Integration

Submitted: Integration Structural Mechanical Electrical Construction

350 Mission St.

ASCE Charles Pankow Foundation Architectural Engineering Student Competition

AEI Team 2-2014

Contents

Narrative

ii	Executive Summary
1	1-Project Introduction
1	**2-350 Mission Site Analysis**
1	**3-350 Mission Reimagined**
3	**4-Team Goals and Core Principles**
5	**5-The Integration Process**
7	**6-BIM Process Design**
7	**7-Collaboration Procedures**
8	**8-Team Principle Resolution**
15	**Conclusion**

Integration Highlights

A summary of 9 key building components, which drove the design and innovative thinking behind 350 Mission.

Principles such as Performance, Endurance, and Connectivity allowed AEI Team 2 to not only generate, but exceed team and project goals.

Through integration metrics and Building Information Modeling, a collaborative team effort evolved into a sustainable and near-net zero building product.

Keeping team principles a constant importance throughout the project, allowed for innovative brainstorming and design excellence.

Appendices

A	Lessons Learned
B	Integration Metric Summary
C	BIM Execution Plan
D	Site Context
E	A Visit to Brubaker Farms
F	Basement Redesign
G	Combined Heat and Power Generation
H	Facade
I	Building Energy Use
J	Bud get
K	Construction Phasing
L	Construction Benefits from Building Systems
M	LEED
N	Life Cycle Analysis
O	Environmental Analysis
P	Building Education
Q	References

Drawings

I1	**Site Analysis**
I2	**Building Overview**
I3	**Software Flow**
I4	**Basement B4 Plan**
I5	**Typical lobby Floor**
I6	**Typical Office Floor**
I7	**Coordination View**
I8	**Construction Sequencing**
I9	**350 Mission Renderings**

Executive Summary. Tasked with the comprehensive design of 350 Mission Street, a new high performance, high-rise office building in San Francisco, AEI Team 2 re-imagined the design and construction plan. Per the guidelines of the project, the team considered the following topics during the design process:

1. **Design Process, Integration and Collaboration** – An integrated, iterative, and holistic approach to the design of 350 Mission was used to create the structure, building services design, and construction plan. The team **implemented a custom plan of Version 2.0 of the CIC BIM Project Execution Planning Guide** (BIM Execution, 2014). In order to develop software interaction schemes, decision-making processes, and design or construction workflows. To aide in the design of 350 Mission, a **holistic, project-wide metric**, discussed in Section 5, was developed in order to emphasize the interactivity of building systems. Using this metric, decisions were able to be executed on a project-wide level.

2. **Sustainability and Energy Efficiency** – The project focuses on integrating environmentally-friendly principles with both the building and community. AEI Team 2 also illustrated the lifecycle economic benefits of applying sustainable and energy efficient technologies. Shown in Table 1, the following measurable metrics contributed to the team's overall decision-making metric:

Table 1: Sustainability and energy efficiency conclusions

Baseline Energy Reduction	100%
Baseline Water Reduction	84%
Baseline Waste Reduction	95%
Baseline Emissions Reduction	99%

3. **Building Reoccupation** – Because San Francisco resides within a seismically-active region, resilience was a major point of consideration for 350 Mission. Decisions were made with a goal of minimizing building downtime, following a major seismic event. These decisions would not only take into consideration life-safety, but also ensure that the building was both economically-efficient and resource-efficient throughout the building lifecycle. For safe structural resistance against lateral forces, the building was strategically designed to a **28% drift reduction beyond the competition guidelines**.

4. **Building Budget** – The budget for 350 Mission is included with the submission. This budget details both construction and life-cycle costs for the building. In order to demonstrate that the innovative systems designed for 350 Mission are able to be codified and actualized, the design team considered the short-term and long-term economics of their proposed designs. The following project delivery metrics explained in section 5 contributed to the overall project success metric:

Table 2: Building budget and schedule conclusions

Building Budget	$131,213,180.87
Building Schedule	19 months

Sandwiched between four taller office buildings, and across the street from the Millennium Tower, and the eventual Transbay Tower, 350 Mission strives to create an identity for itself. The team achieved this by promoting sustainable practices through community connectivity.

Goal Orientation. In order to actualize the project requirement of utilizing integrated and collaborative workflows to deliver a comprehensive building design, achieve sustainability and energy efficiency, enable immediate reoccupation, and deliver an economically-efficient project budget, the team derived three core principles: **Performance**, **Endurance**, and **Connectivity**, illustrated in Figure 1. These principles were guided by the desire of the Pankow Foundation to *leverage advanced design tools and integrated teams to create innovative building systems which can be codified*. The principles guided each area of design as follows: **Performance** guided the sustainability and energy-efficiency of 350 Mission, **Endurance** guided the resilient design of 350 Mission, and **Connectivity** guided the ability of 350 Mission to engage the urban environment in which it resides. These principles were centered on an integrated and collaborative project nucleus which enabled an economically efficient product to be codified and integrated within San Francisco's urban ecology.

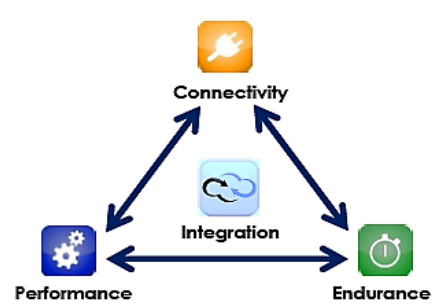


Figure 1: Three core principles revolve around integration

1. Project Introduction

The AEI Charles Pankow Student Design Competition proposed the challenge of designing a 30-story high-rise building in Downtown San Francisco which addressed the desire to focus on three main areas:

1. Embrace construction, design, and life cycle cost concepts pertaining to a Near-Net Zero building (high levels of sustainability and durability are desired).
2. Utilize the existing building design and code requirements as a baseline, and make analytical comparisons with this baseline and alternative options.
3. Consider solutions which enable resilience after a design-level seismic event, reducing structural drift to one half of the code-allowed value.

AEI Team 2 prepared this Integration Submission which addresses the team's collaborative, multidisciplinary approach to the design of 350 Mission. The project submittal includes an elaboration on concept development, design processes and methodologies, and major integrative aspects of developing an exemplary design solution. Figure 2 below shows the context of 350 Mission's site within the urban environment of San Francisco.

2. 350 Mission Site Analysis

Located at the corners of Fremont and Mission Street, 350 Mission will tower 30 stories above street level. The building is comprised of 25 floors of office space; however the project features a double-story lobby, which serves as both the entrance for the building and as a landmark, interactive public space.

350 Mission is located in an area which is considerably populated by residential and business traffic. It is sandwiched between office buildings: 45 Fremont, 50 Fremont, and 50 Beale. Furthermore, the Millennium Tower—primarily comprised of residential, culinary and recreation properties—is located across Mission Street from the site. Beyond, the Transbay Tower will be located one block south of 350 Mission. The Transbay Tower will be the tallest building in the city upon completion and will feature additional office space.

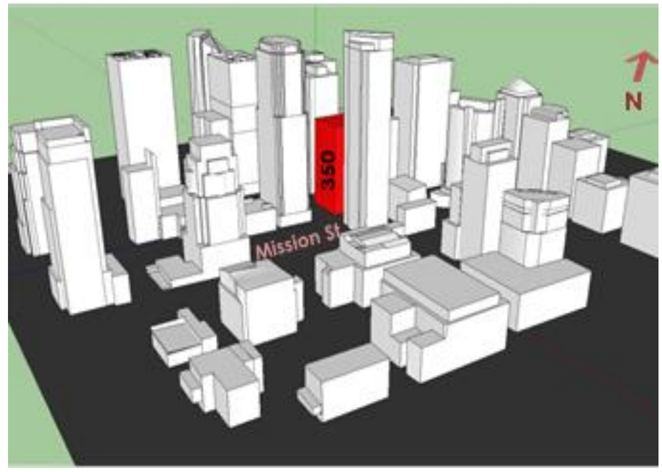


Figure 2: A 350 Mission site analysis

The site is also particularly condensed. 50 Fremont sits less than 20 feet from the property line to the north and 45 Beale is located approximately 15 feet from the eastern edge of the property line. Municipal permits will be required to extend the construction site to the south and west of the property. Based off of San Francisco's Department of Public Works, a Street Space Occupancy Permit must be acquired in order to utilize bus lanes along Mission Street and Fremont Street during the construction process, to extend construction staging boundaries. Surrounding properties will need to be protected from construction activites on the groundand above using fencing and overhead protective walkways, as construction progresses.

It should also be noted that the building is shaded for a majority of the year, given that it is entrenched among many taller buildings. This siting also limits the occurrence of frequent, high-speed winds, illustrated in Drawing Sheet I1. Utility service entrances are located along Mission St. and Front St. and the municipal combined sewer runs along Mission Street towards the Embarcadero, as shown in Figure 2 above.

3. 350 Mission Reimagined

In Figure 3, the building is broken down by major building features. Overall, the design is defined by these major features:

A. **Building Enclosure:** The building features a high-performance, spectrally-selective and seismically resilient facade. Design of the unitized façade was the product of group-wide collaboration and resulted in a conclusion which allowed for significant phasing benefits during construction. In addition to having tremendous constructability benefits. An iterative modeling process allowed the selection of glazing which allows natural light to penetrate the building's office spaces while optimizing solar heat gain (See Appendix H). The high performance curtain wall is seamlessly integrated into the structural design, which was selected through a movement and tolerances study along with precedent research (See Structural Report).

B. **Office Layout:** The office floorplan, as detailed later in this report, was designed as a solution to best utilize the architectural space and provide an environment conducive to business on the floor. Open views will be provided to tenants from within this open floor layout. For more detail, refer to renderings on Drawing I9 and the Office plan overview on Drawing I6.

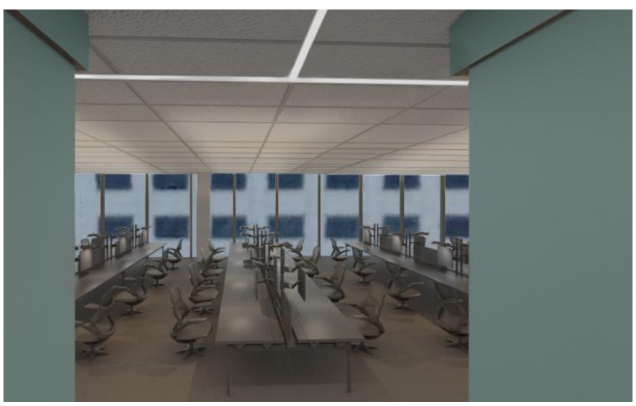


Figure 3: Rendering of Open office

C. **Lobby Design:** The grand lobby was designed as a public space, which will be used, not only as an entrance for building tenants, but also as an education beacon in sustainability (refer to renderings on Drawing I9 and the Lobby plan overview on Drawing I5)

D. **Foundations:** The challenging task of designing a high-rise office building in an area prone to seismic events and poor soil conditions was an area of intense group collaboration, shown in the Construction Report, Drawing C6. The mat slab and integrated structural steel program were designed to withstand significant seismic events with minimal building damage. The design was created in conjunction with the need for additional space in the fourth-level sub-basement for energy creation and water treatment equipment.

Due to site space constraints, the team utilized soil-cement walls as the primary shoring system during excavation. Additional temporary diagonal bracing was fitted surrounding the perimeter of the site during excavation until foundation walls and subgrade floors were established. An illustration of the additional reinforcement may be found in the Construction Report.

E. **External Lateral Structural Systems:** In a combined effort to create a unique architectural identity for 350 Mission, while ensuring seismic resilience, the design of 350 Mission will use exterior diagonal bracing in order to mobilize the exterior of the building for seismic loading. The braces break the height of the building into three 10-story modules and are located on all four sides of the structure. This system interacts with the core structure and floor diaphragms to funnel lateral loads into the foundation. (See Structural Report for details).

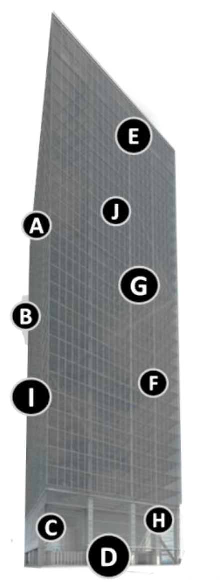


Figure 4: A representation of key building components

A – Building Enclosure
B – Office Layout
C – Lobby Design
D – Foundations
E – External Lateral Structural Systems
F – Gravity Structural System
G – MEP Building Systems,
H – Methane Digester
I - Daylighting

F. **Gravity Structural System:** 350 Mission utilizes a composite slab on metal deck gravity system to handle the loads of an office layout. An efficient, unobtrusive design was achieved to assist in reducing seismic loading and provide a safe, comfortable space for the user. MEP system coordination was heavily considered and an optimum design was achieved to foster the complex interaction of all systems.

G. **MEP Building Systems:** The building's mechanical systems are comprised of radiant cooling panels in the office floors and a thermally-active heating/cooling slab in the lobby. Heating loads are handled by cogeneration waste heat and a supplemental boiler. Dehumidification is provided by an absorption chiller and space cooling chilled water is provided by plate-and-frame heat exchanger-coupled cooling towers.

   A Bus Duct runs up the building core distributing power. LED luminaires illuminate building interiors. In the open office, desk mounted *Tambient* fixtures, provide task and ambient light. Lighting control schemes that involve daylight dimming and vacancy sensing help reduce peak demand loads.

H. **Methane Digester:** One of the flagship features of the building is the thermophilic anaerobic digester. This building system, fueled by food waste and sewage, will provide 350 Mission with electricity and thermal energy. Educational tools explaining this system will be available to lobby occupants and passersby; Appendix P explains this educational aspect. The building will also be connected to grid, allowing electricity to be given to and taken from the electrical grid over the course of the day (See Appendix I)

I. **Daylighting:** Office workstations contain luminaires that dim with daylighting. Photosensors will signal dimming and control automated roller shades that will shield office workers from excess daylight (Refer to the electrical report for more detail regarding shading).

J. **Core:** The building's core will utilize a concentrically braced framing system. Pieces of this system were designated to be prefabricated, with the help of local San Francisco steel manufacturers, to aid in phasing of building construction. The pace of construction was increased due to design decisions made to the core (Refer to Appendix I in the Construction Report). Construction of the core is expected to be reduced from 19 weeks to 15 weeks, as illustrated in Appendix I of the Construction Report. The core was integrated into the team's "Psuedo-SIPS" sequenced schedule. In "SIPS," or short interval production scheduling, a series of repetitive activities are executed to complete construction.

4. Team Goals and Principles

Team Mission Statement

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

Figure 5: The three core principles that drove the design and integration of 350 Mission

The team's design for 350 Mission set out to create a holistic building system which fully embraced the goals of the ASCE/AEI Charles Pankow Foundation Competition:

"To improve the quality, efficiency and value of large buildings by advancing innovations in structural components and systems that can be codified"

"To improve the performance of building design and construction teams by advancing integration, collaboration, communication, and efficiency through innovative new tools and technologies, and by advancing new means and methods for project team practices"

In order to effectively *leverage advanced design tools and integrated teams to create innovative building systems which can be codified*, the team developed a set of holistic project goals, guided by three core values: **Performance, Endurance,** and **Connectivity**. These guiding principles are elaborated upon alongside their affiliated project goals below:

4.1 Performance

Life Cycle Processes in Action. In Performance, the team focused on achieving high-performance throughout the building's lifecycle, from design to disassembly:

- ***Conception—****high-performance design methods:* Team members of differing disciplinary backgrounds utilized cutting-edge technology to collaborate and produce innovative building systems.
- ***Creation****—high-performance material design and construction:* Team members sought to create designs, which would minimize materials, construction waste and expedite construction time in order to minimize the waste and embodied energy inherent in creating a building.
- ***Operation****—high-performance occupancy:* The team designed mechanical and electrical systems which utilize features meant to minimize primary energy consumption. These systems drive our Net-zero design. Furthermore, team members collaborated on the design of a building enclosure which minimizes energy demands on thermal and electrical equipment. The team managed to achieve a LEED Platinum Certification for 350 Mission.
- ***Disassembly****—creating a performance material removal system:* The team desired that building systems were easy to remove, maintain and recycle. Just as systems were designed to be easy to install and construct, their disassembly was deemed to be just as important for material re-use and re-servicing purposes. A Waste Management Plan can be accessed in Appendix D in the Construction Report.

In order to achieve high levels of performance throughout the building's life-cycle, the team defined several goals listed below:

Near-net Zero Goal

Table 3: Goals for Achieving Net-Zero

Energy	Achieving *Near-net Zero Energy* will be defined as achieving an Energy Use Intensity (EUI) of *near zero* for a typical meteorological year
Water	Achieving *Near-net Zero Water* will be defined as consuming zero municipal water for non-potable end-uses.
Waste	Achieving *Near-net Zero Waste* will be defined as sending less than 10% of operational byproducts to landfills.
Emissions	Achieving *Near-net Zero Emissions* will be defined as offsetting all but 10% o emitted CO_2 equivalent.

