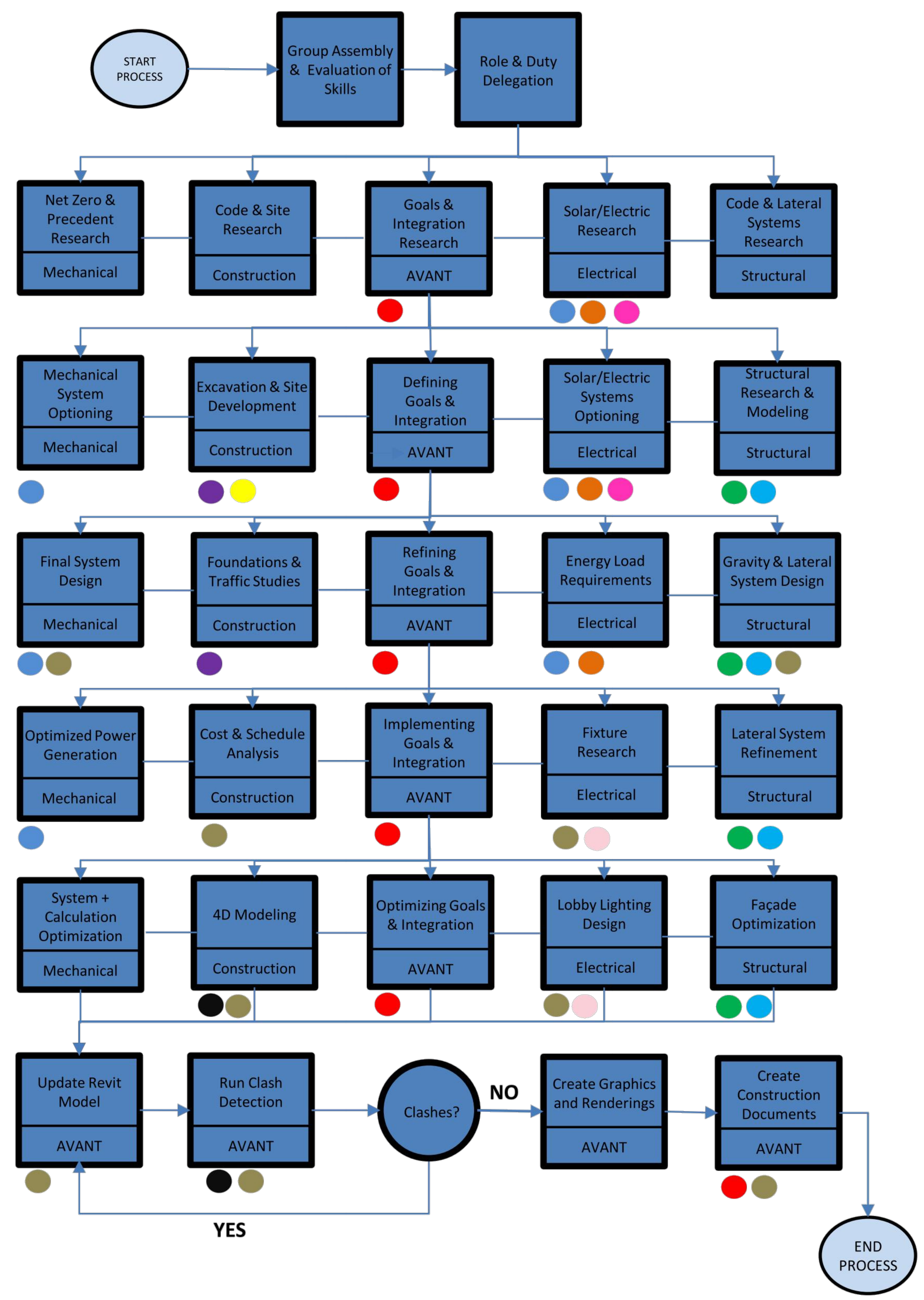
** Additional BIM Execution information can be found in the Integration Report.

Communication Technologies

Symbol	Name	Software Uses
	University Server	Store and share large files and backups, organize documents
	Revit Central Model	Integrated modeling
Google Drive	Google Drive	Group communication and small document sharing
	GroupMe Application	Informal and 'instant access' group communication
	External Hard Drive	Backup all project documents

An important aspect of this project comes with file sharing, communication, and software integration. Through Group Me, and Google Drive, easy communication could be established between members. Revit was also a main source of software integration between trades. With careful organization, files and models could be safely stored in external hard drives and through a secure server.

Project Progress Process Flow Chart



PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE

AEI 2 - 2014

DRAWING TITLE

BIM Execution Planning

SCALE: N/A

JOB NUMBER: 350 MISSION

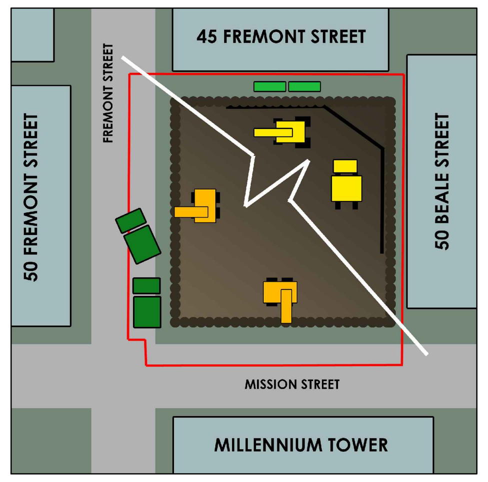
DATE: 02/17/2014

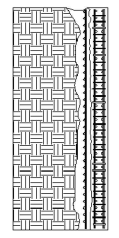
DRAWN BY: AEI 2 - 2014

SHEET NUMBER:

C2

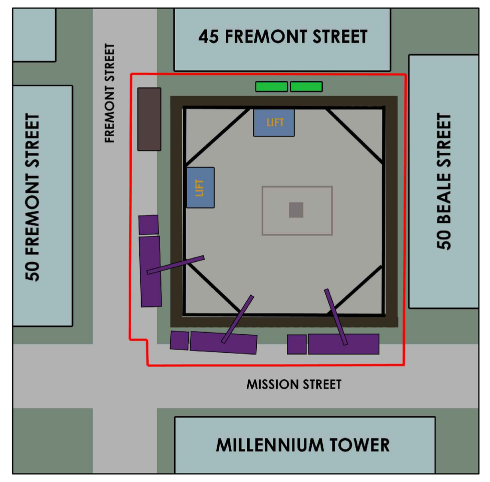
SEQUENCING BREAKDOWN

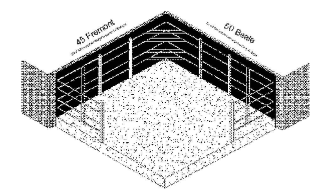
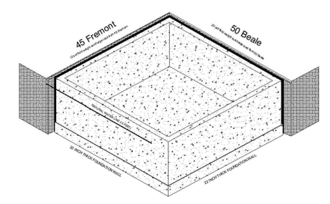





January 2013 - April 2013: Shoring & Excavation. Following demolition of the existing building at 350 Mission, and preparation of the building site, work will begin on establishing the perimeter's cement-soil wall. Hollow stemmed augers will be used to dig concentric borings along the southern and western perimeters of the building footprint. The excavated perimeter will be approximately 3 feet in width. As the borings are prepared, a mixture of cement will be mixed with the layer of soil and allowed to set. This stage is illustrated in the southwestern half of the image above left. Trucks will haul away loose soil as necessary. The concentric borings will take 2-3 weeks to prepare around the perimeter of the site.

Once the cement-soil wall has been set, excavation will commence. Earth movers will haul away soil within the established perimeter. As excavation progresses, additional bracing, pictured above right, will be installed to further stabilize the cement-soil walls. It's important to note the cement-soil walls will also harbor steel reinforcement. This additional lateral bracing of the cement-soil walls will remain in place until construction begins on the subterranean levels of 350 Mission. As each subterranean level is established, the bracing will be removed. The permanent foundation wall will be poured against the cement-soil wall. A cut section of the cement-soil and foundation wall setup is pictured above right.

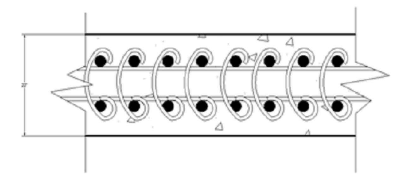


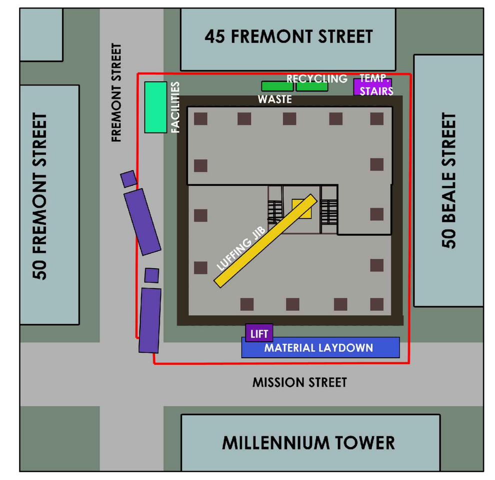



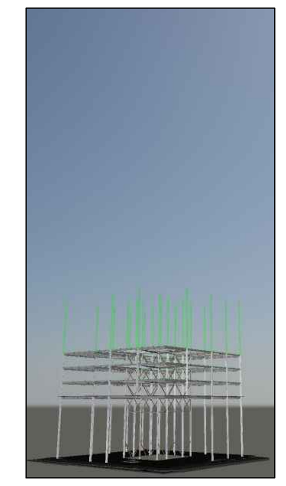
April 2013 - July 2013: Building Foundations & Subterranean Construction. Once excavation has reached a depth of -47 feet, soil conditions will be monitored. If the Colma Sand layer at -47 feet is not consistently stable, the site will be overexcavated and lightweight concrete will be poured to right below the base of the mat slab. Here the working slab will be prepared and the 5 foot thick mat slab will be poured. A key will be integrated into mat slab, which will further absorb the loads imposed by the crane.

8 concrete trucks will deliver concrete to the site in groups of 4. We expect the mat slab pour to take 22 hours. Connections to the foundation wall system will be established prior to the pour.

The subterranean concrete levels will be installed layer by layer, with cement-soil wall shoring removal occurring accordingly. The poured foundation wall utilized an enhanced rebar cage, consisting of two mats of cross reinforced rebar. A cross section of the rebar cage is pictured below. Each individual rebar cage will be installed prefabricated, allowing relatively streamlined installation. The foundation wall system is 22" in depth.



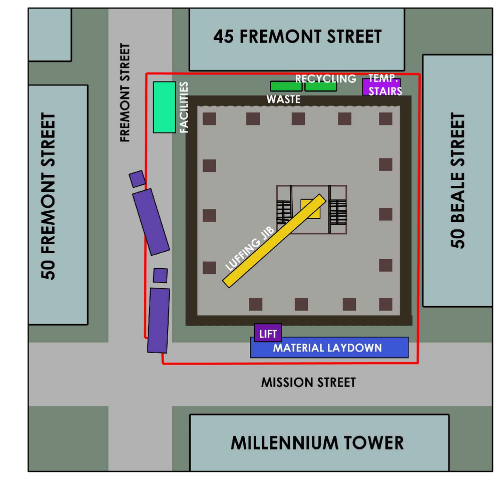


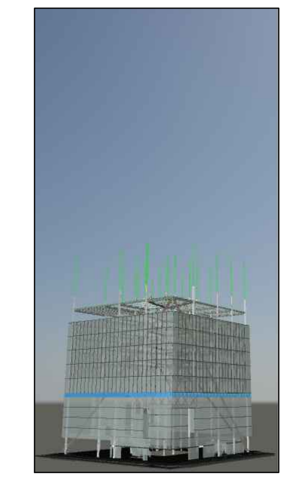


July 2013 - September 2013: Floors 1-4. The crane will be installed upon the central concrete key following mat slab curing. Once construction arrives at street level, a temporary stair will be developed at the northeastern corner of the building footprint. This temporary stair will provide access to the bottom 5 above-ground level of the building. The two centrally located staircases will rise as floor slabs are completed on each office floor. The additional staircase provides an additional means of egress along the lobby and mechanical levels.

Material deliveries will enter the site at the southwestern corner of the construction site. Enhanced temporary site office facilities will be placed at the northwestern corner of the building site and will remain for the duration of the project. Access behind the office will still remain to allow access for waste/recyclable removal.

The bottom four floors of the building will structurally be established differently than the floors above, considering the multi-story lobby space.



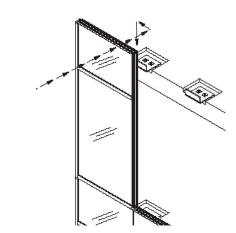


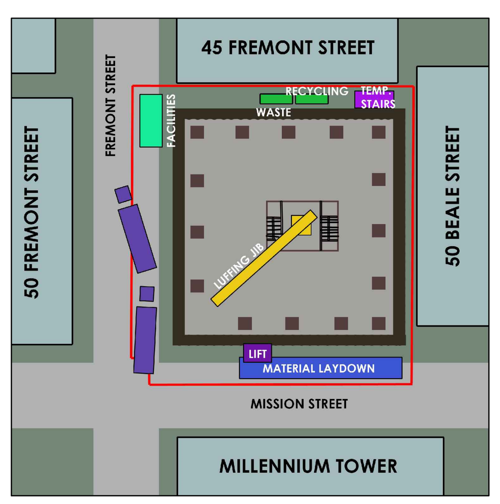
September 2013 - December 2014: Floors 5-8. The majority of the superstructure is divided into 4-floor phases. Work will be completed by repeating short interval tasks per each floor. Structural steel columns will be spliced every two floors. Beams and girders will follow, and then floor decking.

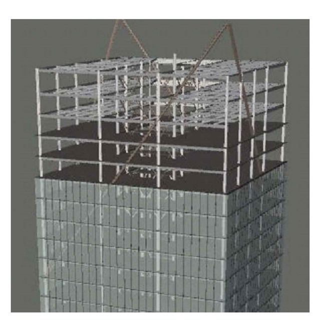
The central crane will complete primary work during this stage of construction. A lift will be installed at the southern perimeter of the building to move project personnel and materials.

The facade begin installation at ground level once vertical construction has arrived at floors 9-12. The facade will be tied into the structure via cutouts in each floor's decking system. Each connection along the floor deck will be grouted following installation of the unitized facade.

Cutouts in the floor slab will be formed by placing Styrofoam channels along the edge of each slab. This Styrofoam will be removed once the deck has set, and the metal plates which tie-in the facade will be placed. The Kawneer united wall is pictured below.

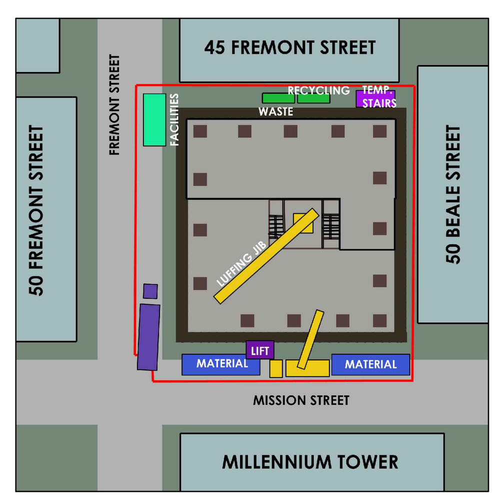






December 2013 - April 2014: Exterior Lateral Beams. Along the exterior of the building, three externally-bracing structural pieces span the height of each building face. These structural pieces can only be installed once each end of the element may be set in place.

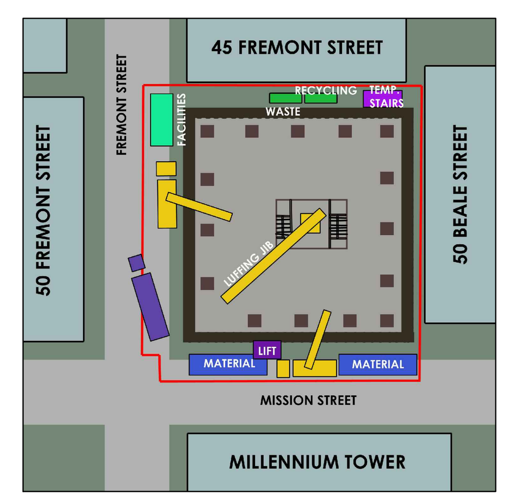
These exterior braces will be visible to the public, a key piece of our building's exterior design.



December 2013 - February 2014: Floors 13-16. Two mobile cranes will be stationed on-site once construction has progressed above the twelfth floor. The first will aid installation of the unitized building facade, while the structure progresses above.