4.2 Endurance

Physical Resilience over Time. The team's design for 350 Mission is planned to withstand the tests of time. Significant measures were executed to ensure the structure of the building will combat the effects of a seismic event. The building is designed to enable its occupants to reoccupy the office spaces as soon as possible following an earthquake. Furthermore, team members utilized building systems and features which were durable and adaptable in composure, low in carbon content, and critical to enabling the long life span of the building.

- ***Near Immediate Occupancy***—Structural design ensured that building occupants would be able to re-inhabit the building shortly after a seismic event. For this to occur, considerable enhancements to the structural system were implemented, and MEP systems were designed to avoid seismic impact. A movements and tolerances study was performed on the façade to ensure that it would be fully intact after a design-level earthquake (Refer to structural report appendices for more detail).
- ***Reliable Operation***—Quality control in building construction is critical to ensuring a lasting,

functional building. Team members sought to recognize potential for error in building construction, and prevent system fallacies.

- ***Enhanced Life Safety***—Keeping the occupants of the building safe and aware of potential hazards in the building was critical to creating a design which could fully serve its users over a long period of time.
- ***Reduced Drift during a Seismic Event***—Structural team members strove to reduce the size and weight of the core, sending loads to the exterior of the building. By taking this action, seismic drift was drastically reduced.
- ***Indoor Air Quality***—Maintaining high levels of indoor air quality not only ensures the resilience of office workers over time, but prevents material degradation due to air moisture content and particulate deposition.

4.3 Connectivity

Real-Time User Interaction. It was important to connect the design of the building with the building occupants and the surrounding community. The team approached this "connection" with people through thorough architectural and environmental enhancement, as well as education in sustainability.

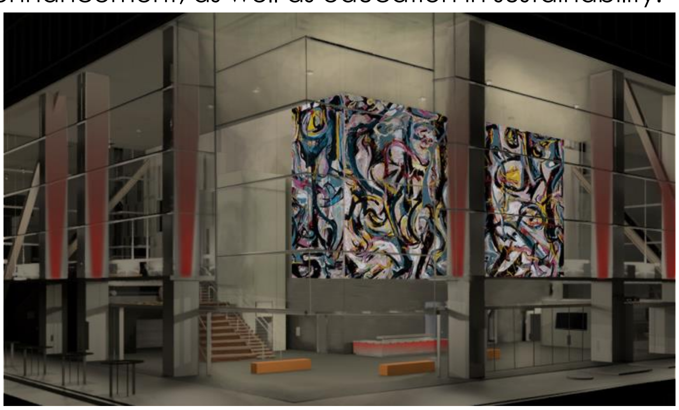


Figure 6: Rendering of Building Lobby

- ***Occupant Interactivity***—The team utilized the lobby as an education tool. When 350 Mission is operating independent of electricity and natural gas grids column up-lights and light under the reception desk will move from white light to color-changing. Furthermore, educational signage and postings will be used during the construction process. Passersby would be exposed to publications and illustrations which highlight the innovative feats accomplished in the design at 350 Mission.
- ***Architectural Enhancement***—The team's design features an awe-inspiring cantilevered building corner, which also serves as the main entrance. Furthermore, flat, crisp glazing of the building complements the building's structural steel skeleton. Structural steel lateral bracing will beautifully impose structural shapes through to the building facade.
- ***Community-Level Sustainability***—The team took efforts to mitigate site and water pollution during and after building construction. Public poster publications detailed steps taken to manage site water and prevent contamination on site by construction materials. Furthermore, waste from local businesses and utilities provide the fuel for 350 Mission's energy generation systems. The building's methane digester was designed to not only utilize by-products from 350 Mission, but also from municipal compost and sewage.

Performance. Endurance. Connectivity. These three ideals illustrate all the concepts the team worked to include in a manner which made the very best final product. Quality design and construction resulted in a city enhanced by design and incredible strides in building system innovation and sustainability.

5. The Integration Process

The aforementioned principles and goals guided the direction of the project; however, in order to actualize goals in a holistically-beneficial manner, the team needed a method of quantifying design decisions. The team created two project scorecards—one which illustrates project success as a whole, and one which illustrates discipline interactivity—to illustrate the multidisciplinary effects of discipline decisions. The **Holistic** and **Interactivity** metrics enabled decisions to be easily visualized and allowed the team to create designs which were beneficial for the project as a whole, without a single stakeholder outweighing another.

5.1 Holistic Metric

The contributing focal areas of the project, as discussed in the Core Principles section, form the numerical basis for empirically representing the impacts of project decisions. Feedback is given as to how individual decisions aide or detract from each of **Performance**, **Endurance**, and **Connectivity**. The metric graphic is illustrated below in Figure 7.

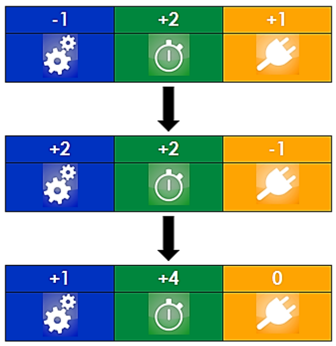


Figure 7: Holistic metric measuring decisions made concerning Performance, Endurance, and Connectivity

Individual decisions are score-carded on the basis of overall project health, and are assigned an index based on adding or detracting from overall project goals. Individual decisions are indexed based on achieving *Very Good (2), Good (1), Neutral (0), Poor (-1)* or *Very Poor (-2)* project impacts in the categories of **Performance, Endurance** and **Connectivity**. These assessments are based on *percent improvements or detractions* in each of the following categories shown in the flowchart below.

Performance
- CO2 per Year
- Grid Electricity Per Year
- Building Schedule
- Embedded Structural Cost

Endurance
- Building Drift
- Ulitity Redundancy
- Air Quality

Conectivity
- Visual Presence
- Tactile Interaction

5.2 Interactivity Metric

The Interactivity Metric was derived in order to ensure a balanced team dynamic, illustrating when certain disciplines are predominantly influencing discussions and when other disciplines are suffering consistently. The goal of this metric was to ensure that the project achieves a balanced, multifaceted design which embraces all aspects of design and construction equally.

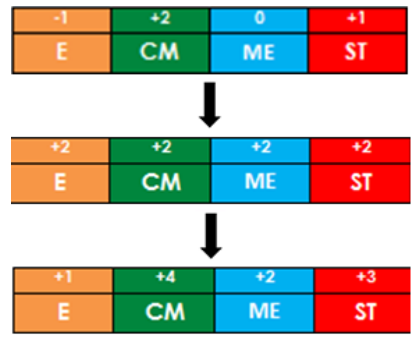


Figure 8: Interconnectivity Metric which ensures a balanced team dynamic

These assessments are based on *percent improvements or detractions* in each of the following categories:

Electrical
- Electrical use per day
- Peak Electrical Demand
- System Voltage Change
- Equipment Quantity

Construction
- Project Budget
- Project Schedule
- Embedded Material Carbon
- Material Supplier Distance

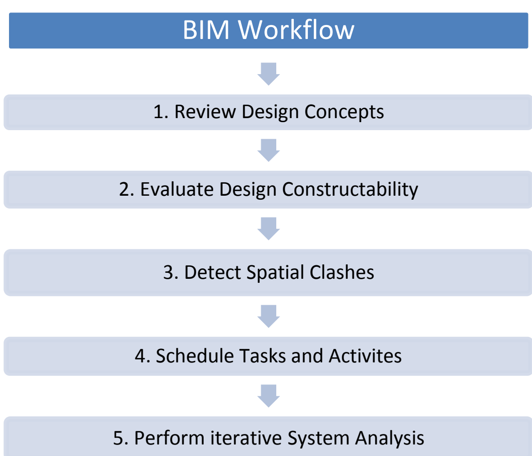
Mechanical
- Heating Load
- Cooling Load
- Water Demand
- Promary Energy Quantity

Structural
- Structural Drift
- Material embedded Carbon
- Structural Elasticity

5.3 Project Delivery Methodology

Organization and planning were important components of successfully delivering the design and construction plan for 350 Mission. In order to effectively structure the necessary deliverables, Building Information Modeling was utilized. Using BIM software and processes, team members were able to spatially coordinate all disciplines in real-time, while simultaneously keeping track of equipment and load changes as they updated in the model. In order to effectively create the processes and workflows necessary to execute this integrated project delivery method, the CIC BIM Project Execution Planning Guide, Version 2.0 was utilized (BIM Execution, 2014). Using this structure afforded the team these benefits and capabilities:

Figure 9: BIM Workflow



The BIM Ex Plan, created for 350 Mission, afforded the team a great resource when deciding how to properly and effectively utilize BIM technologies. In conjunction with the project requirements, it enabled the team to properly plan the exact level of model detail, as well as team member responsibilities for delivering parts of the Building Information Model. For reference, excerpts from the team's BIM Ex plan can be found in Appendix C.

Further discussions on some of the key sections of the BIM Ex Plan are provided below in order to illustrate how BIM added value to the delivery of 350 Mission.

6. BIM Process Design

One of the biggest challenges of working within a group is the sharing of information. The team used close to two dozen different programs, each of which aided and organized building design (See Drawing I3 for an interactivity graphic which shows the software used and its compatibility with other software programs).

Autodesk Revit was the primary spatial modeling software used on the project. Because of its ability to populate physical components with technical and analytical information, Revit became an important communicative medium for the group.

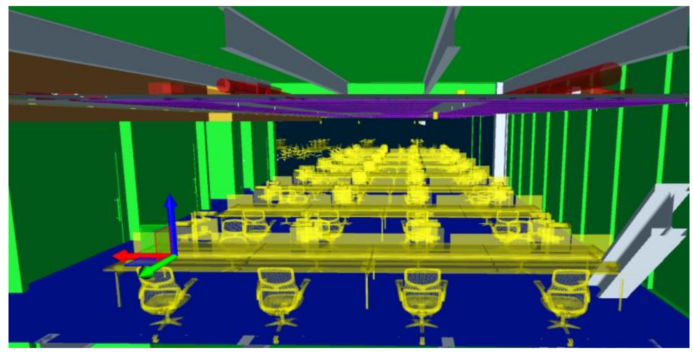


Figure 10: Revit was utilized to interact with Navisworks in order to identify clashes in the designs

Additionally, the spatial model was exported into NavisWorks, enabling the team to check for physical and clearance clashes. This ensured that components would physically fit during installation, minimizing project waste and expediting schedule as much as possible.

7. Collaboration Procedures

7.1 Communication Technology

Group interaction was absolutely critical to project success. To fully embrace a design which represented a creative, crowning achievement in engineering design required considerable information and idea sharing. On a day-to-day basis, the multi-user text messaging service GroupMe was used. This allowed a single message to be sent to the entire group in order to allow all members of the team to be kept aware of changes and requests in real-time. GroupMe was very useful when trying to quickly and efficiently arrange team meeting times, even if team members were travelling, across campus or unable to access a computer.

7.2 Team Meetings

Mandatory scheduled meetings took place three times a week, and collocated work sessions took place after the meetings at a minimum. Because the team occupied a collocated work space, collaborative work and design sessions took place more frequently than the mandated minimum. Due to conferences and job searching, team members were frequently traveling. In order to account for this, meetings would be held via video conference or telephone.

During these team meetings, building design would be iteratively re-altered to ensure project goals were aligned, and to ensure the project was progressing. Meeting minutes and transcripts were posted online in order to allow team members to reference relevant information at a later date. An example of Meeting Minutes (with a glimpse into how meetings ran) can be found in Appendix C.

7.3 Decision-making

As a group, the team was constantly making decisions which defined the final product we were designing. Because decisions needed to be made in order to benefit the project as a whole and not necessarily any single discipline, the team utilized both the Holistic and Interactivity Metrics, as seen in Figures 7 and 8. Decisions would be analyzed based on their ability to add to or detract from the three main team principles, and discipline-level impacts were also analyzed in order to ensure that no single discipline was being negatively impacted repeatedly.

8. Team Principle Resolution

Applying values of **Performance, Endurance,** and **Connectivity** around the integrated project nucleus discussed above, the team achieved the goals of the ASCE/AEI Student Competition and those we set forth for ourselves early in design.

8.1 Integration in order to Enable Performance

In considering the **Performance** of the building, a major step towards actualizing the Near-net Zero goal was generating large quantities of energy on-site. The team achieved this goal through a number of solutions.

Figure 11: Team Meeting

8.1.1 Towards Reaching Near-net Zero

Due to the building's site constraints solar energy and wind energy were determined to be infeasible. For detailed analysis on how this decision was made, refer to the Electrical and Mechanical narratives, respectively. The team turned to building waste products to generate energy. Through extensive analysis and research, it was found that harvesting energy from methane-generating sewage and compost would provide large quantities of thermal and electric energy. However, there was very little space for an anaerobic digestion plant. In order to create room for an anaerobic digestion facility, additional floor-to-ceiling height was desired in the lowest subgrade level in order to take advantage

The construction team analyzed the site in order to find the depth of the Colma Sand layer—the maximum depth which would support a mat slab. It was then found that the weight of the structure would have to be reduced in order to allow the mat slab to be reduced to a thickness which would enable the presence of the desired methane plant. Before proceeding, the two aforementioned decision-making metrics were utilized to assess this change in Figure 12. After analyzing on a project-wide basis, is was decided that the mat slab thickness would be reduced.

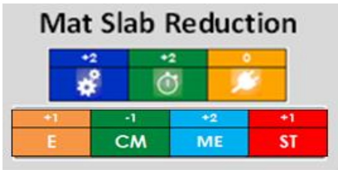


Figure 11: Values based on the Interconnectivity and Holistic Metric for the mat slab reduction

Electrical
- the digestion plant enabled electricity to be created on-site

Construction
- additional earth would need to be excavated and additional dewatering would be necessary (Reference Appendix G in Construction report for dewatering plan).

Mechanical
- the digestion plant enabled the creation of electricity and thermal energy for mechanical end-uses in addition to creating room for a water purification facility

Structural
- The lightweight and efficient superstructure would likely allow for a reduction in thickness though overturning moment might become problematic.

Performance
- the digestion plant enabled 350 Mission to achieve its Near-net Zero goals

Endurance
- the reduction in structural weight necessary to reduce the mat slab size helped reduce seismic drift

Connectivity
- because the Sustainability Plant is far below ground, it is not awarded metric points because of minimal interactivity

This 5' mat slab reduction is shown in Figure 12. By making this decision, the team increased the usable floor space in the fourth-level sub-basement from just under 1,500 SF to 11,300 SF. This allowed for the siting of the space-consuming bio-methane production facility. This also allowed for space to be given to the AquaCell blackwater recycling system. Creating space for wastewater recycling completely eliminates the need for municipal water for non-potable end-uses. **With one concerted, collaborative effort, 350 Mission went from being simply resource-efficient to completely resource-independent**.

By combusting the bio-methane created in the anaerobic digestion facility, large amounts of heat and electricity are generated. In order to most efficiently take advantage of this thermal energy, a double-effect absorption chiller was used to dehumidify ventilation air. By designing an absorption cooling system, thermal energy is able to be used year-round, allowing for effective utilization of site-generated fuel resources at all times. The anaerobic digestion facility also requires year-round heating to maintain high temperatures in the digesters.

8.1.2 Demand Reduction

Because the anaerobic digestion facility can only produce a finite amount of thermal and electrical energy, design decisions were made specifically to lower the energy demanded by building operations. In summary, team members utilized thin client data infrastructure, regenerative elevator breaking, Tambient lighting, and a passive cooling façade to reduce demands.

Figure 12: The basement was redesigned to accommodate from the bio-methane production

Data To minimize heat and electrical loads from computing equipment within the building, our team utilized a system which directly tied individual computers into a primary central building computing center. To reduce the energy required at each individual workstation, a thin client system was used instead of a traditional computer system. In a thin client infrastructure, the CPU is removed from the user's workstation and information is relocated to a server in the building's designated server room. Reference the electrical report for a full description of this system. This infrastructure reduces the power requirements by about 37%; from 765,000 kWh (with a typical computer system) to 484,398 kWh. Detailed load calculations can be found in the electrical Appendices. Not only does this system reduce the required power, a thin client system is more efficient when addressing cooling of the space. A centralized load can be controlled more efficiently than one that is dispersed throughout the office floors.

Elevators Regenerative elevator braking was another method used to decrease the energy requirements. Implementing this system generates electricity, reducing the elevator's energy requirement by 75% (Refer to the electrical report for a more detailed explanation of regenerative elevator braking).

Lighting Due to the fact that lighting is typically the largest electrical load in a building, much care was taken to choose fixtures with low energy requirements. The California Energy Code requires an office building to have a lighting power density of 0.75 w/sf. However, the Tambient system used on the office floors has a power density of 0.6 w/sf, reducing the lighting power demand (Refer to the Electrical narrative and associated appendices).