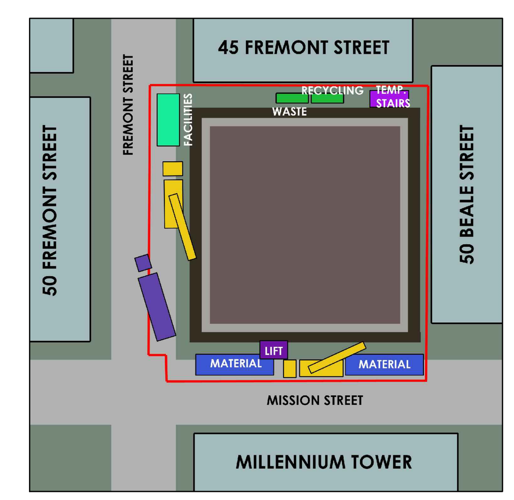
The second will not be placed until floors 21-24 begin installation. Not only will these cranes install pieces of 350 Mission, but will also be used to remove segments of of the tower crane as it is removed.

The lift will remain in place until the crane is removed and elevators have been installed. Elevators will be used to move materials for interior finishes, as available.



February 2014 - April 2014: Floors 21-24. Mechanical and electrical equipment installation has progressed above floor 12. Structural work is nearing completion as construction reaches the floor 24.

Interior installation begin on the lowest floors of the building. The tower crane will complete structural work and install rooftop mechanical equipment.



April 2014 - July 2014: Final Stages. Final building fit-out occurs during the final months of construction. The building will be fully enclosed by early may.

Trade work will continue through July. Two mobile cranes will complete segmented removal of the tower crane. Final materials will be installed via the newly installed building elevators, and lift on the exterior of the building. The lift will be removed from the building facade, and the facade will be completed via interior access.

The temporary on-site office will be removed, as will the temporary exterior staircase.

PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE

ASCE STUDENT COMPETITION

AEI 2 - 2014

DRAWING TITLE

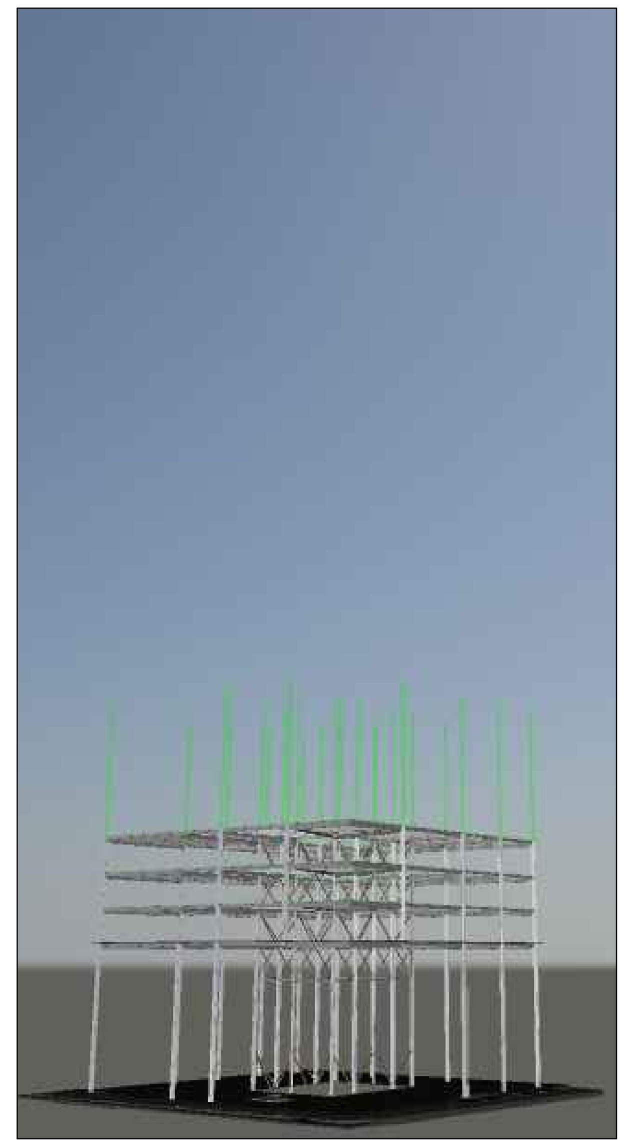
CONSTRUCTION - SEQUENCING BREAKDOWN

SCALE:	N/A
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	AEI 2 - 2014
SHEET NUMBER:	C3

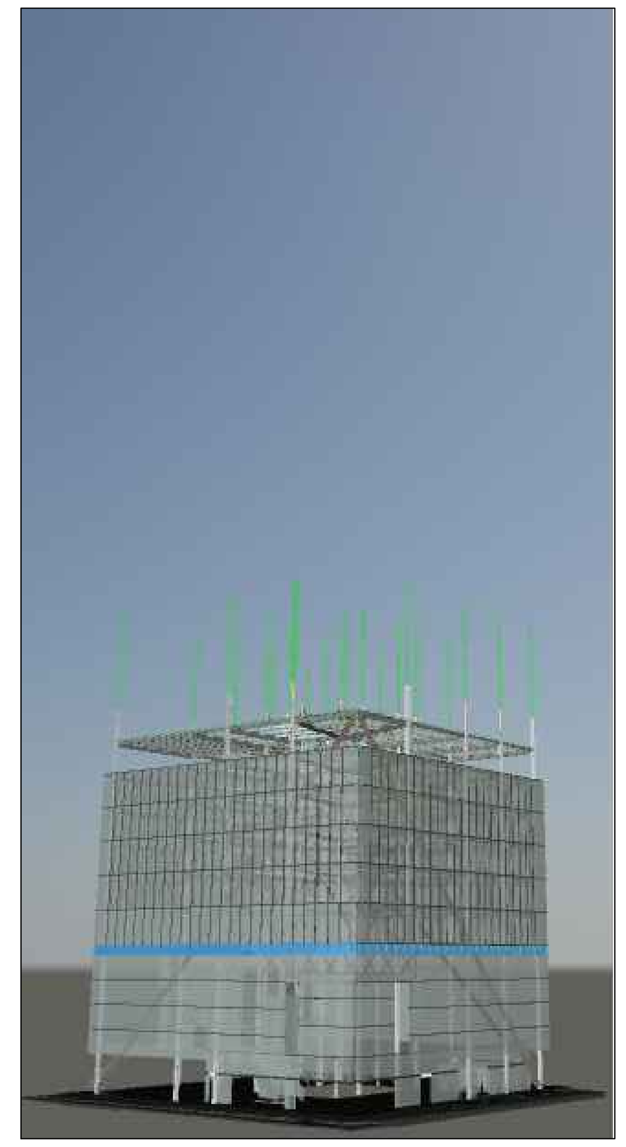
January 1, 2013 - July 16, 2013
Work on 350 Mission will begin at the start of 2013, following the demolition of the previous building on-site. The excavation shoring will commence following site setup. Excavation will take approximately 1.5 months to complete. The site will then be prepared for mat slab and foundation wall construction. Additional bracing installed to shore the excavation soil-cement walls will be removed as subgrade floors are set in place. There are a total of 4 levels below the first floor of the building. It will take approximately 1 month to set the mat slab in place and 2 months to complete the subgrade levelS.

Once construction reaches above ground levels, the construction crew will initiate our "Psuedo-SIPS" concept, where series of repeated activities will round out the building's construction. The following steps highlight progression of the building once construction has begun on the floors above ground.

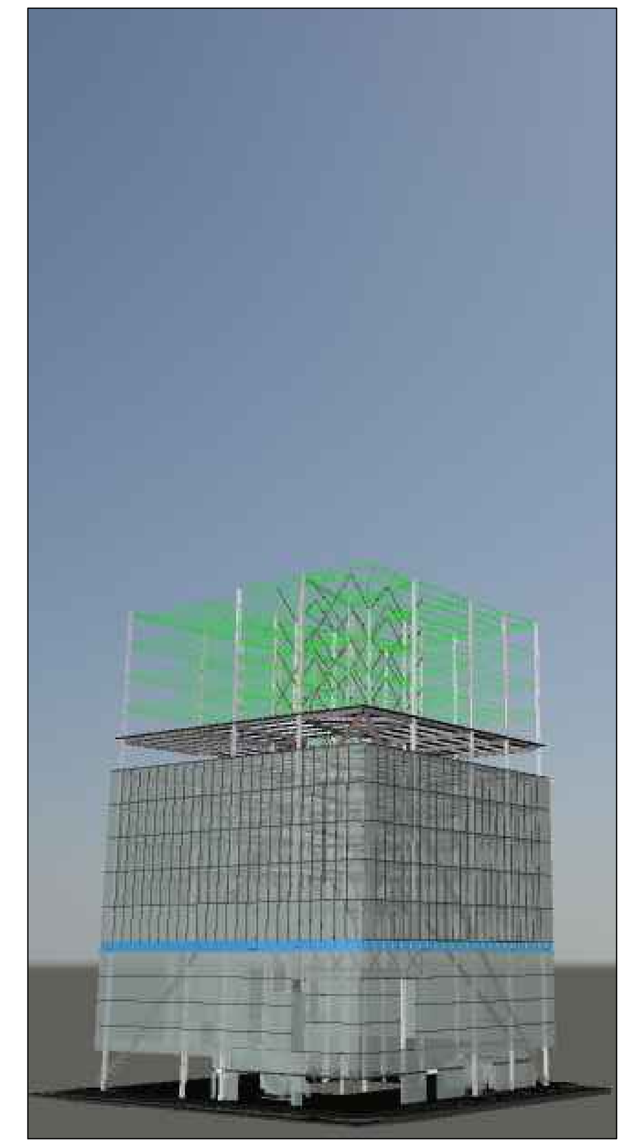
July 17, 2013: The structural steel, concentrically-braced core and exterior steel columns rise above ground level of the building. These columns will be temporarily braced as steel beams and girders are set in place. These pieces composed the lobby space of 350 Mission.