Façade Because space cooling is typically an electricity-intensive process, it was desired to design a façade which, its very construction, optimized energy performance over the course of the year. IES Virtual Environment was used to conduct an initial load study in order to find performance areas to target. For a detailed load breakdown refer to the Mechanical Narrative. It was found that the areas which presented the largest area for improvement were solar gain and lighting energy. It was also found that, for the majority of the year, heat loss through the façade helps to mitigate heat loads within the building. Two façade options were discussed for 350 Mission—unitized curtain wall vs. double-skin façade. The metric summary of the discussion is shown below in **Figure 13.** In short; the double-skin façade was abandoned due to its weight, construction complexity and seismic fragility.

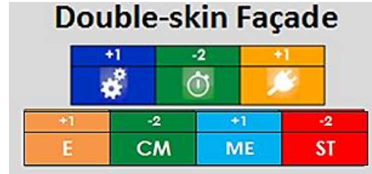


Figure 13: Values based on the Interconnectivity and Holistic Metric for the double-skin façade abandonment

A façade which enabled the building to reject heat throughout the year while optimizing solar gain and maximizing daylight was desired, so AEI Team 2 ran parametric studies on glazed curtain wall enclosures which had a high visible transmittance to solar gain ratio.

Table 4: Shading Study Parameters

Assembley Type	Assembly U-value [BTU/hr-SF-F]	SHGC	VT
Viracon Insulating Triple Pane	0.17	0.25	41%
Guardian 62/27	0.35	0.39	63%
Solarban 60	0.40	0.27	70%

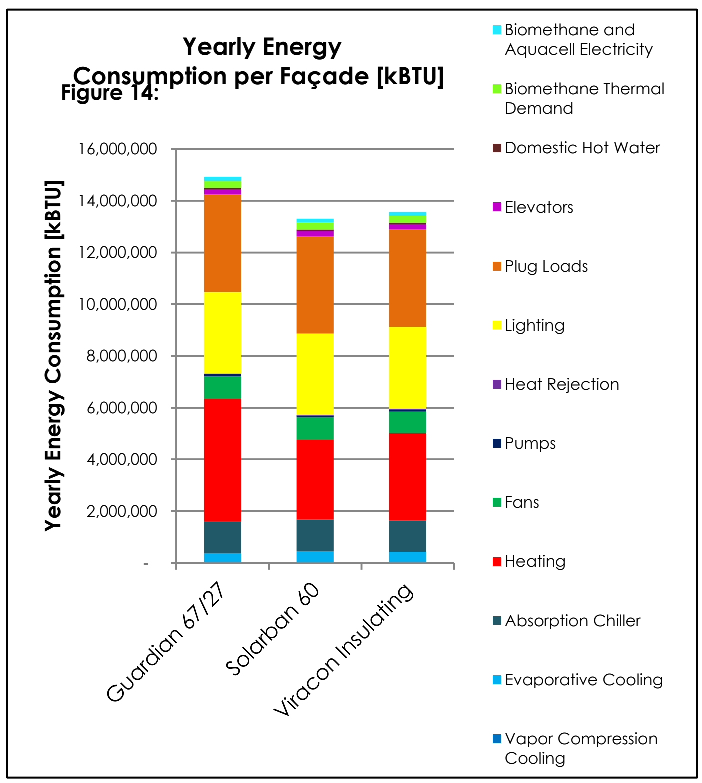


Figure 14:

As a result, an envelope which not only met the specifications of the movements and tolerances analysis conducted by the Structural Team, but minimized thermal and electrical loads was selected. The specifications of the façade are shown below, in addition to a cross section of the curtain wall. The decision to utilize an all-glass curtain wall was supported by the following metric analysis represented in Figure 15.

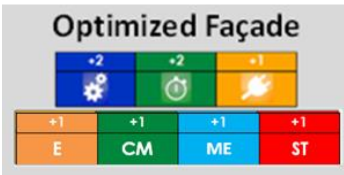


Figure 15: Decision to Optimize Facade

Electrical

- The high visible transmittance allows large amounts of natural lighting through, allowing artificial lighting in the building to be dimmed, saving energy

Construction

- Unitized curtain walls are easy to prefabricate and construct expediently—this is advantageous with the limited construction site

Mechanical

- Optimized solar gain drastically reduces heating energy while keeping cooling energy low over the year

Structural

- Its lightweight construction drastically and unitized capabilities offer greater movement allowances then a double skin façade.

Performance

- The optimized VT to SHGC ratio enabled optimal energy performance while allowing for expedient construction

Endurance

- Designed to meet movement and tolerance analysis specifications, the façade will withstand a design-level seismic event while minimizing lateral seismic weight

Conectivity

- The sustainable façade outwardly projects the values which make 350 Mission an innovative and unique project

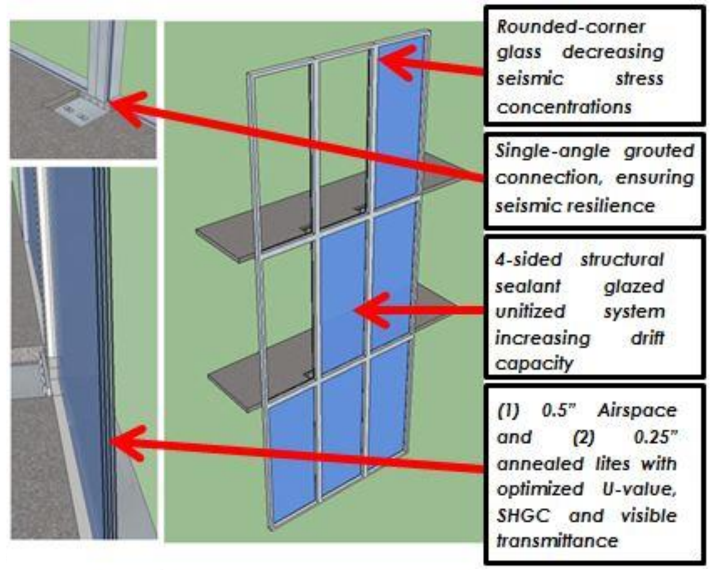


Figure 16: Values based on the Interconnectivity and Holistic Metric for the optimized facade decision

8.1.3 Near-Net Zero Results

By making space for a fuel-creation plant and the associated energy generation equipment, Team 2's 350 Mission was able to achieve an **EUI of -0.02 kBTU/SF-yr**. This is **100% lower than the ASHRAE 90.1 Baseline model** as well as the existing design for 350 Mission. This also allowed for an AquaCELL water purification system, which enables a **potable water use reduction of 84%**.(Appendix Refer to Mechanical Report further detail) In total, **over the building's 50-year lifecycle, 52,830 tons of carbon are saved**.

8.1.4 Reduction of Embodied Construction Energy

Prefabrication became a critical component of construction sequencing. By identifying ways to construct pieces of the building off site, the team avoided conflicts within the condensed construction site. Material waste and site pollution were also reduced by limiting on-site construction. Building subsystems such as the core structural members as well as the radiant cooling system were designed to be prefabricated in order to accelerate the construction schedule (Reference Construction Report, Appendix I for Schedule)

8.2 Integration to Enable *Endurance*

One of the most progressive goals of the project was to create a building which would **Endure** over time. To embrace this idea of having a building built to last, decisions were made in design in material and system selection which would work together to ensure a quality, durable project.

8.2.1 Emergency Power

Emergency power is generated by the 310 kW bio-gas micro-turbine systems. Biogas reserves are stored in order to ensure fuel supply in the event of a disaster resulting in a power loss. This is connected to an emergency panel that powers life safety end-uses, such as emergency lighting. This integrated system, which usually provides thermal and electrical energy to the building under normal circumstances, **saves up to $65,000 first cost, because capital investment in an additional emergency generator is avoided**.

Figure 18: Internal Combustion Engine

8.2.2 Lateral Weight in Mind

One main concern when considering the life-cycle resiliency of the building is how it will endure repeated major seismic events over its lifetime. Early and constant communication between all team members allowed for not only a lightweight and efficient structural system but also a lightweight and efficient building as a whole. An instance where structural and mechanical teams collaborated on maintaining a lightweight structure pertained to the evaporative fluid coolers mounted on the roof of 350 Mission. A design which maximized efficiency, yet remained under 500,000 lbs—the weight deemed by the structural team's structural analysis, to cause an extreme torsional irregularity as defined by ASCE7-10 Ch. 12—was created in order to optimize the results for both disciplines as well as the project. Another key design component was implementing radiant panels as the space conditioning method for a typical office floor. With an average operational weight of approximately 2 lb/SF, the panels greatly diminish the weight placed on the structural system over a typical Underfloor Air Distribution (UFAD) HVAC design, which typically weighs five times more at equivalent operating conditions. Early and effective communication between all parties was essential in utilizing efficient systems reducing gravity loads on the foundation as well as seismic forces.

8.2.3 Structural Core

Selecting of the buildings structural core for lateral resistance was another area that called for an integrated decision. At one point in the process steel-plated shear walls were compared against a braced frame core using the comparative metrics, the results of which are discussed below.

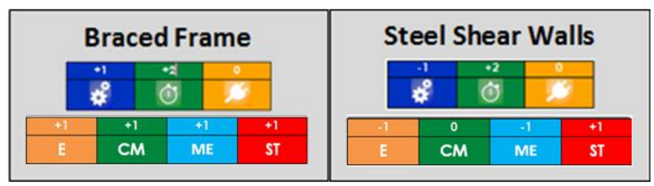


Figure 17: Values based on the Interconnectivity and Holistic Metric for the steel shear was vs. the braced frame when dealing with the core's structural system

Electrical

- Braced frames were preferred over shear walls due to ease of electrical shaft access

Construction

- Steel-plated shear walls are favorable for schedule reasons compared to the braced frame, however their expense was deemed prohibitive

Mechanical

- Braced frames were preferred over shear walls due to ease of mechanical shaft access

Structural

- Steel-plated shear walls were deemed to be excessively stiff for our needs, so braced frames were preferred due to economy

Performance

- Braced frames were shown to marginally aide energy performance due to improved pressure drop while coordinating ductwork around core

Endurance

- The seismic resilience of shear walls was deemed excessive, as braced frames were able to more economically meet seismic requirements

Conectivity

- Little effect was shown

8.2.4 MEP Start-Up

A main design concern of high rise construction in seismically active areas is the ability to re-occupy a space soon after a seismic event occurs. A building with a strong life-cycle resiliency can provide near immediate occupancy in the aftermath of an event by allowing system components to be able to endure and function in such a scenario. Seismically-braced radiant cooling panels were designed in favor of a UFAD system because of the excessive measures which are necessary to allow underfloor plenums to withstand seismic forces (For further detail see Mechanical Appendix Q). Additionally, the building's lighting system is mounted to movable workstations instead of the suspended ceiling, de-coupling them from seismic forces.

8.2.5 Endurance Results

By collaborating to design systems which not only performed well independently, but as an integrated component of the whole building system efficient endurance, positive results were achieved. For example, through the collaborative identification of lightweight systems lateral weight was kept low. This aided in **allowing seismic drift to be kept at 33" at the top of the building**. This is **28% under the high performance requirement set by the competition**. For the analysis which determined this value (See the Structural Appendices D& F). Additionally, mechanical and electrical end-uses are designed to maintain minimal seismic damage during an earthquake due to seismic decoupling or bracing.

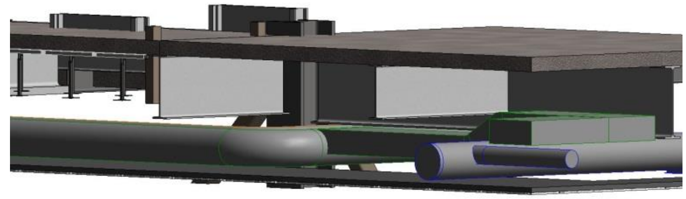


Figure 19 : Plenum space with a reduced size and weight slab

8.3 Integration in order to Enable Connectivity

Instilling and developing sustainable concepts within the building environment is important to the goals of the project. It was important to **Connect** with the tenants of the building and the surrounding community in design. Several features were integrated into the building to achieve this goal of **Connectivity.**

8.3.1 Building Enclosure

Designing a high-performance, sustainable façade was a priority for AEI Team 2 because, by designing a high-performance façade, 350 Mission is able to outwardly project an image of sustainability to the community of San Francisco. The building's envelope creates a unique architectural identity within San Francisco while creating a sustainable, resilient encasement for all which makes 350 Mission a holistically high-performance building (See Appendix H for more Façade detail).

8.3.2 Lobby Enhancement

Further connectivity to the community and surrounding urban environment was accomplished via additional architectural and structural integration. The southwest corner of 350 Mission is a major focal point as it faces the Transbay Terminal, a major hub for transportation and pedestrian traffic. The structural team focused closely on this corner when they designed the superstructure in order to preserve this architectural feature. Cantilevered perimeter beams were designed on every floor at this corner to support gravity loads and help provide the building with an inviting feel.

The lobby is where all users of the building will meet. In order to instil a connection between the public and the building, the design team sought to educate, entertain, and interact with the users through the lighting design. The lobby lighting scheme reflects the energy-use status of the building and informs occupants when the building is operating completely off of the electrical and natural gas grids, and when the building is drawing power from the municipalities. The lighting design scheme can be read in full detail in the lighting/electrical report.

The creation of a public restroom in the landmark lobby which uses electro-chromic glazing creates a public display of the innovative technologies and thought processes which went into 350 Mission. The electro-chromic glazing creates visual interest, drawing people to the exhibit in order to allow them to learn about the building. Once at the public restroom, visitors can read about how the restroom, and many others around San Francisco, enable 350 Mission to operate autonomously from the energy grid.

In order to create a landmark interactive lobby which maintains a sleek visual appearance, a radiant floor heating and cooling system was proposed in order to keep the space comfortable despite potential in-rushes or out-rushes of air. The structural team also needed to utilize the slab as a rigid diaphragm for transferring superstructure lateral loads into the basement structure. The final design, outlined in the Mechanical and Structural reports, allowed each system to achieve its desired performance and keep the space appealing for the user. A thickened floor slab beyond those of the other key rigid diaphragm floors was provided in order to ensure no damage to the radiant slab during a seismic event.

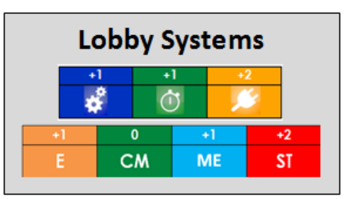


Figure 20: Values based on the Interconnectivity and Holistic Metric for the decisions with the lobby systems.

The agglomeration of these engineering decisions sum to a holistic lobby system which preserves the integrity of the vision for the space—an interactive environment which connects with, and draws visitors from, the adjacent transit hub. By enabling a sleek, landmark aesthetic, the lobby welcomes visitors into a space which not only serves as the hub for 350 Mission, but as a teaching tool for that which makes the building unique. The entirety of the engineering decisions which crafted the outcome of the lobby are analyzed with the comparitive metrics below.

Electrical

- By illustrating the utility activity through the lighting system, the architecture is visually and communicatively enhanced

Construction

- The construction team, having minimal residual visual effect was not impacted by the lobby enhancement Construction team to enhance

Mechanical

- By featuring an electrochromic plumbing exhibit, transparency of building operation enhances the connectivity of the space. The thermal slab allows for a sleek appearance which is unhindered by HVAC equipment

Structural

- The innovative diagonal bracing takes root in the lobby floor and is showcased architecturally. Additionally, the structure enables the soutwest corner to remain open without visual interruption, preserving architectural integrity

Performance

- The efficient systems which maintain comfort in the space also enable a clean and sleek appearance

Endurance

- The structural system which enables the buildng to withstand a design-level seismic event also creates an open appearance on the southwest corner, allowing the space to connect with the adjacent transit hub

Conectivity

- The lobby serves as a hub for the building, as well as a teaching tool and an interactive cultural exhibit through the LED lighting, electrochromic restroom and informative lighting scheme

8.3.3 Connectivity Results

By creating a high-performance, sustainable façade which enables the innovative structural system to be showcased, 350 Mission is able to outwardly project that which makes it unique and innovative to the community of San Francisco. As members of the community are drawn to the building through its visually-engaging appearance, they are drawn into the landmark, interactive lobby. Once within the lobby, visitors are engaged by the building, the lighting scheme enabling them to see how 350 Mission operates. As they progress through the lobby space, the public restroom exhibit transparently informs them of how the building, through symbiotically connecting with the municipal infrastructure, is able to achieve Near-net Zero operation. By visiting 350 Mission, it is the hope of the team that occupants will leave having learned something new and novel about how they can promote sustainability in their own lives, propagating positive environmental impact throughout San Francisco.

Conclusion. After being tasked with the design project of creating a sustainable and Near-net Zero product for 350 Mission, positive and profitable results were able to be obtained. Per the guidelines of the project, and following specific goal orientations, such as **Performance**, **Endurance**, and **Connectivity**, certain integrated and collaborative workflows created guidance for the following project criteria: Comprehensive building design, achieving sustainability and energy efficiency, enabling immediate building reoccupation, and providing an economically-efficient project budget.