September 23, 2013: Structural steel associated with floors 5-8 are set in place. Floors 5-8 compose the first phase of repeated construction activity. As steel rises above to floors 9-12, floor decking and facade work will commence on the lower levels.



October 29, 2013: The first of the lateral braces are installed prior to facade initiation. Steel is finishing on floors 9-12. Facade work will begin on the lowest four floors and continue through floors 5-8. MEP installations will continue on the subgrade floors and on the lowest above ground floors.



December 4, 2013: The development of the core is clearly pictured above. It rises at a rate ahead of the surrounding structure, as it primarily supports building loads. Beams and girders will be installed on floors 13-16. Facade work finishes on floors 5-8, and begins on floors 9-12.

January 30, 2014: Structural work begins on floors 17-20. Facade lags slightly to prepare for installation of next level of exterior lateral beams.

February 27, 2014: Structural beams and girders are installed on floors 17-20. Preparation continues on the installation of upper lateral beams. MEP installation now occurs on floors 9-12.

April 19, 2014: Structural columns and core reaches floors 21-24. Beams and girders will be set in place in the coming months. MEP installation commences on floors 13-16.

April 30, 2014: Final series of external lateral bracing has been installed. Facade rapidly catches up to sequencing plan to complete exterior the building. Following decking installation, roof work will commence. MEP work moves into the upper levels of 350 Mission.

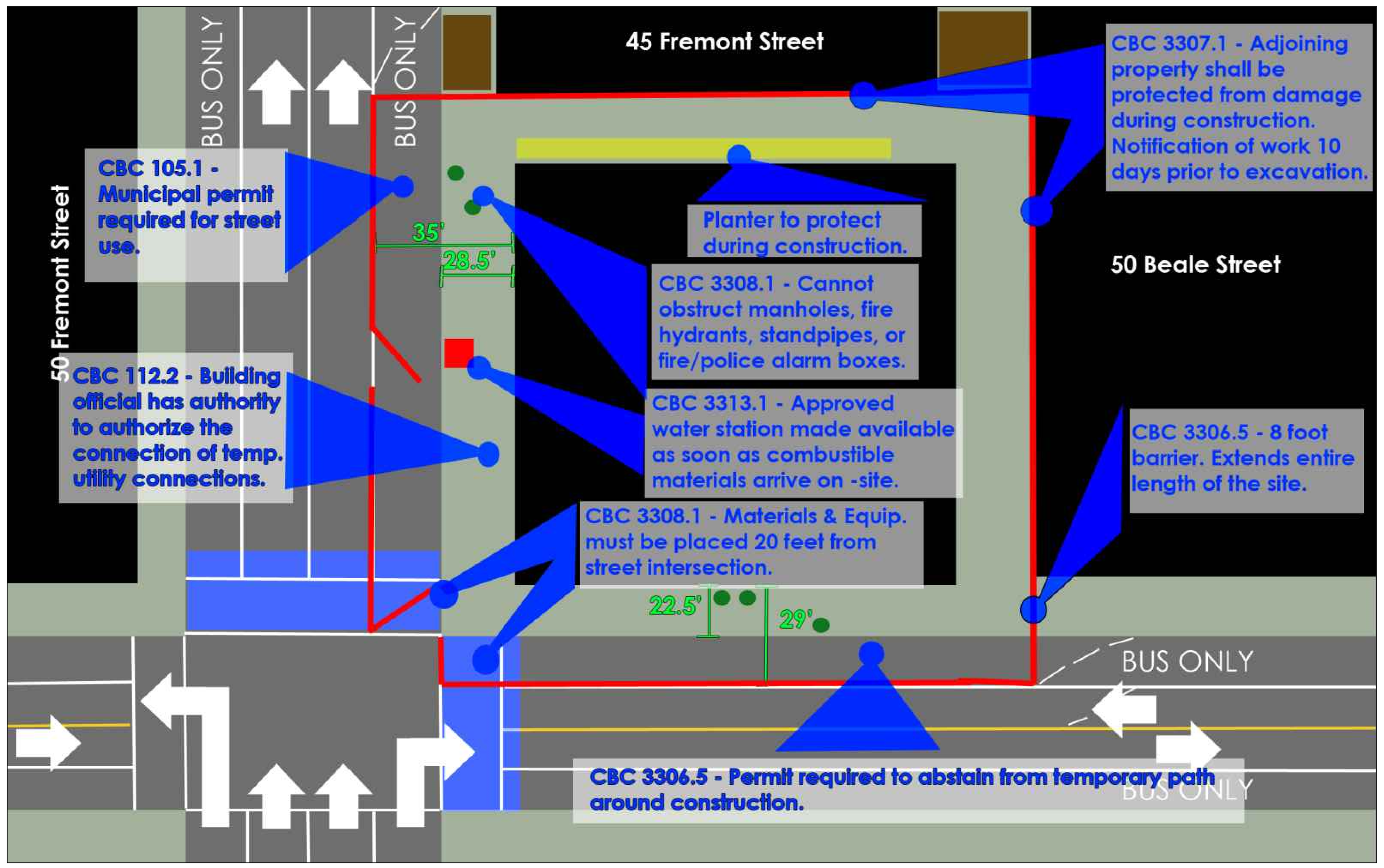
July 2014: Substantial completion. Occupation pending approval by building official. Work is complete, barring any minor interior installations.

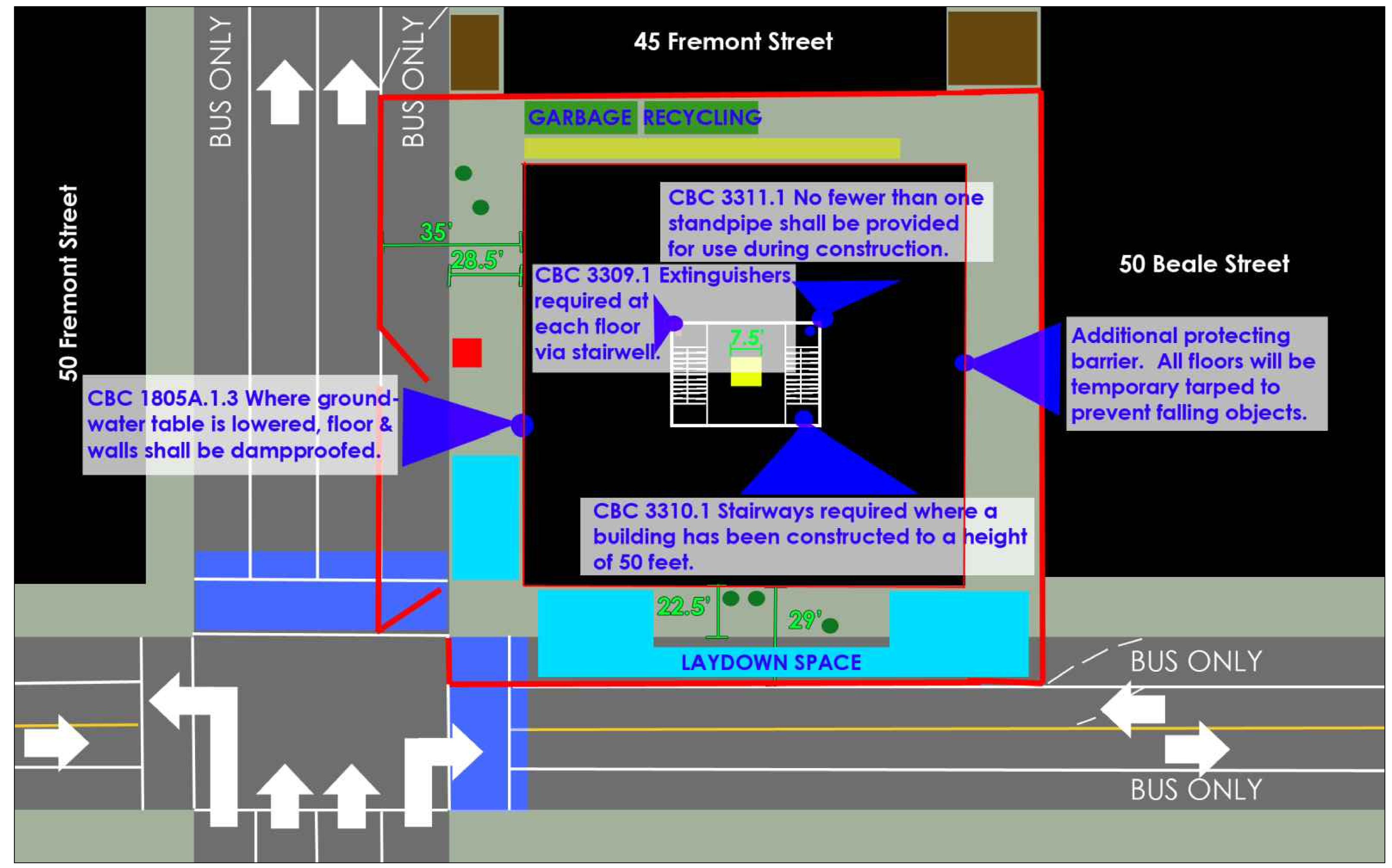
PROJECT
AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE
ASCE STUDENT COMPETITION
AEI 2 - 2014

DRAWING TITLE
CONSTRUCTION - 4D PROJECT SCHEDULING

SCALE: N/A
JOB NUMBER: 350 MISSION
DATE: 02/17/2014
DRAWN BY: AEI 2 - 2014
SHEET NUMBER:
C4





ADDITIONAL IMPACT

3306.6 Barrier design (continued). All barriers should be designed to resist loads as described in Chapter 16 of the California Building Code, OR as follows:

- Barriers shall be provided with 2-inch by 4 inch top and bottom plates
- Barrier material shall be boards not less than ¾ inch thick or wood structural panels not less than ¼ inch thick
- Wood Structural use panels shall be bonded with an adhesive identical to that for exterior wood structural use panels.
- Wood Structural use panels ¼ inch or 5/16 inch thickness shall have studs spaced not more than 2 feet on center
- Wood Structural use panels 3/8 inch or ½ inch in thickness shall have studs spaced not more than 4 feet on center provided a 2 inch by 4 inch stiffener is placed horizontally at mid-height where the stud spacing is greater than 2 feet on center.
- Wood structural use panels 5/8 inch or thicker shall not span over 8 feet

3308.1 Storage and handling of materials. The temporary use of streets or public property for the storage or handling of materials or of equipment required for construction or demolition, and the protection provided to the public shall comply with the provisions of the applicable governing authority.7

REQUIRED INSPECTIONS

- 110.3.1 Footing and foundation inspection. Footing and foundation inspections shall be made after excavations for footings are complete and any required reinforcing steel is in place. For concrete foundations, any requires forms shall be in place prior to inspection.
- 110.3.2 Concrete slab and under floor inspection. Concrete slab and under-floor inspections shall be made after in slab or under-floor sheathing installed, including the subfloor.
- 110.3.3 Lowest floor elevation (flood hazards)
- 110.3.4 Frame inspection. Framing inspections shall be made after the roof deck or sheathing, all framing, fire blocking, and bracing are in place and pipes, chimneys, and vents to be concealed are complete and the rough electrical, plumbing, heating wires, pipes, and ducts are approved.
- 110.3.5 Lath and gypsum board inspection
- 110.3.6 Fire and smoke resistant penetrations
- 110.3.7 Energy efficiency inspections

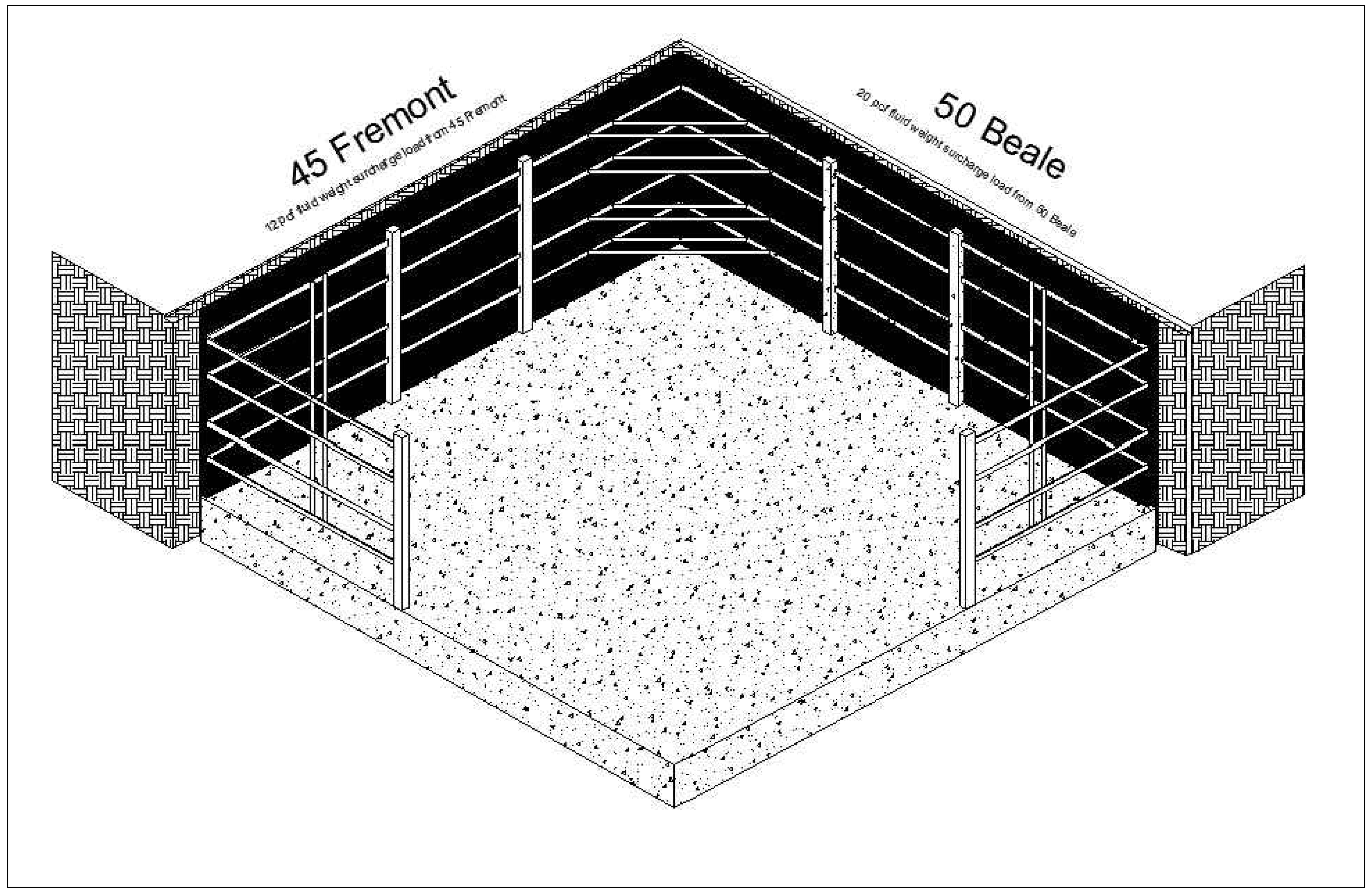
PROJECT
AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