After implementing a **custom plan of Version 2.0 of the CIC BIM Project Execution Planning Guide**, beneficial software interaction schemes, decision making processes, organization tactics, and design and construction workflows paved the Building Information Modeling road for creating the design for 350 Mission. This plan was used as the backbone and supporting documentation for the entire project.

Dealing with sustainability and energy efficiency, the following measurable metrics were tallied and can support the implementation of 350 Mission's sustainable and Near-net Zero goals. **The building uses 100% less energy than the baseline building** and the current design. It also uses **84% less potable water**, **95% less waste** and **99% fewer emissions**. In total, the proposed system will **save $13,650,000 over a 50 year life-cycle** and will **reduce greenhouse gas emissions by 52,830 tons**.

Building power will be generated onsite. **Sewage and building waste will be converted into BioMethane** via anaerobic digesters in the basement. **An internal combustion engine will then convert the fuel to electricity and thermal energy**.

Building reoccupation was a large design consideration when strategizing the construction of a 30 story high-rise in the seismically active city of San Francisco. Decisions made with a goal of minimizing building inactivity, following a major seismic event, directly impacted the building's structural design for resistance against lateral forces. This being said, per the competition guidelines, **the building was strategically designed to a 28% drift reduction beyond project guidelines**.

Concerning construction logistics for 350 Mission, the project budget, key factors which drove for a higher initial cost, were the complexity of the mechanical systems, a need for foundation reinforcement per seismic code requirements, and the constraints of the congested San Francisco city grid. Juxtaposed with a high initial cost, the design process allocated savings in several key building components. Through comprehensive structural analysis, steel reduction for the core maximized savings, and prefabrication of numerous building systems allowed for major schedule reduction. **350 Mission's budget was calculated at $131,213,180.87 and ran an aggressive schedule of 19 months**.

Sticking with the mission statement of, "AEI Team 2 is dedicated to connecting communities, and enriching society through integrative, high-performance solutions and enduring principles", a high quality, holistic building system was designed. Using Building Information Modeling, and integrated and collaborative ingenuity, 350 Mission will radiate as a presence within the city of San Francisco, paving the path for sustainable and energy efficient design.

Appendix A-Lessons Learned

Throughout the design process for the 350 Mission project the design team encountered many challenges, and through these instances expanded their knowledge and designing efficiency. The examples listed below are just a selection of the many lessons learned and reformations made throughout the project lifetime. Some of the lessons are related to things the team did correctly and efficiently, and some are related to time the team failed and had to re-analyze their decisions. The team is confident that the lessons learned will continue to aid them in their current and future professional success.

1. Team organization and communication lines before the design phase starts is very important:
    a. Even before the design phase of the project began, the design team had open communication discussing the project guidelines and design goals. Team members analyzed the original design and competition requirements as soon as the information was released. A Google Group was set up for team members to disseminate information as they completed initial research into engineered systems and construction processes. This early communication allowed the team to start the design phase already on the same page as far as goals and workflow were concerned.

2. File structure/organization is extremely important:
    a. Due to the collaborative and iterative nature of design, the team found that a set file structure and naming guidelines greatly increased workflow efficiency. The team's file structure allowed information, models and images to be grouped under project milestone markers, but separated based on content for easy searching and access. Each discipline also had set folders to organize their information, and the identical file structure for each discipline allowed increased collaboration efficiency.

3. Regular group meetings are very helpful:
    a. The design team found that regularly meeting to discuss where each discipline was in the design process and upcoming design decisions was crucial to achieving a smooth working environment. Because of the collaborative nature of the project, decisions made by each discipline affected all other team members. These weekly meetings were used to discuss major decisions and design features. Updates were given by each discipline as to where they were at on the project timeline and what their schedule was for completing required tasks for upcoming project milestones. An additional benefit of the regular meetings was creating a time where all members, each with differing schedules, could be together for discussion and planning.

4. Industry professionals are an invaluable resource and wealth of knowledge:
    a. The design team took every opportunity it could to interact with industry professionals who were willing to lend a critical eye to the building design. Each discipline was adept at finding professionals with experience in specific areas of building design; and the team as a whole sought individuals who were well versed in holistic design and workflow efficiency. The design team enjoyed being exposed to this 'real-life' knowledge and found the professionals to be very cordial; especially when the group prepared information and questions ahead of time.

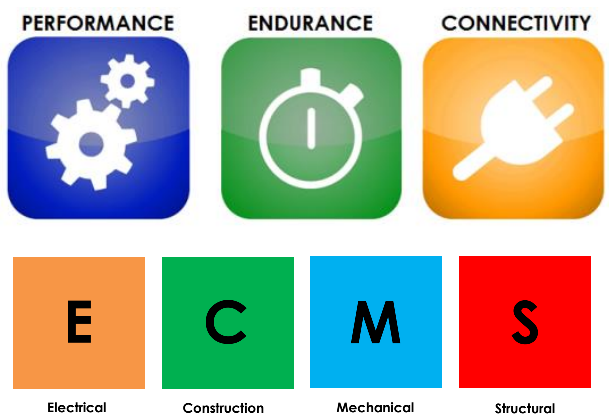
5. BIM tools and technology are essential for graphic representation and information exchanges:
    a. One positive aspect of the collaborative BIM project environment is that members of the team can easily and intelligently discuss cross-discipline issues. One tool that helps facilitate this discussion is the ability to visually represent components and design details with the software. The team found this ability helped educate each team member to certain aspects of design quickly and effectively. Information could be shared numerically or analytically within each discipline, while images and models helped other disciplines understand concepts and design empirically.

6. Model organization is important early on in the project:
    a. The project team found that the foundation of model standards and grids early on in the project helped ease some of the common issues with collaborative design. Finalizing architectural and structural grid lines for all applicable models was crucial in creating spatial knowledge for all disciplines. Setting up the Revit central model with disciplinary links allowed the engineers to simultaneously and progressively add to the whole building model. Keeping models up-to-date enabled intelligent discussion when inter-disciplinary conflicts arose.

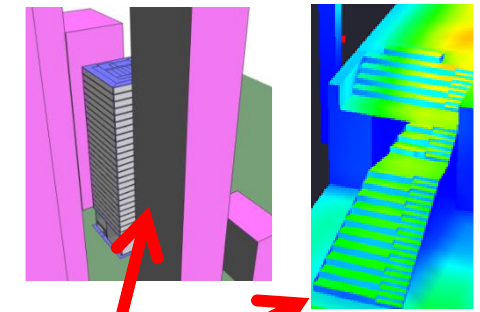
7. Engineering analysis and design software is powerful but MUST be fully understood and used with caution:
    a. Each discipline enjoyed using state-of-the-art software and design technology in order to streamline the design phase and conquer difficult and lengthy analyses. However, each discipline learned early on that a full knowledge of how the software works was paramount in creating accurate, effective output. Because of the need to 'self-teach' various software,

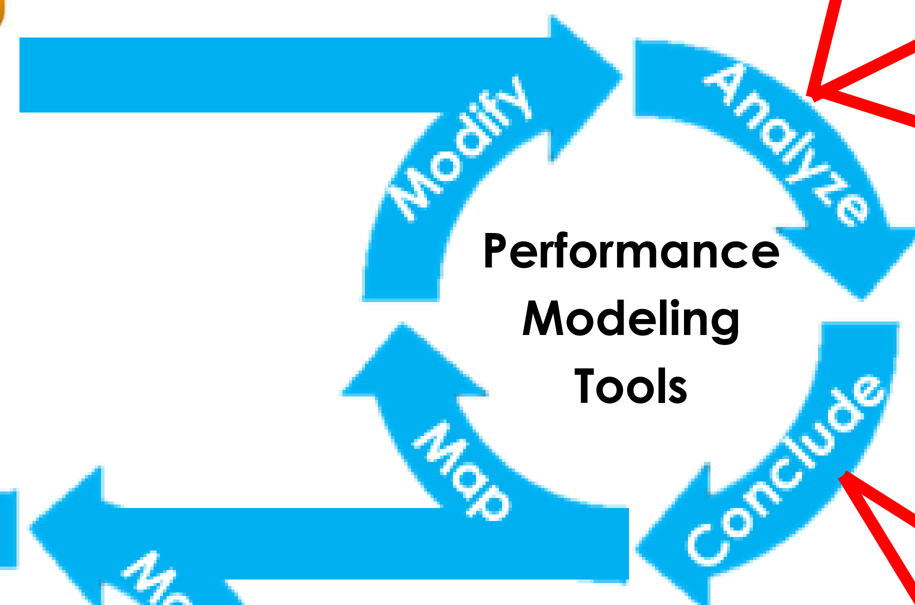
Appendix B- Integrated Design Process Summary

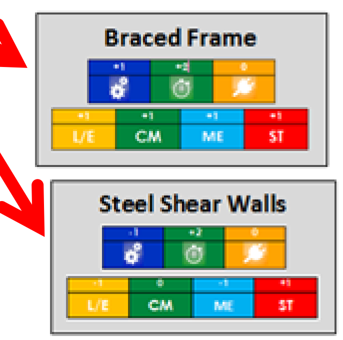
1. Team and project goals were formed based on the project requirements and the Pankow Foundation's vision. These goals were used to objectify decisions throughout the project.



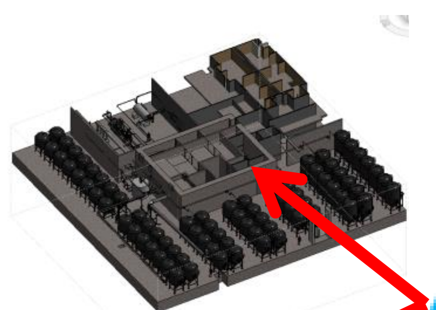
2. Ideas across all disciplines were formed and analyzed using several different analytical modeling tools. These studies allowed for valuable input when making design decisions.

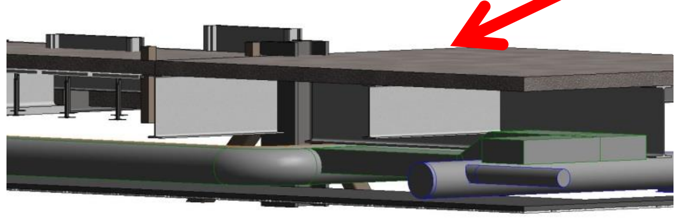


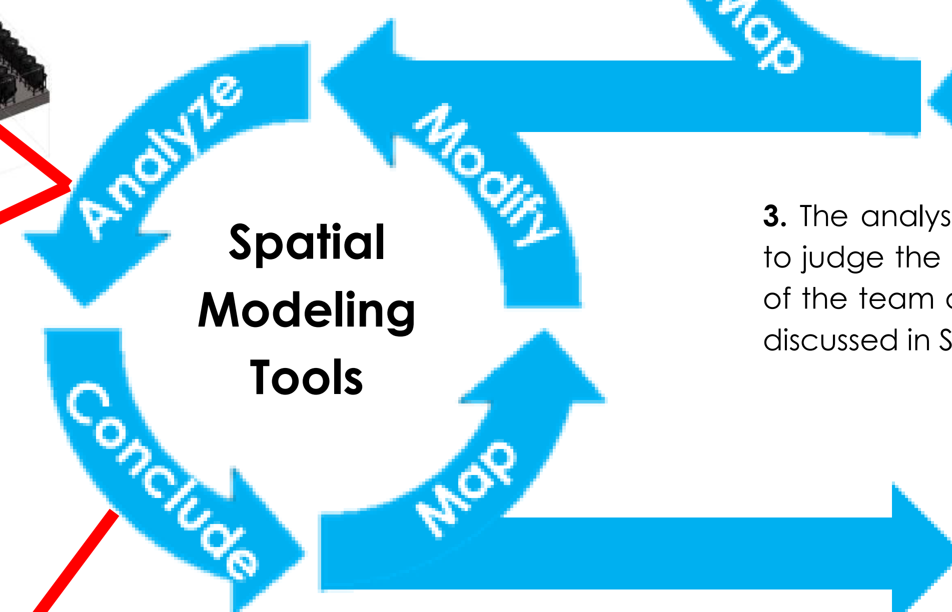




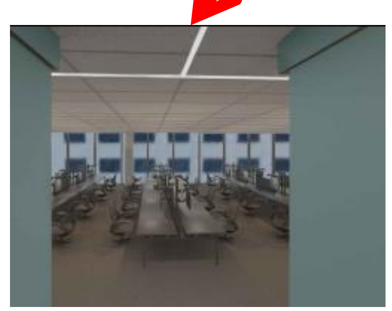
3. The analysis is used in order to judge the decisions in terms of the team and project goals discussed in Step 1.



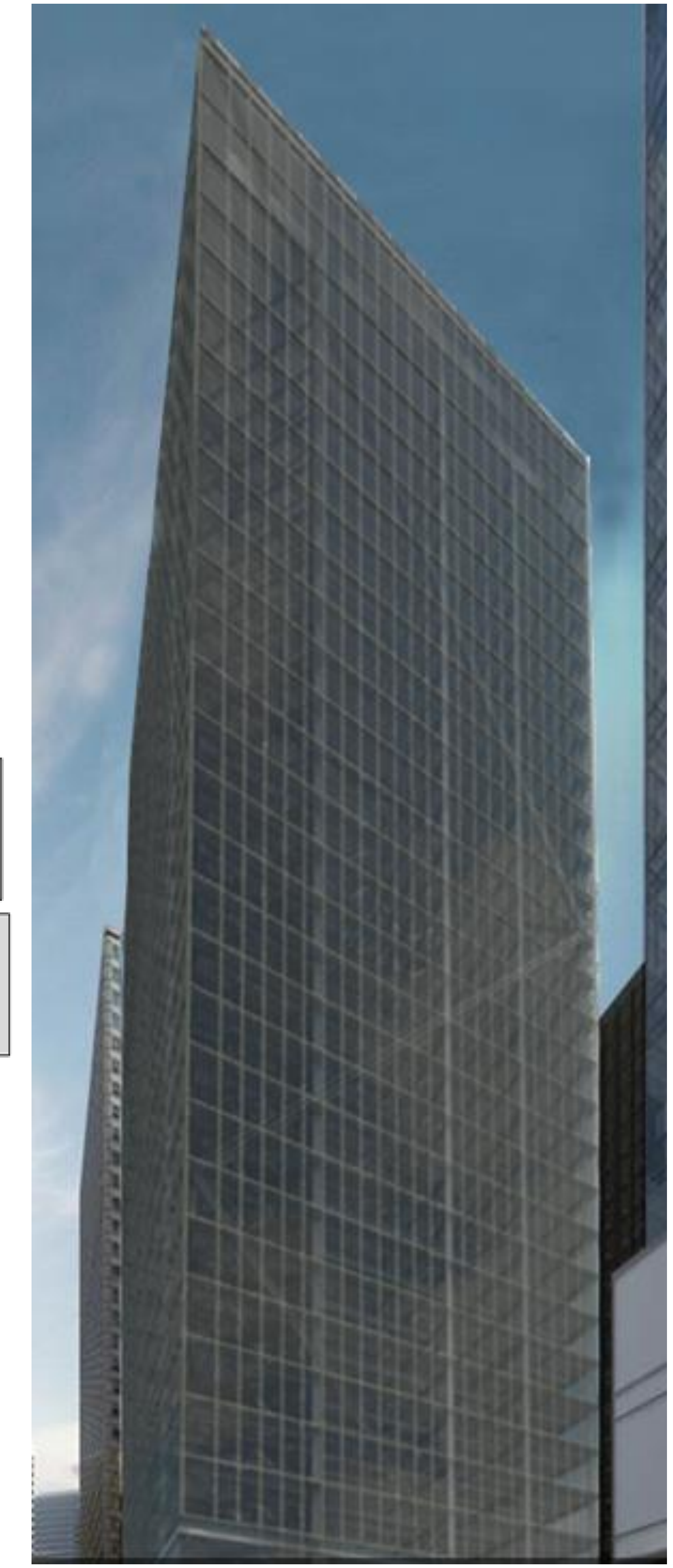




4. Spatial modeling tools like Revit and Sketchup are used to coordinate trades and validate aesthetic decisions. These tools also enable expedient creation of production documents.



5. After synthesizing all of these tools and decision-making workflows, a final, bespoke version of 350 Mission is created, achieving high levels of seismic and resource performance.



Appendix C -BIM Execution Planning

1. Introduction to Building Information Modeling & Group Progress

Building Information Modeling, or BIM as it's affectionately referred to, describes the method of collaboratively sharing information during the design phase of a building, in order to innovate the best solution possible. Architectural, engineering, and construction personnel all work together throughout project development to create a building which is efficiently designed and constructed to the best of the budget's ability. In the case of the ASCE Competition, the team collaborated to achieve the project's primary goals. The team sought to create a design which was mechanically Net zero, meaning it was self-sufficient in operations, and financially practical. The following charts, graphs, and illustrations highlight how the team worked together to produce its final design for 350 Mission. Firstly, the team's progression over the course of project activities is highlighted below.