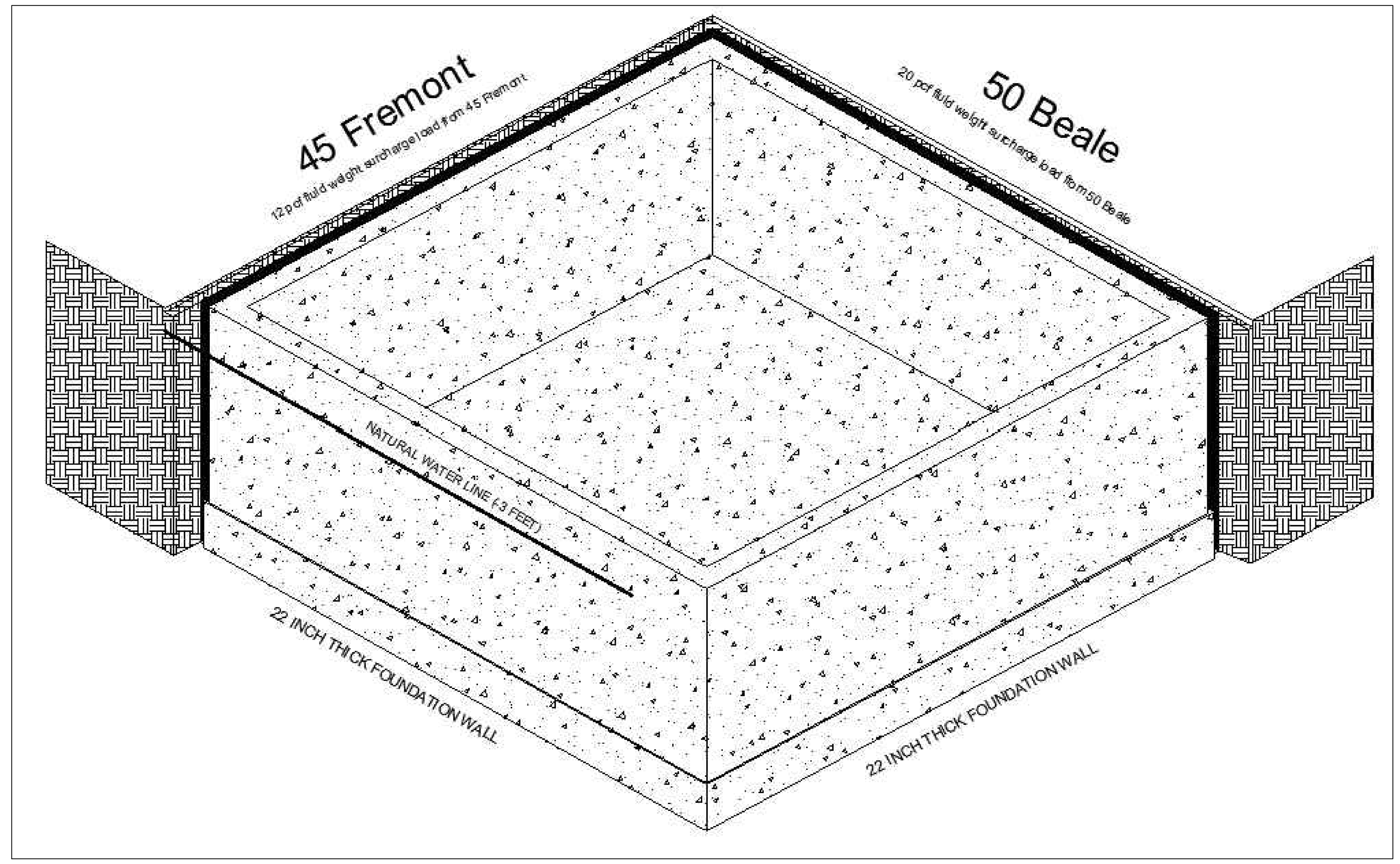
PURPOSE
ASCE STUDENT COMPETITION
AEI 2 - 2014

DRAWING TITLE
CONSTRUCTION - CALIFORNIA BUILDING CODE IMPACT

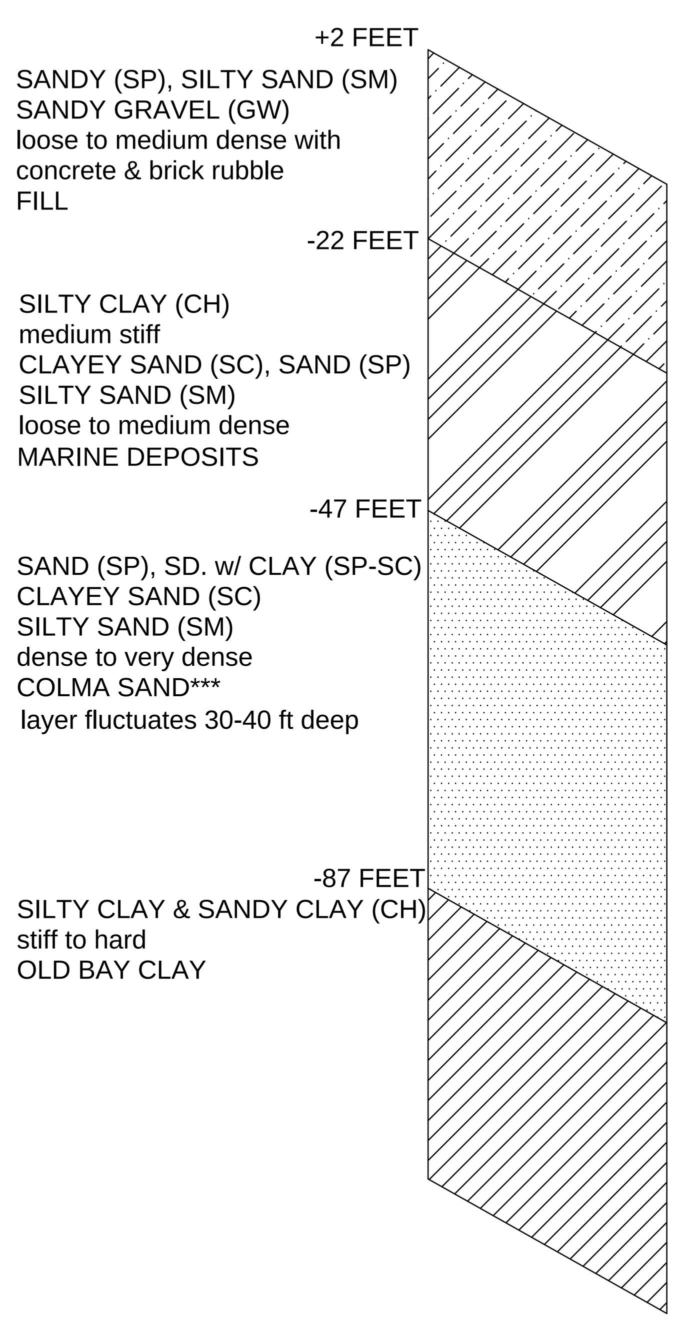
SCALE: N/A
JOB NUMBER: 350 MISSION
DATE: 02/17/2014
DRAWN BY: AEI 2 - 2014
SHEET NUMBER:
C5

EXCAVATION & FOUNDATION DEVELOPMENT





IDEALIZED LAYERS



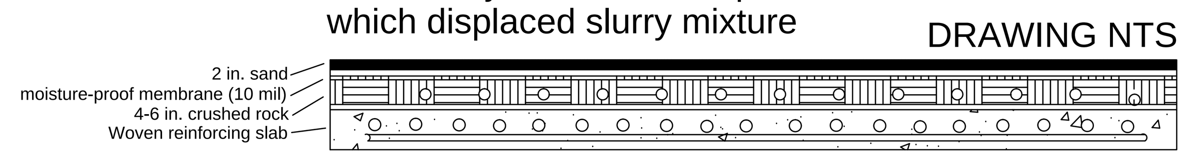
ABOVE: Mock-ups of shoring system installation & foundation wall system.

LEFT: Idealized soil layers; based on information provided in the Treadwell & Rollo soils report.

RIGHT: Further detail about site conditions which was considered in the excavation, foundation, and construction preparation.

MAT SLAB PREP / BASE MAT:
-over-excavate as necessary
-T&R recommend slab base w/ woven reinforcing fabric
-crushed rock may be used to drain w/ PVC every 30 feet to sump which displaced slurry mixture

DRAWING NTS



WATERPROOFING BASE MAT:
-back-up moisture barrier to be included between structural mat & topping slab
-free draining rock covered by moisture-proof membrane
-membrane covered with 2 in. sand protects membrane during construction aid in curing the concrete floor slab
-perforated pipes every 30 feet in rock layer to drain

MAT FOUNDATION:
-if soft foundations, sand overexcavated to bearing mat'l & replaced w/ lean concrete
-Colma sand layer required to support base pressure
-Sand effective shear modulus, G= 5.05 x 10^5 psf
-Poisson's ration, v=0.3
-Stiffness increase & decrease of 20 %
** Factor of safety of 1.5 included in T&R data

BASEMENT WALLS:
-all basement walls should be waterproofed
-must withstand adjacent lateral loads
-surcharge from traffic & pile of adjacent struct. incl.
-waterstops should be placed at all construction joints
-wall backfill should be compacted to at least 90 percent relative compaction using light compaction equipment

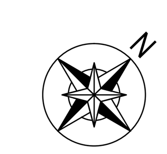
UTILITIES & TRENCHES:
-connections must accommodate differential movement
-trenches excavated min. 4 in. below bottom of pipe/ conduit & have clearances of 4 in. on both sides
-placed away from any removable shoring to avoid displacement
-should be bedded in sand or fine gravel & covered w/ 6 in.
-Utility backfill complies w/ Section 703 San Fran Standard Specs

CONSTRUCTION MONITORING:
-slope indicators (inclinometers) - installed behind each exterior wall remaining two embedded in shoring walls along north & east side
-piezometers- each shoring wall- should have two casings one to measure groundwater level in the fill & marine deposits two in the colma sand
-survey points - installed on adjacent buildings & streets (w/i 50 ft)
-monitor conditions of existing buildings consistently
-monitor conditions of shoring consistently

CONCRETE DIAPHRAM WALLS
-walls constructed in panels
-poured prior to excavation
-excavated, reinforcing placed
-concrete pumped in via tremie pipe which displaced slurry mixture
-diaphram walls used as temp. shoring
-expect 1/2 inch of shoring settlement
-passive pressure below bottom of exc. equivalent fluid wt of 400 pcf & 200 pcf* above/below water level respect.