Project Milestones

PROJECT MILESTONE	START DATE	COMPLETION DATE	PROJECT DELIVERABLE	INVOLVED PROJECT STAKEHOLDER
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 AEI 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.

BIM Resource Allocation Plan

TASK	OPTION	STAFF SIZE	HOURS ALLOCATED/WK	WEEKS
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.

Project Timeline

Below, a timeline illustrates how the project progressed. First, preliminary research was conductive. Conceptual design was developed from early research. Over several months, the team developed a design and construction plan which best suited the goals of the project.

2. Utilizing BIM Processes

Sharing information efficiently was critical to project success. A central file sharing folder was developed to allow team members to share information with ease. Program integration was also critical to project success. Below, right, a process chart illustrates how process developed over the project timeline and how programs impacted each stage. Further software integration can be found on **Drawing I3.**

BIM Usage Chart

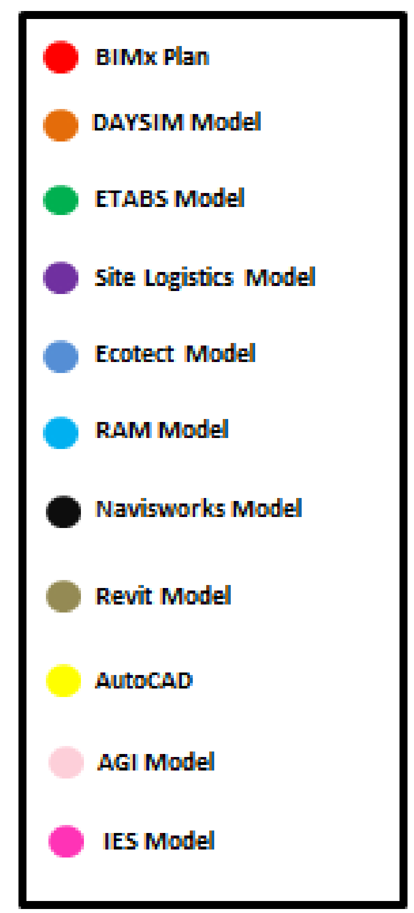
BIM USE	OBJECTIVE	RESPONSIBLE PARTY	EFFORT
Integrated Schematic Model	Create and update a model of 350 Mission St. that not only encorperates systems from each option that are essential to the design process, but to also have a 3D representation of system collaboration.	All Members	Significant
Energy 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 incorporated 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 energy efficient building, and keep renewable paybacks realistic throughout the life of the building.

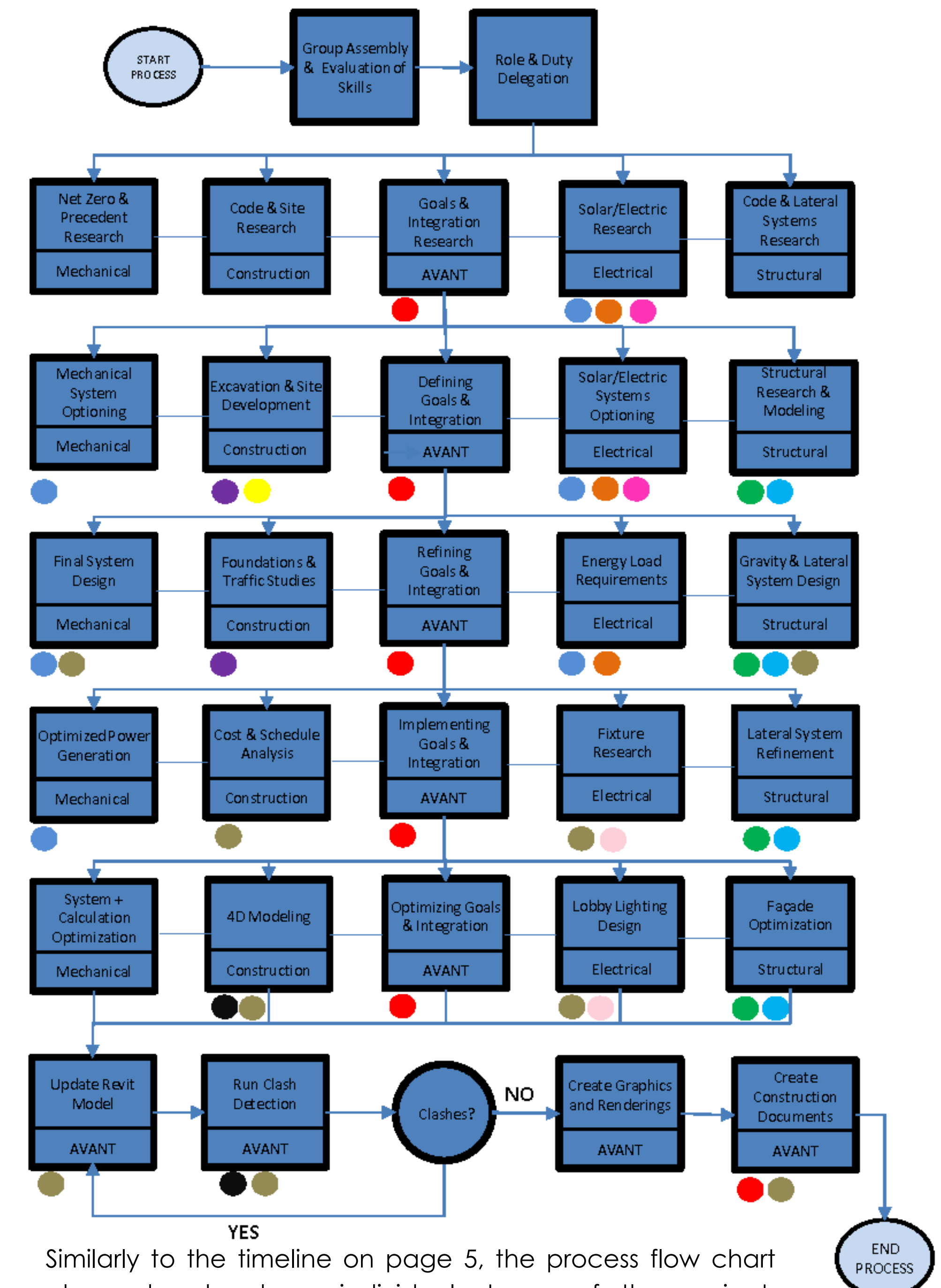
File Structure

File Location	Home Folders	File Type	Discipline
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.



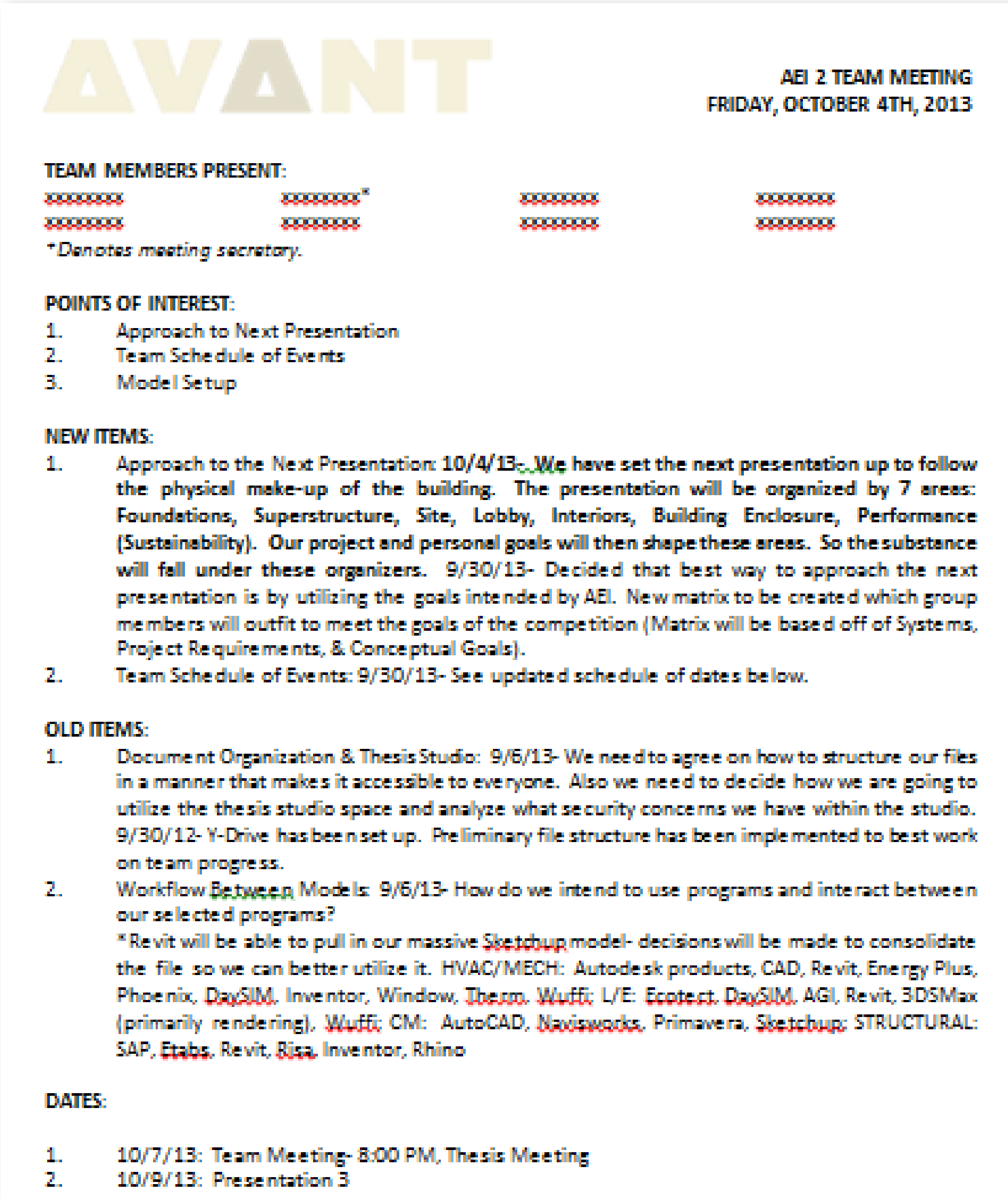
Team Process Flow Chart



Similarly to the timeline on page 5, the process flow chart above breaks down individual stages of the project, highlights stage-specific activities, and illustrates how specific pieces of software impacted the process.

3. Communication in the BIM Process

Communication was key to project success. Multiple methods of communication were utilized to fully connect team members. The design was dependent on how well potential building systems worked together towards the team's final plan for 350 Mission. All exchanges of information were also stored for reference during project development.


AVANT

AEI 2 TEAM MEETING
FRIDAY, OCTOBER 4TH, 2013

TEAM MEMBERS PRESENT:

xxxxxxxx	xxxxxxxx*	xxxxxxxx	xxxxxxxx
xxxxxxxx	xxxxxxxx	xxxxxxxx	xxxxxxxx

**Denotes meeting secretary.*

POINTS OF INTEREST:

1. Approach to Next Presentation
2. Team Schedule of Events
3. Model Setup

NEW ITEMS:

1. Approach to the Next Presentation: **10/4/13- We have set the next presentation up to follow the physical make-up of the building. The presentation will be organized by 7 areas: Foundations, Superstructure, Site, Lobby, Interiors, Building Enclosure, Performance (Sustainability). Our project and personal goals will then shape these areas. So the substance will fall under these organizers.** 9/30/13- Decided that best way to approach the next presentation is by utilizing the goals intended by AEI. New matrix to be created which group members will outfit to meet the goals of the competition (Matrix will be based off of Systems, Project Requirements, & Conceptual Goals).
2. Team Schedule of Events: 9/30/13- See updated schedule of dates below.

OLD ITEMS:

1. Document Organization & Thesis Studio: 9/6/13- We need to agree on how to structure our files in a manner that makes it accessible to everyone. Also we need to decide how we are going to utilize the thesis studio space and analyze what security concerns we have within the studio. 9/30/12- Y-Drive has been set up. Preliminary file structure has been implemented to best work on team progress.
2. Workflow Between Models: 9/6/13- How do we intend to use programs and interact between our selected programs?
   *Revit will be able to pull in our massive Sketchup model- decisions will be made to consolidate the file so we can better utilize it. HVAC/MECH: Autodesk products, CAD, Revit, Energy Plus, Phoenix, DaySIM, Inventor, Window, Therm, Wuffi; L/E: Ecotect, DaySIM, AGI, Revit, 3DSMax (primarily rendering), Wuffi; CM: AutoCAD, Navisworks, Primavera, Sketchup; STRUCTURAL: SAP, Etabs, Revit, Risa, Inventor, Rhino

DATES:

1. 10/7/13: Team Meeting- 8:00 PM, Thesis Meeting
2. 10/9/13: Presentation 3

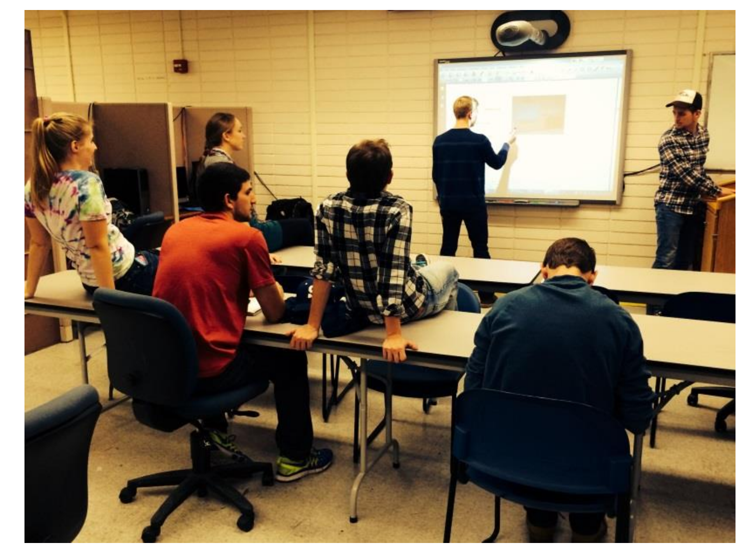
AEI Team 2 Meeting Minutes: Meeting minutes were kept during group meetings for recordkeeping purposes. These documents allowed group members to clarify points discussed during major group meetings.

The team utilized a private folder through the university to share files. Files were organized based on particular building systems, and university-set submissions.

Most 3D communication took place through Autodesk Revit. Multiple models interacted with one another to make up the team's design for 350 Mission.

Early communication and presentation preparation was completed through Google Drive because of the utility's ability to work remotely. GroupMe was used to instantly message the entire group in a moment's notice.

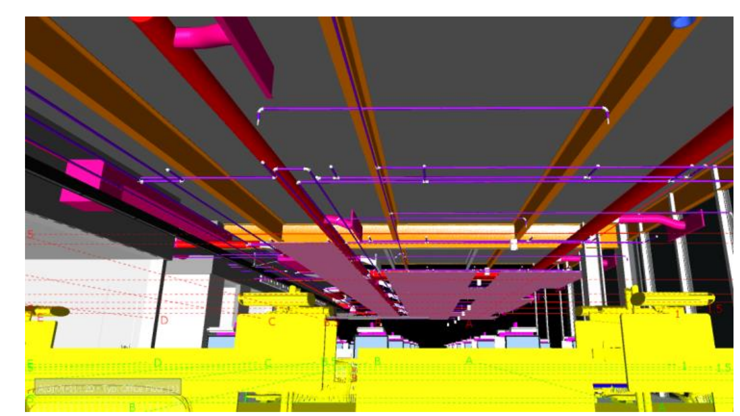
Symbol	Name	Software Uses
	University Server	Store and share large files and backups, organize documents
	Revit Central Model	Integrated modeling
Google Drive	Google Drive	Group communication and small document sharing
	GroupMe Application	Informal and 'instant access' group communication
	External Hard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



The team utilized cutting edge, modern technology to share ideas as a group. Presentation and report preparation took place in university-sanctioned modules which featured Smart boards and high definition monitors, which could interact with personal computer units.

Group meetings could be easily enacted and recorded utilizing the available technology. The team considered team meetings invaluable to the project development process.

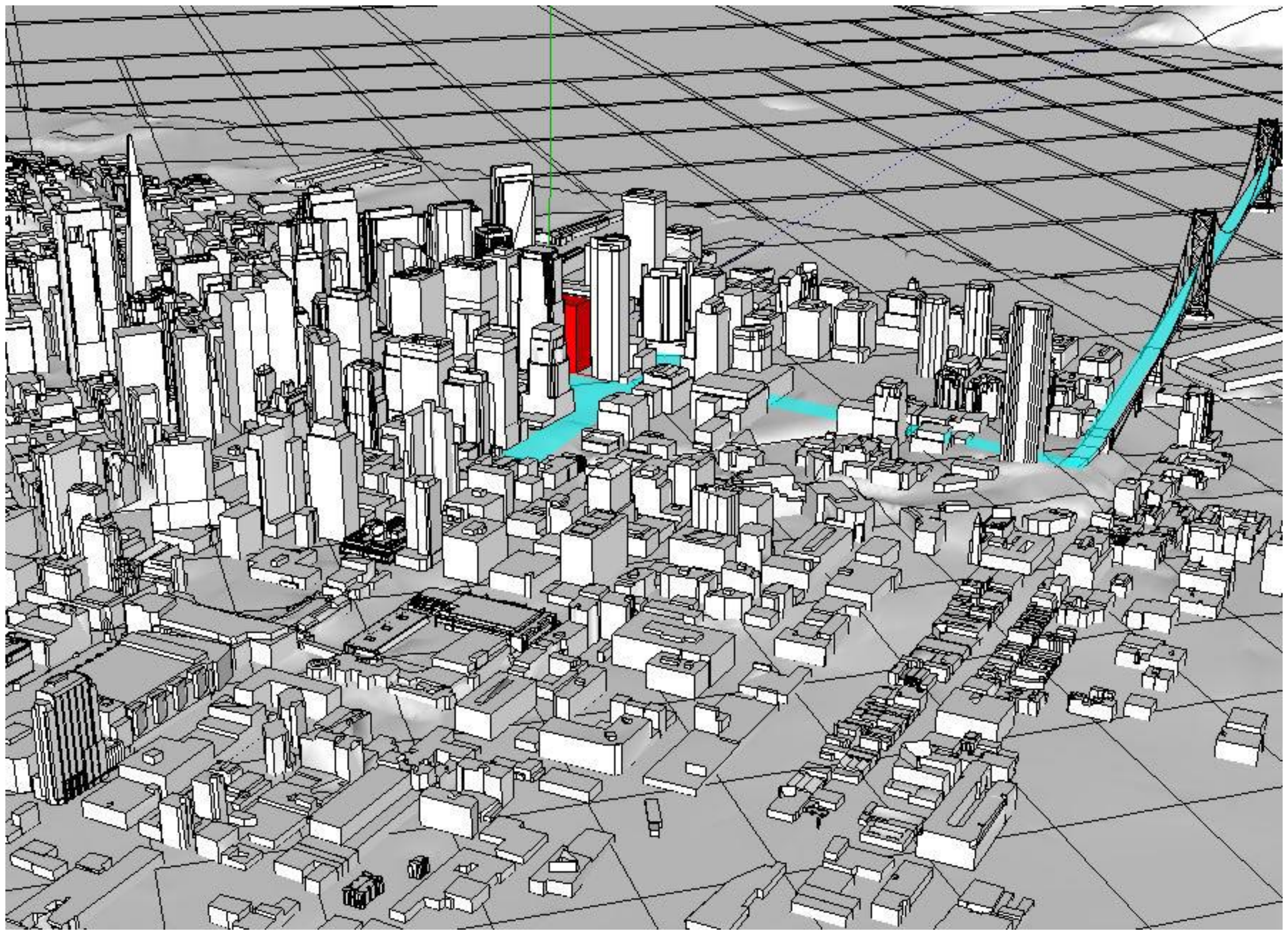
Early team meetings were critical during the early stages of the project to establish a basic plan for design coordination. Design of the systems above the ceiling relied on this group dynamic.



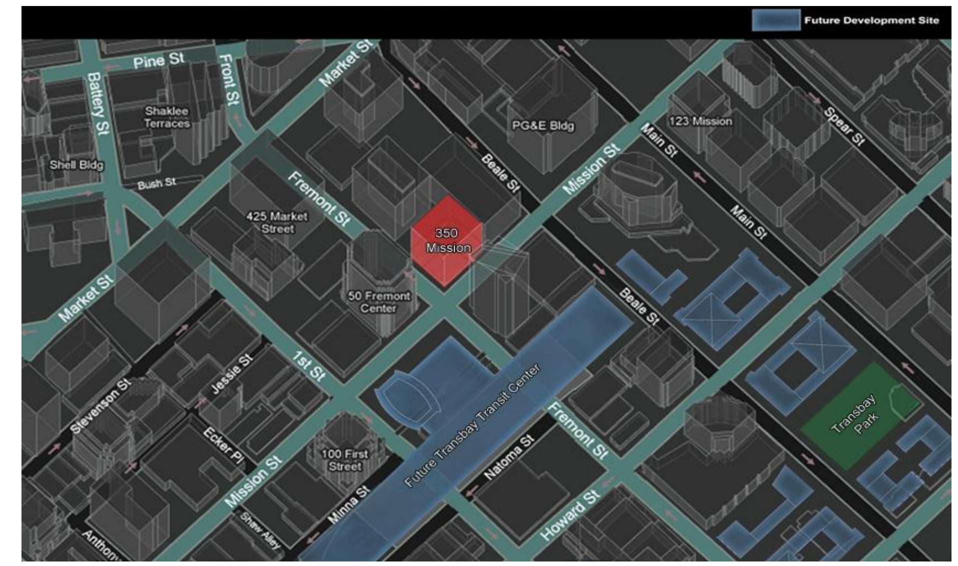
Appendix D – Site Context

Seamless integration with the architecture of 350 Mission was a key goal of all members of the project team as well. All disciplines involved wished to provide the opportunity for some form of architectural enhancement. Therefore and early activity all members of the team took part in was documenting the context of the site and the urban condition the building would be sitting in. This would allow the teams design and construction decisions to be motivated in part by the architectural impact they may have on a building/site wide level.

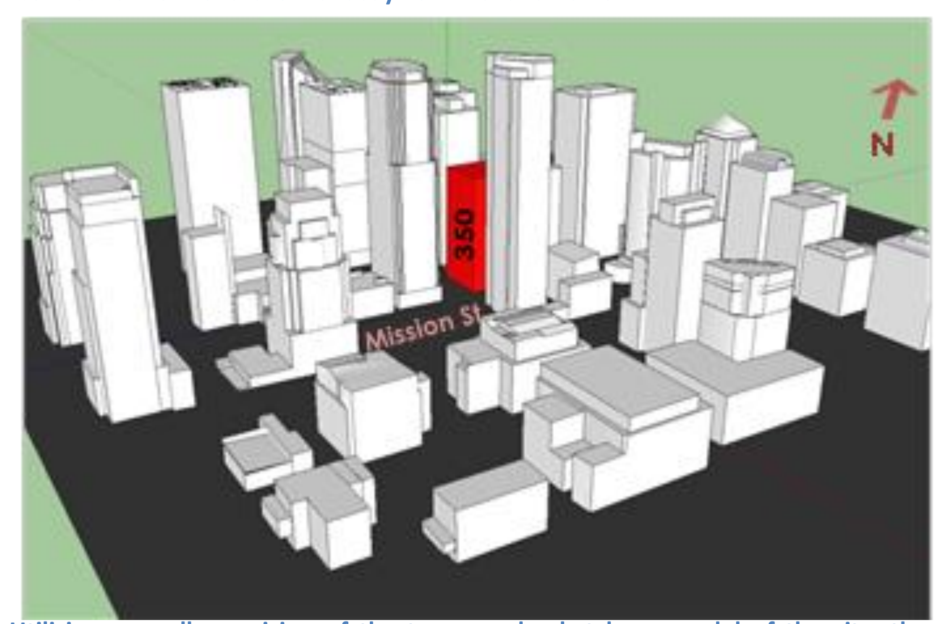
This process was aided by the September 26th, SOM Webinar where the speakers briefly identified some important site aspects that were key to the architectural goals of the project and would be worthwhile considering in our own design process. The results of this investigation and documentation are presented below.



Shown above is part of the project teams site context take aways on a larger scale. Highlihgted in blue are some of the important features of 350 Missions Urban setting. Notably are the locations of the future Transbay Terminal as well as the important connection to the Bay Bridge via Freemont Street.



Above is an image provided by SOM for the AEI Student Competition. The project team used this image to note the proximity of 350 Mission to other future developments going in. Also the importance of the southwest direction as a connection to the future Transbay Terminal and Tower.

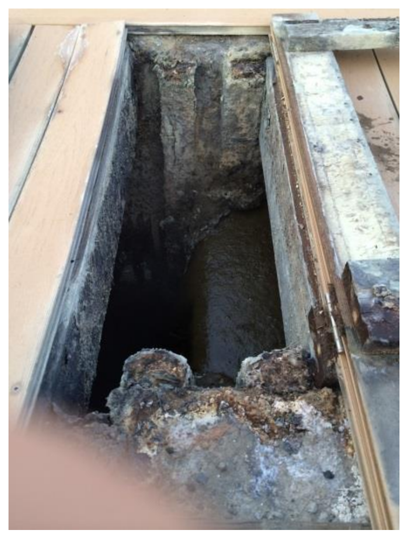


Utilizing a smaller verision of the team made sketch up model of the city, the project team was able to get a close up understanding of how 350 Mission sits in its Urban Condition. Of note was its height and stature in comparison to the buildings surrounding it. It is not trying to compete for height with its neighbors but still opportunity must be given to creat its own unique identity.

Appendix E – A Visit to Brubaker Farms

One of the critical systems integrated into our mechanical design for 350 Mission was a biomethane digester. This composition utilizes methane produced by compost, waste, and sewage remains and transforms it into energy usable by building systems. On November 15th, our team visited Brubaker Farms. Brubaker's has received considerable attention since the farm installed a methane digester on the farm's grounds. The digester is fed by composted waste materials, and cow manure. It not only powers mechanical and electrical systems at the farm, but also provides energy to neighbors of the farm. The farm saves a considerable amount of money by producing its own electricity, and also makes money by selling electricity back to the local grid. The trip to Brubaker Farm was an invaluable experience which helped the team understands the full impacts of installing such a system in the design of 350 Mission.

The team climbs atop the digester unit. The cover could support the loads imposed by us walking on it. Once a cow was found on top!



Digested products leaving the digester. The leftover materials are used to make bedding for animals at the farm.

Above: the team investigates a grate used to filter waste materials from grease. The farm uses waste grease from local businesses to produce methane.

The cow manure is harvested from the individual cow pavilions at the farm and pulled into an underground system that feeds the methane digester. The digester is constantly mixing to idealize residence time and minimize impact from turbine shutdown.

Temperature is consistently monitored, as is a backflow valve. The gas is chilled down to a humidity of less than 50°F because of the sulfate concentration. Carbon dioxide content is also monitored. Too much carbon dioxide in the system will cause the digester engines to malfunction.

The space housing the proposed system for 350 Mission must be appropriately designed to handle potential loads caused by digester malfunctions. Flammable hazards must be isolated from the digester, as several products of the digester are highly reactive with fire.

Only stainless steel is used in metal fittings, as other types of metals may erode from the gases produced in the digester. Comparable systems in Europe also utilize wood as a primary system component to absorb hydrogen sulfide from the digester.

The team observes the byproduct pond near the digester.

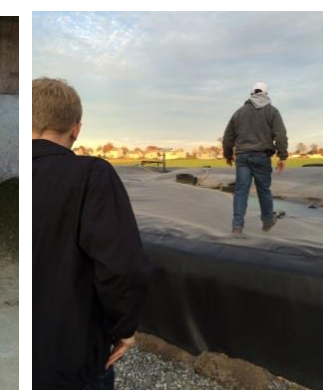
Filtered excess materials from the digester were stored in a pool.

The digester was located at the back corner of the farm.

The digester is a total of 16 feet deep and 96 feet wide in diameter. Programmable logic controls, or PLC controls, are used to maintain the digester at proper functioning levels.

The digester produces enough electricity to consistently power as many of 200 single family homes.

Byproducts of the digester are expelled into a basin. The leftover material may be dried and used as bedding for the animals. Personnel at Brubaker's told the team that the animals really enjoy the bedding material and it's completely sanitary. The farm also sells the material to nearby farms.



Above left: filtered and dried waste from the digester. Above center: The team is led onto the digester; Brubaker Farms personnel leading the team. Above right: The team visited the cows of Brubaker farms. The animals were very interested in the team's presence at the farm, and never missed the opportunity to come up to the group. At right: PLC control equipment, located in a facility near the biomethane digester.

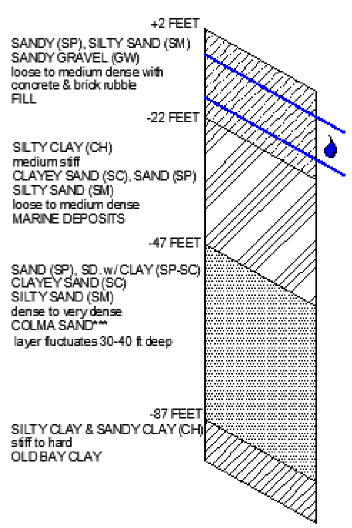
Appendix F - Basement Redesign

The redesign of the sub-grade levels of 350 Mission caused some contentious issues for the design team. Each discipline had various goals they wanted to achieve in the basement levels, as shown in Table ??? below. Through collaborative efforts, open communication, and consideration for holistic design; the team was able to achieve all desired goals, increase building energy efficiency, and add value to the building design.

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

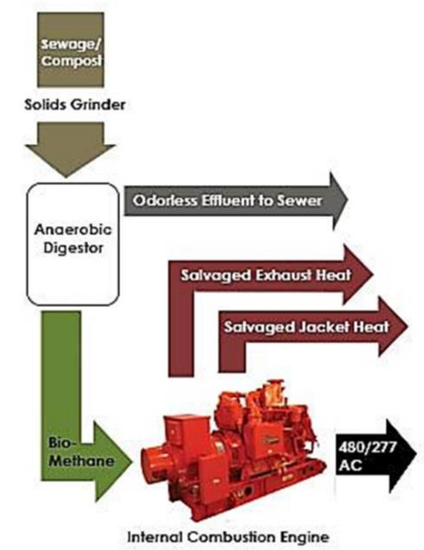
The main inter-disciplinary issue was the mechanical and electrical designers needed a larger floor-to-ceiling height in order to fit the methane digester system in Level B4. The structural team worked to reduce the weight of the superstructure and in turn minimize the mat slab thickness. The construction 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.

Construction



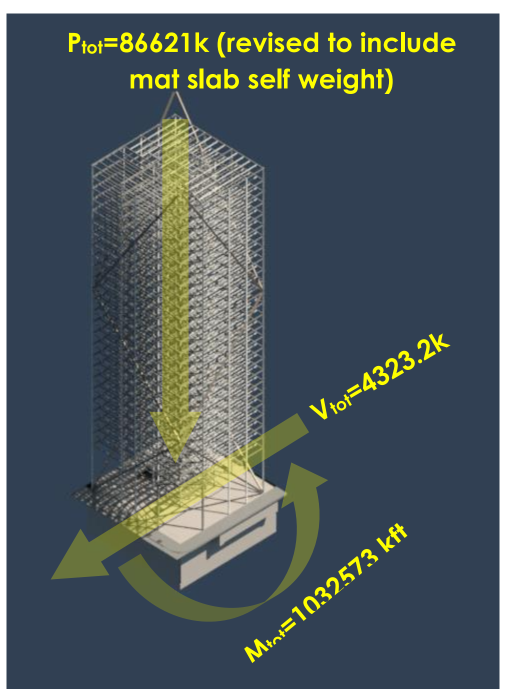
- **$ 1,687,143** savings on mat slab cost
- Mat slab depth at 47' feet below grade in Colma Sand layer
- Colma Sand layer provides 8,000-10,000 psf bearing capacity

Electrical

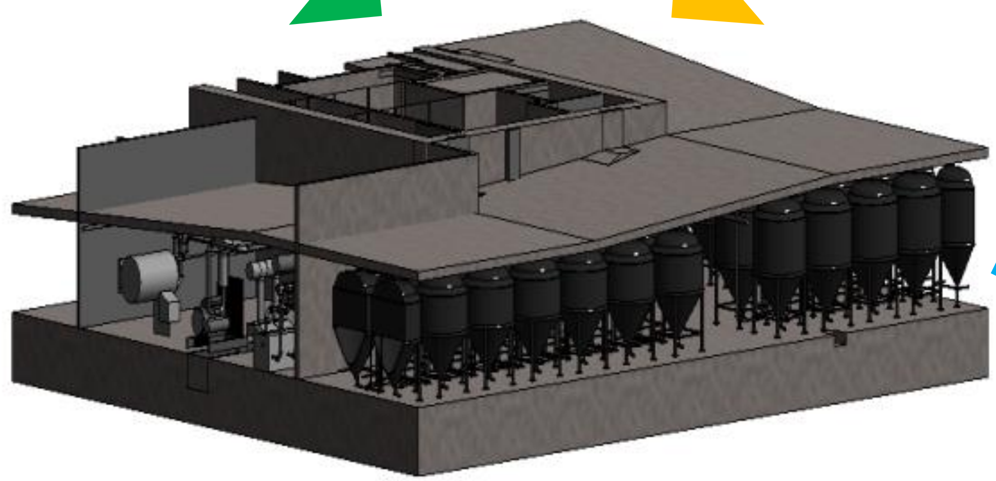


- Generates **310 kWh** for building power loads
- Full system is **78%** efficient based on usable output and fuel input
- **2,715,600 kWh** generated on site

Structural

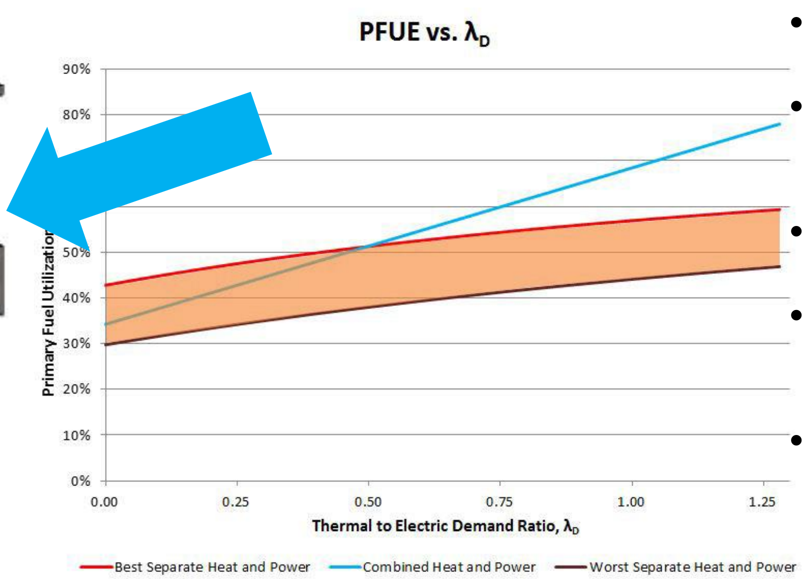


Reduced building gravity loads on foundation by 48%
Reduced mat slab thickness from 10 ft to 6 ft.