DEWATERING:
-must not affect adjacent sites - must monitor
-workpad may also be used as temp drainage system
-shoring should limit necessary dewatering
-permit required to run through municipal storm water drain; fee associated
-excessive dewatering could cause harmful site settlement & may change effective stress

UTILITIES:
- must prepare for 4 in. differential settlement
-flexible connections should be used



PROJECT
AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE
ASCE STUDENT COMPETITION
AEI 2 - 2014

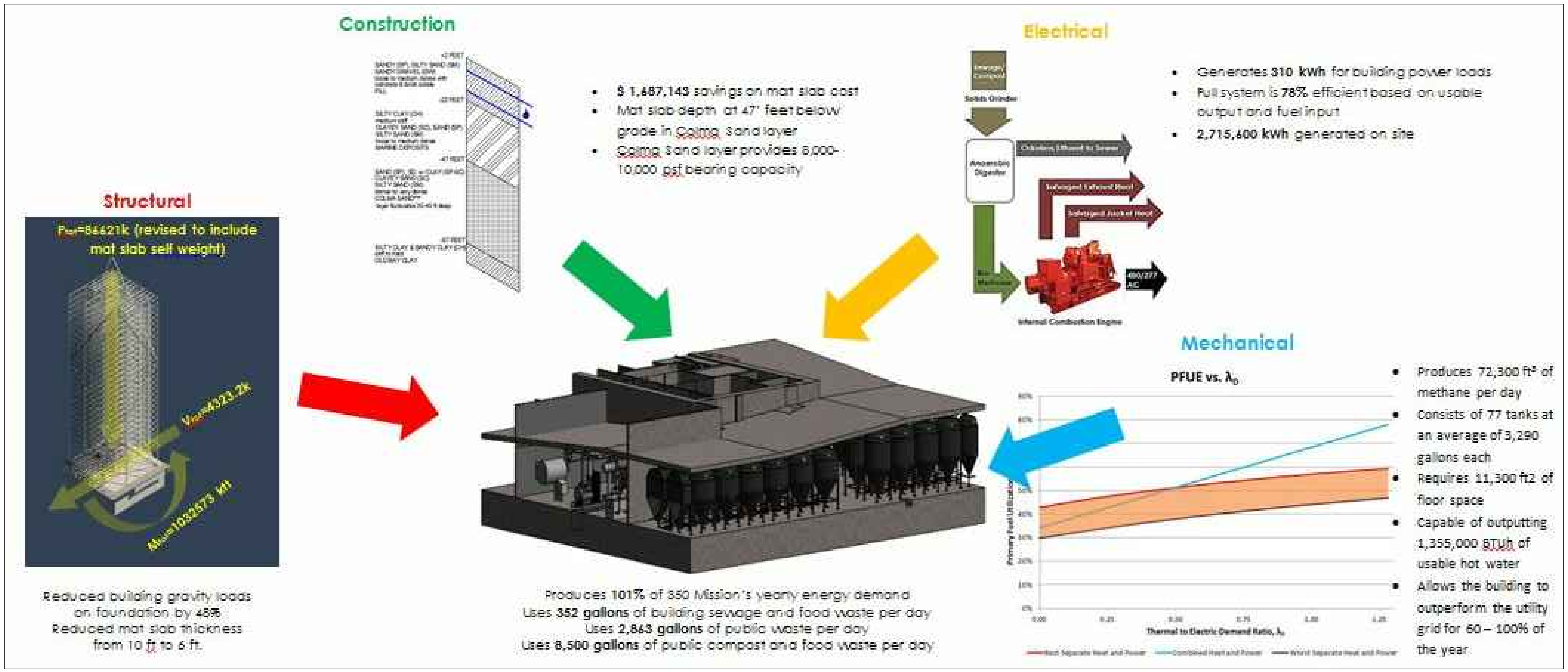
DRAWING TITLE
CONSTRUCTION - FOUNDATION DEVELOPMENT

SCALE:	N/A
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	AEI 2 - 2014
SHEET NUMBER:	C6

BASEMENT COORDINATION

Discipline	Goal
Mechanical	Place methane digesting system on lowest sub-grade level
Structural	Reduce loads on bearing soil and decrease mat slab thickness
Electrical	Implement turbine into methane digester for power generation
Construction	Decrease excavation requirements and expedite sub-grade schedule considerations

The main inter-disciplinary issue was the mechanical and electrical designers needed a larger floor-to-ceiling height in order to fit the methane digester system in Level B4. The structural team worked to reduce the weight of the superstructure and in turn minimize the mat slab thickness. The construction team analyzed this action to assure the building continued to rest firmly in the desired Colma sand layer described on the geotechnical report. In the end the structural and construction teams were able to justify a mat slab depth reduction of 4 feet and the mechanical and electrical teams were able to place their power generation equipment in the desired location. Please see the disciplinary reports for detailed descriptions of all analysis and design.



PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE

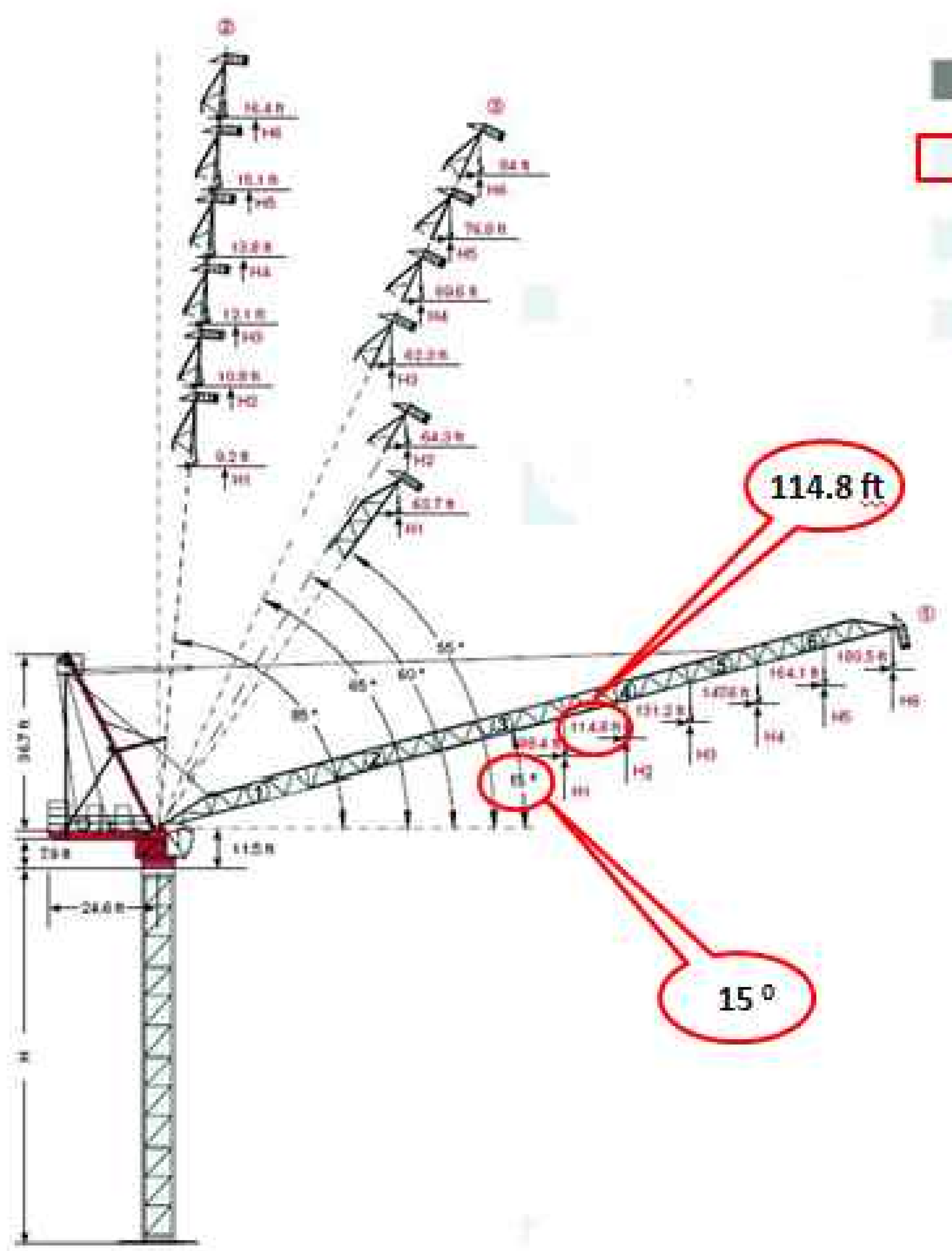
ASCE STUDENT COMPETITION
AEI 2 - 2014

DRAWING TITLE

CONSTRUCTION-BASEMENT COORDINATION

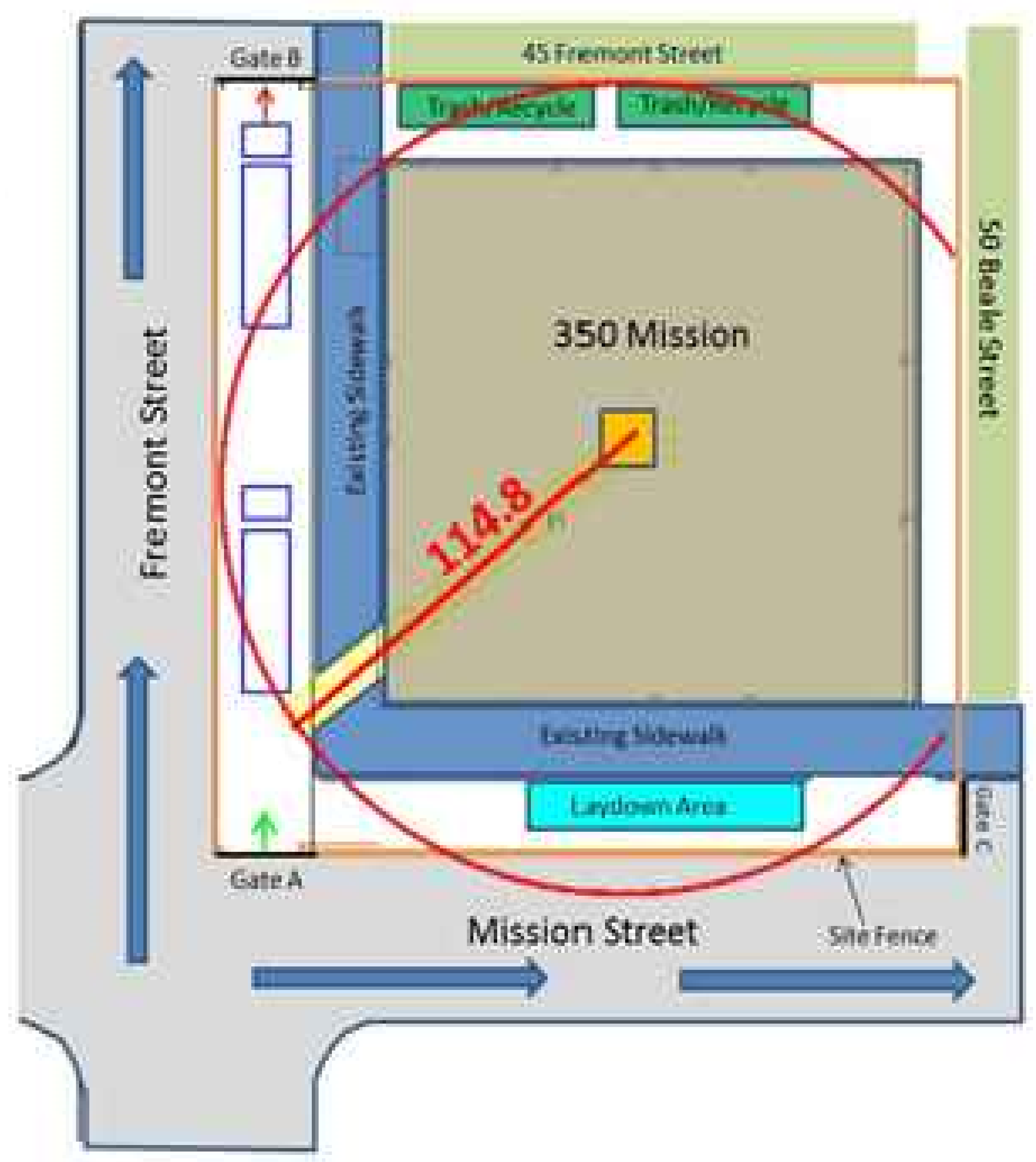
SCALE:	N/A
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	AEI 2 - 2014
SHEET NUMBER:	C7

TEREX CTL 180-16 H20 LUFFING JIB TOWER CRANE



45 AFC 80
67 AFC 80

(jib) →	A (11,023 lbs)	B (11,023 lbs)	C (4,409 lbs)
98.4 ft	1	3	0
114.8 ft	1	3	0
131.2 ft	1	3	0
147.6 ft	1	3	0
164.1 ft	1	3	0
180.5 ft	1	3	1



(jib) →	C	H
98.4 ft	32.8 ft	110.7 ft
	39.4 ft	147.6 ft
	45.9 ft	159.9 ft
114.8 ft	32.8 ft	98.4 ft
	39.4 ft	135.3 ft
	45.9 ft	147.6 ft
131.2 ft	32.8 ft	98.4 ft
	39.4 ft	135.3 ft
	45.9 ft	147.6 ft
147.6 ft	32.8 ft	98.4 ft
	39.4 ft	123 ft
	45.9 ft	135.3 ft
164.1 ft	32.8 ft	98.4 ft
	39.4 ft	123 ft
	45.9 ft	135.3 ft
180.5 ft	32.8 ft	86.1 ft
	39.4 ft	110.7 ft
	45.9 ft	123 ft

			49.2 ft	65.6 ft	82 ft	98.4 ft	114.8 ft
17,637 lbs →	83.7 ft	lbs	17,637	17,637	17,637	13,955	10,957
17,637 lbs →	93.8 ft	lbs	17,637	17,637	17,637	16,446	13,007
26,455 lbs →	67.3 ft	lbs	26,455	26,455	20,260	15,565	12,214
17,637 lbs →	97.4 ft	lbs	17,637	17,637	17,637	17,417	13,911
26,455 lbs →	69.6 ft	lbs	26,455	26,455	21,385	16,601	13,162
17,637 lbs →	96.1 ft	lbs	17,637	17,637	17,637	17,086	13,625
26,455 lbs →	72.2 ft	lbs	26,455	26,455	22,465	17,571	14,065
35,274 lbs →	56.1 ft	lbs	35,274	29,233	21,958	17,086	13,625
17,637 lbs →	97.8 ft	lbs	17,637	17,637	17,637	17,527	14,110
26,455 lbs →	72.8 ft	lbs	26,455	26,455	22,796	17,990	14,551
35,274 lbs →	56.4 ft	lbs	35,274	29,476	22,311	17,527	14,110
17,637 lbs →	98.4 ft	lbs	17,637	17,637	17,637	17,637	
26,455 lbs →	75.1 ft	lbs	26,455	26,455	23,832	18,960	
35,274 lbs →	58.1 ft	lbs	35,274	30,668	23,369	18,519	

Crane Specifications

- Maxiumum Jib Length: 180.5 ft
- Capacity @ Max Length: 4,409 lbs
- Crane Maxiumum Capacity: 35,274 lbs
- Actual Jib Length: 114.8 ft
- Initial Crane Height: 449'
- Final Crane Height: 449'
- Jib Angle: 15 º
- Heaviest lift: W14X730 @ 27' = 19,710 lbs (assisted by mobile crane)

Construction and Deconstruction Plan

- Located within the center of the core, an internal climbing method will be utilized in order for the crane to reach heights required to construct 350 Mission.
- A hydraulic cylinder at the crane's base will elevate extra crane stem pieces through its hollow core, to a higher floor.
- Every 100 ft the crane constructs, it will be raised 98.4 ft to accommodate for unconstructed floors below. This raise will occur 4 times to eventually reach a final crane height of around 450 ft.
- For deconstruction purposes, a small crane will be constructed on the roof of the building, taking apart the tower crane piece by piece. This smaller crane will then be deconstructed by an onsite mobile crane.

PROJECT
AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE
ASCE STUDENT COMPETITION
AEI 2 - 2014

DRAWING TITLE
CONSTRUCTION - CRANE BREAKDOWN

SCALE: N/A
JOB NUMBER: 350 MISSION
DATE: 02/17/2014
DRAWN BY: AEI 2 - 2014
SHEET NUMBER:
C8