Produces **100%** of 350 Mission's yearly energy demand
Uses **352 gallons** of building sewage and food waste per day
Uses **2,863 gallons** of public waste per day
Uses **8,500 gallons** of public compost and food waste per day

Mechanical

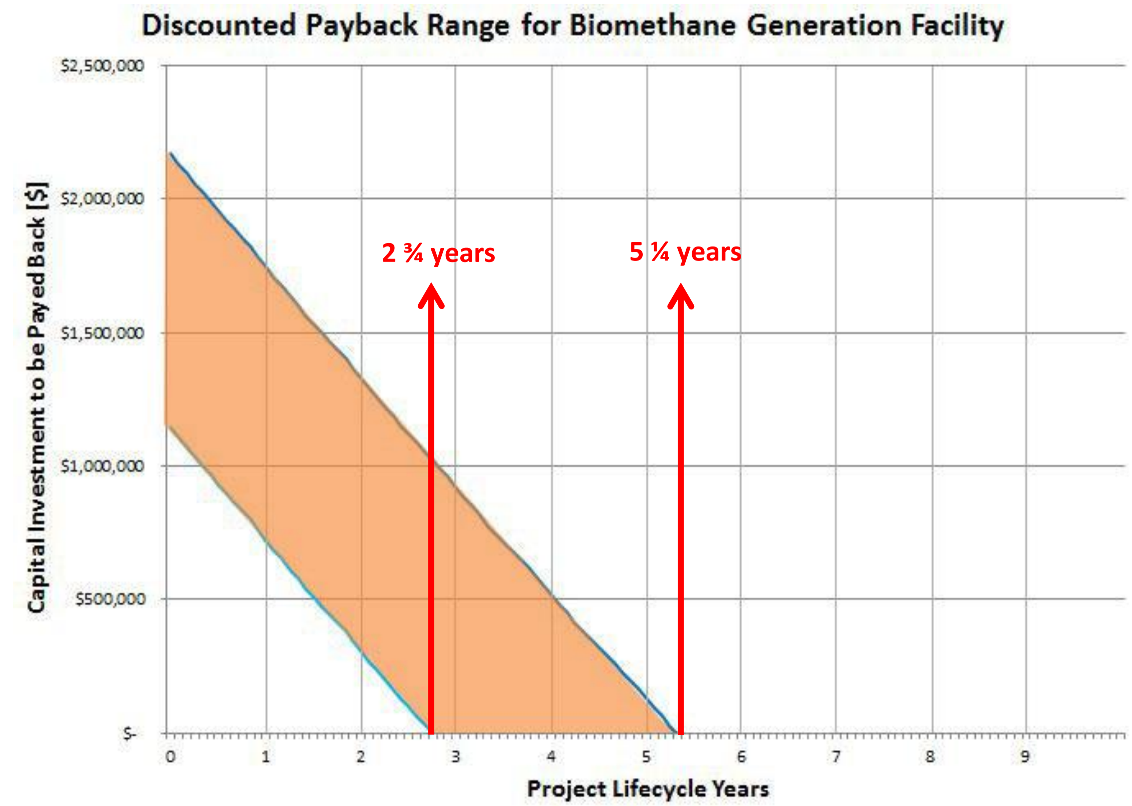


- Produces 72,300 ft^3 of methane per day
- Consists of 77 tanks at an average of 3,290 gallons each
- Requires 11,300 ft2 of floor space
- Capable of outputting 1,355,000 BTUh of usable hot water
- Allows the building to outperform the utility grid for 60 – 100% of the year

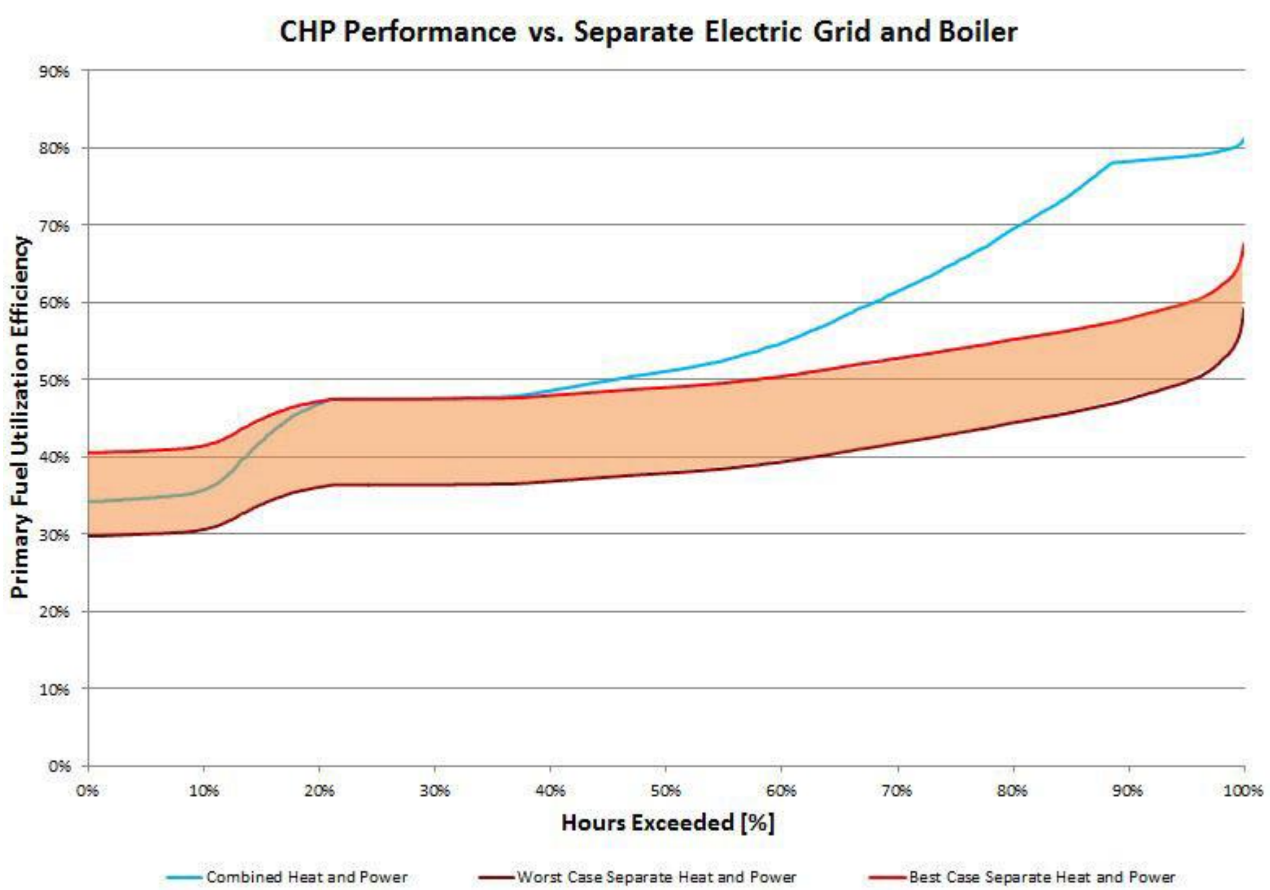
Appendix G – Combined Heat and Power Generation

imagination at work

Waukesha IC Engine		
Biomethane Flow Rate	4,649	[ft³/hr]
Usable Electricity	**310**	[kW]
Usable Jacket Heat	**785**	[kBTUh]
Exhaust Heat Output	877	[kBTUh]
HX Effectiveness	65%	
Usable Exhaust Heat	**570**	[kBTUh]
Electrical Efficiency	34.2%	
Overall Efficiency	**78.0%**	



Payback Analysis Conclusions. The figure on the left illustrates that, based on the sensitivity analysis, the BioDigestion Facility and Internal Combustion will have a discounted payback between 2 ¾ and 5 ¼ years. Though the project was presented to infer that budget would not be a major constraint in the pursuit of high-performance design, it is shown by this study that Near-net Zero Energy can be achieved in an economically-feasible, codifiable manner.



2,715,600 kWh

ELECTRIC OUTPUT

PER YEAR

11,869,800 kBTUh

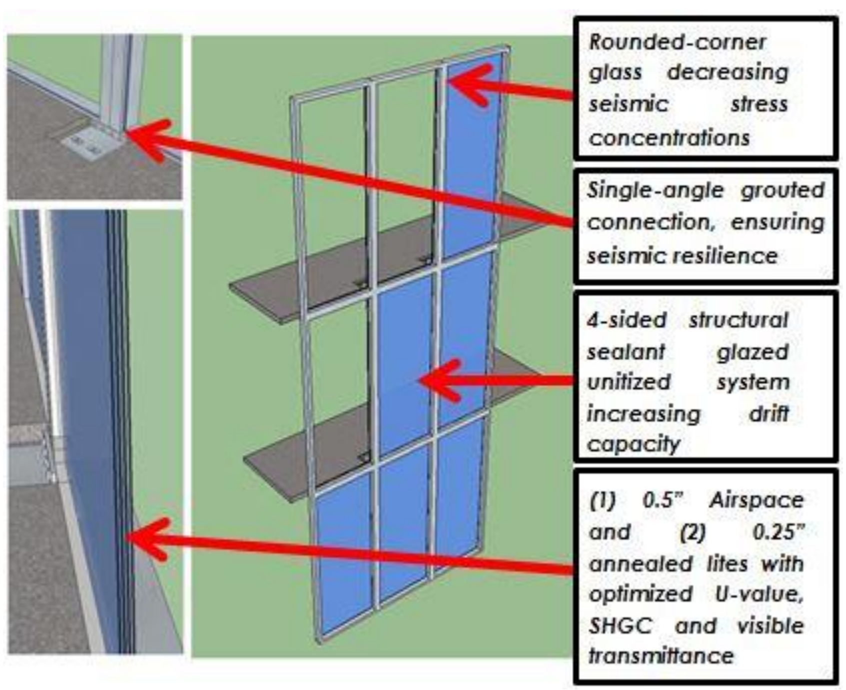
THERMAL OUTPUT

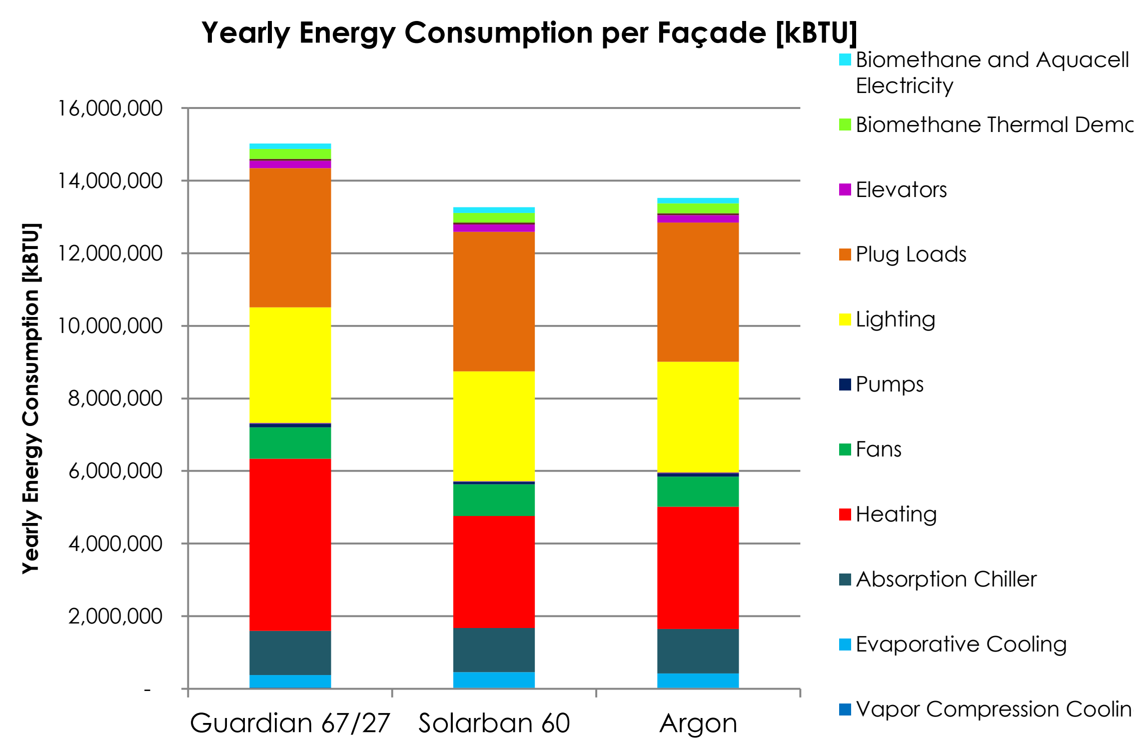
PER YEAR

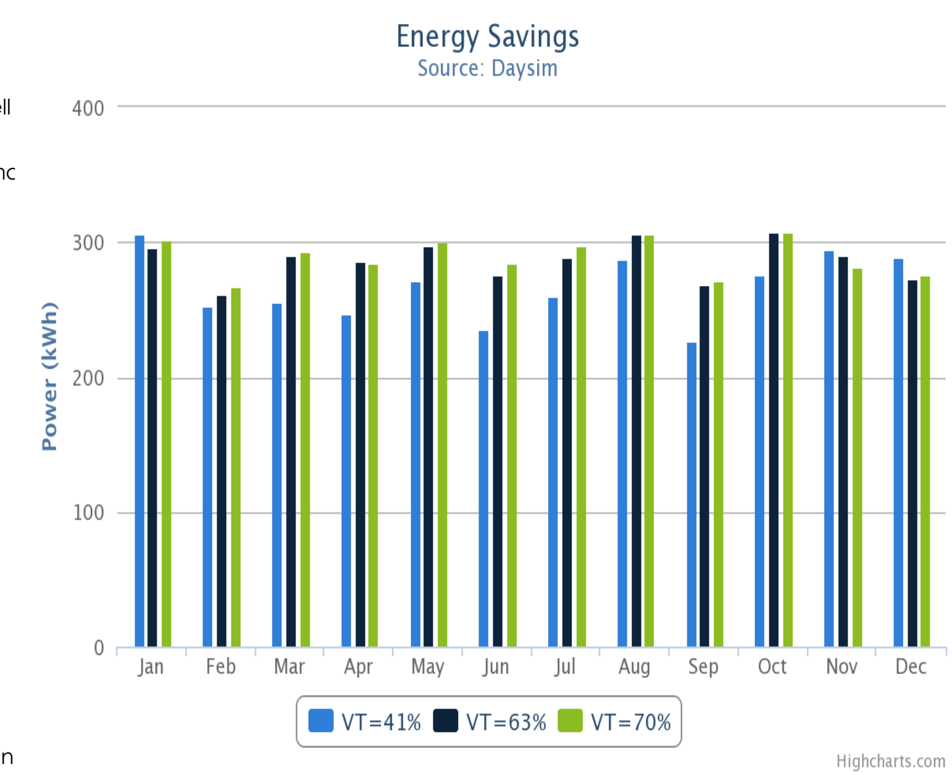
Appendix H- Façade

Facade Selection was a main point of building integration. Three glass types were selected for comparison. Following analysis, Solarban glass was selected. The daylighting savings were found to be negligible, while the extra insulation the glass provided decreased the heating load substantially.

Glass Type	Assembly U-value [BTU/hr-SF]	SHGC	VT	Space Conditioning Consumption [kBTU]	Yearly Energy Consumption [kBTU]	Total Kwh Saved with Daylight Dimming
Viracon Triple Pane	Viracon Triple Pane	0.17	41%	5,959,743	13,527,888	3201.37
Solarban 60	Solarban 60	0.40	70%	5,720,988	13,267,638	3475.44
Guardian 62/27	Guardian 62/27	0.35	63%	7,325,589	15,027,720	3444.13

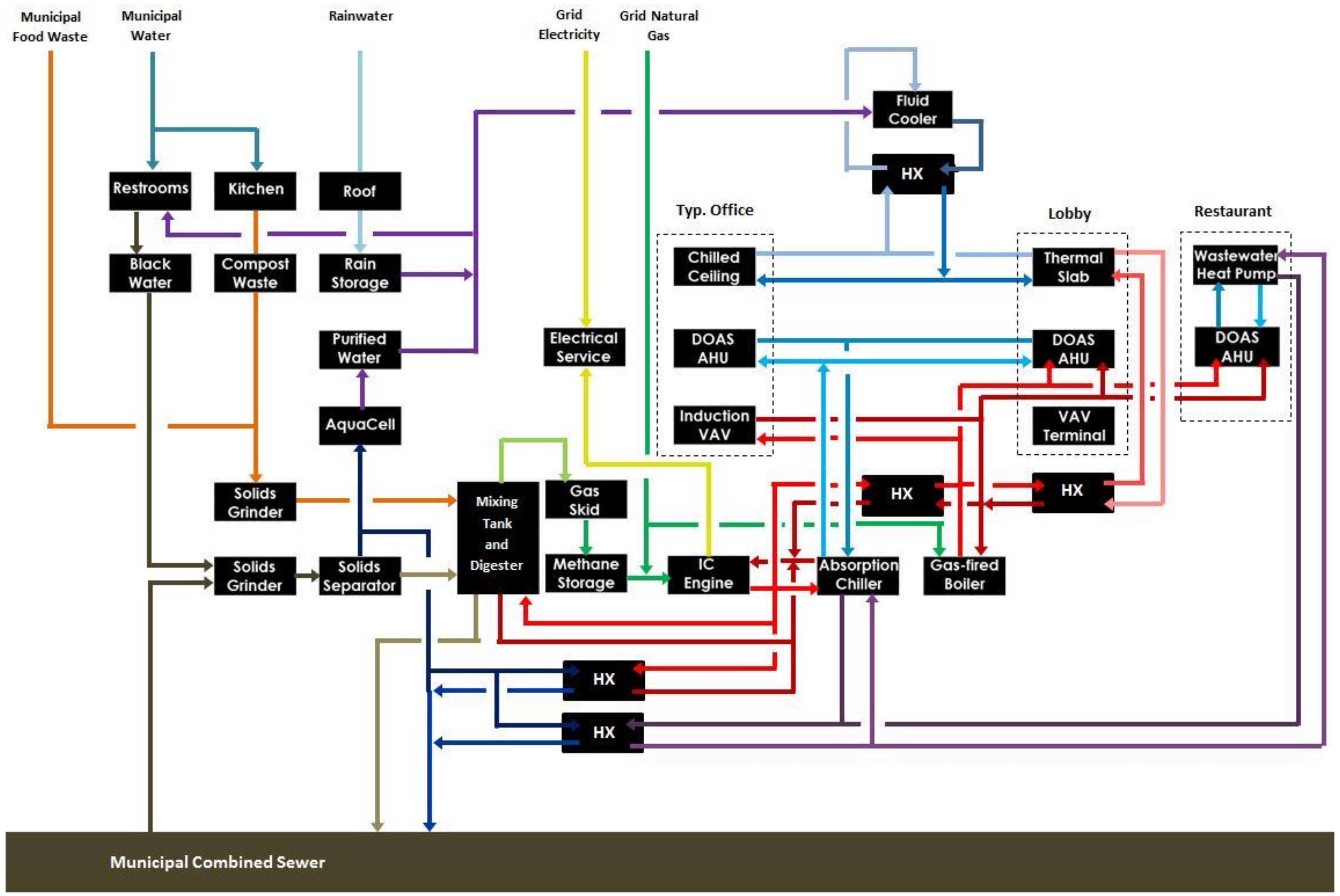






Visual Transmittance	Total kWh Saved
41%	3201.37
63%	3444.13
70%	3475.44

Appendix I - Building Resource Use



ENERGY

EUI: -0.02

100% REDUCTION

WATER

GAL: 1,169,158

84% REDUCTION

WASTE

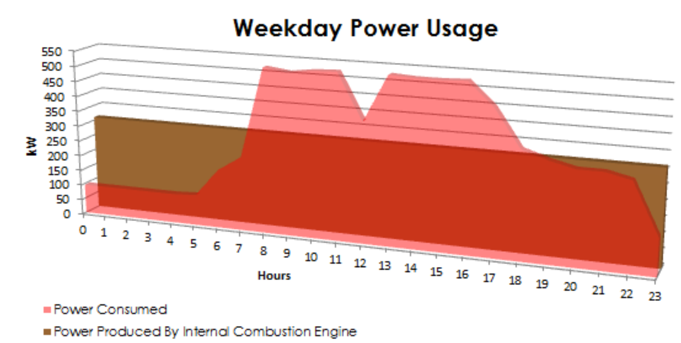
TON: 321

95% REDUCTION

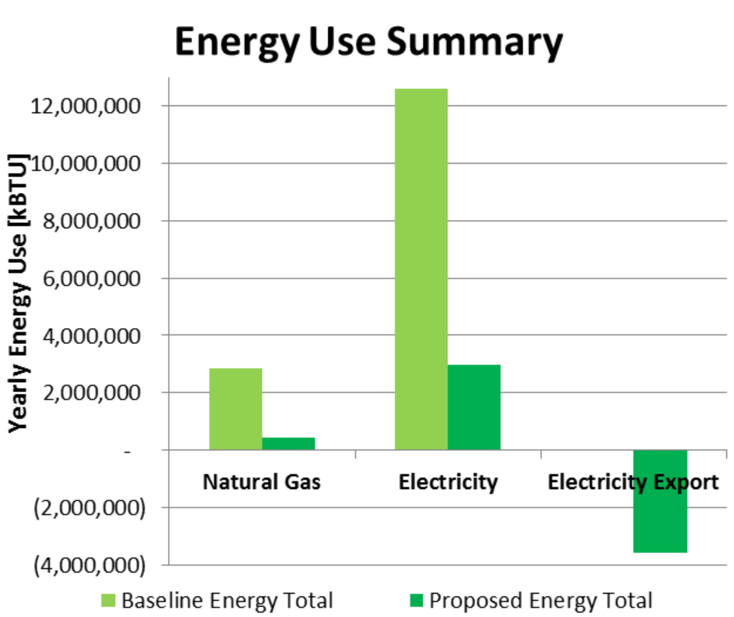
EMISSIONS

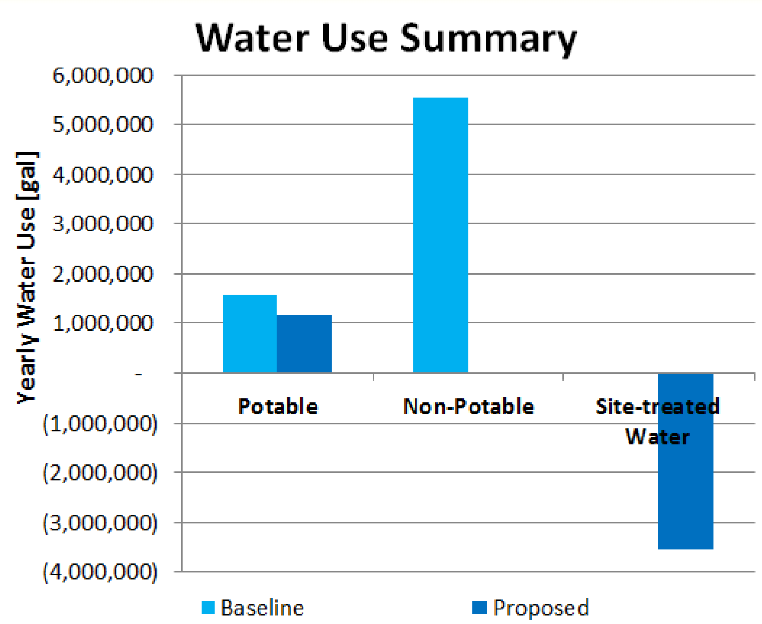
TON$_{CO2}$: 25

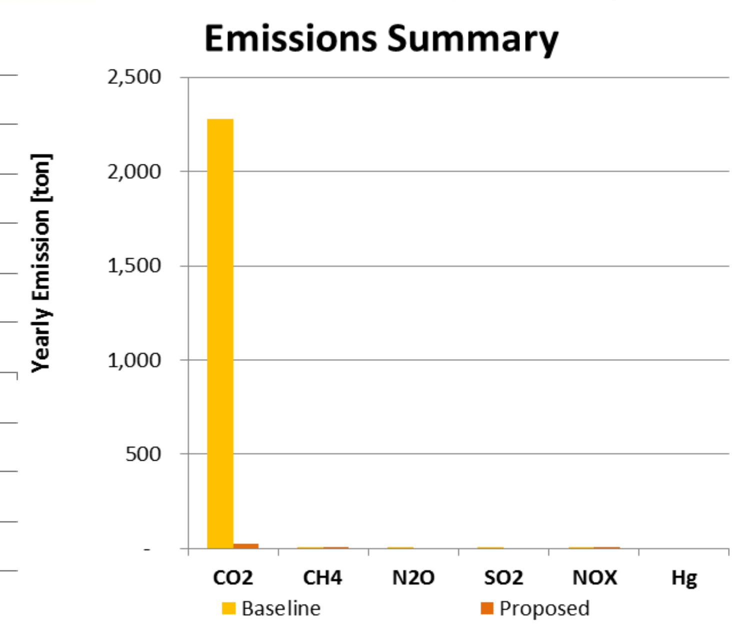
99% REDUCTION

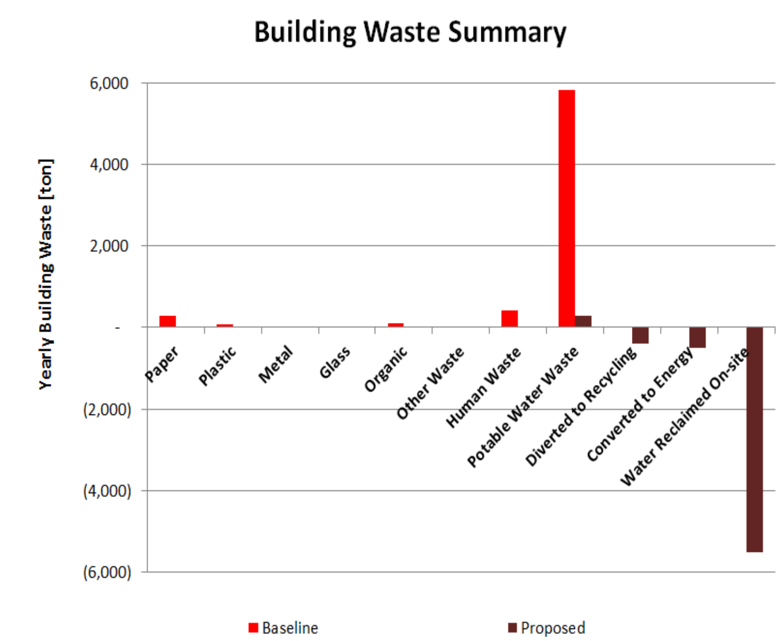


The profile on the left illustrates a typical weekday's electrical usage, showing periods during which electricity is both purchased and sold to the grid. The amount sold to the grid offsets the purchased energy and allows the building to minimize its environmental impact.









Appendix J - Budget

350 MISSION STREET

NEW DESIGN ESTIMATE

GARAGE, UNDERGROUND PARKING

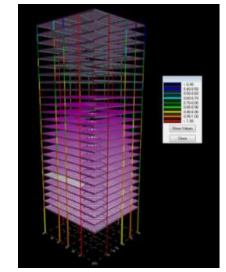
CODE	SECTION	INFORMATION	UNIT	UNIT COS'	COST PER S.F.	% OF SUB-TOTAL	TOTAL UNITS	TOTAL COST
A. SUBSTRUCTURE								
1010	Standard Foundations	Mat slab*(2) - 5 foot thick*(7)	-	-	-		-	$425,000.00
1030	Slab on Grade	5 in. reinforced concrete with vapor barrier & granular base	SQFT SLAB	6.93	3.47		18496	$128,177.28
2010	Basement excavation	Excavation 24 feet deep	SQFT GROUND	10.85	5.43		18496	$200,681.60
2020	Basement Walls	Concrete Walls*(1)*(5)	LNFT WALL	82	0.4	22%	710	$58,220.00
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	$1,734,924.80
B20 Exterior Enclosure								
2010	Exterior Walls	Cast-in-Place Concrete Slab, Steel Columns and Beams	SQFT WALL	25.65	4	7.10%	21760	$558,144.00
C. INTERIORS								
1010	Partitions	Concrete block*(3)	SQFT PARTITION	43.16	0.83		3600	$155,376.00
1020	Interior Doors	Hollow metal	EACH	9216	0.09		28	$258,048.00
2010	Stair Construction	Concrete	FLIGHT	66.25	34	2.30%	14	$927.50
D. SERVICES								
D20 Plumbing								
2010	Plumbing Fixtures	Drainage in parking areas, toilets, & service fixtures*(4)	EACH	0.06	0.06		43	$2.58
2020	Domestic Water Distributic	Electric water heater	SQFT FLOOR	0.11	0.11		73984	$8,138.24
2040	Rainwater drainage		SQFT GROUND	2.52	1.26	2.40%	18496	$46,609.92
D30 HVAC								
3010	Terminal Package Units	Exhaust fans	SQFT FLOOR	0.17	0.17	0.30%	73984	$12,577.28
D40 Fire Protection								
4010	Sprinklers	Dry pipe sprinkler system	SQFT FLOOR	4.12	4.12		73984	$304,814.08
4020	Standpipes	Dry standpipe system	SQFT FLOOR	0.15	0.15	7.20%	73984	$11,097.60
D50 Electrical								
5010	Electrical Service & Dist	200 ampere service, panelboard & feeders	SQFT FLOOR	0.14	0.14		73984	$10,357.76
5020	Lighting & Brance Wiring	T8 fluorescent fixtures, receptacles, switches, & misc	SQFT FLOOR	3.23	3.23		73984	$238,968.32
5030	Communications & Security	Addressable alarm systems & emergency lighting	SQFT FLOOR	0.18	0.18		73984	$13,317.12
5090	Other Elec	Emergency generator, 11.5 kilowatts	SQFT FLOOR	0.06	0.06	6.10%	73984	$4,439.04
E. EQUIPMENT & FURNISHINGS								
1030	Vehicular Equipment	Ticket dispenser, booths, automatci gates	SQFT FLOOR	0.41	0.41	0.70%	18496	$7,583.36

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	$116,440.00
B. SHELL								
B10 Superstructure								
1010	Floor Construction	Concrete slab, metal deck, beams, columns	SQFT FLOOR	28.26	26.49		554880	$12,968,211.00
1020	Roof Construction	Metal deck, open web steel joist, beams	SQFT ROOF	9.54	0.54	20.40%	18496	$352,903.68
1030	Core Construction	Steel members, hollow tubing	LF of members		-		27157.75	$8,665,351.78
1040	Exterior Bracing	Steel lateral members	LF of members				2113.33	$597,674.23
B20 Exterior Enclosure								
2020	Exterior Windows	Doubled glazed, heat absorbing, tinted plate glass wall panel	EACH	75	24.29	18.80%	12000	$1,800,000.00
2030	Exterior Doors	Double aluminum & glass doors	EACH	6311	0.67		10	$126,220.00
B30 Roofing								
3010	Roof Coverings	Single-ply membrane fully adhered	SQFT ROOF	5.76	0.36	0.30%	18496	$213,073.92
C. INTERIORS								
1010	Partitions	Gypsum board on metal studs	SQFT PARTITION	5.5	2.96		100000	$1,100,000.00
1020	Interior Doors	Single-leaf hollow metal	EACH	1152	2.89		910	$2,096,640.00
1030	Fittings	Toilet partitions	SQFT FLOOR	0.39	0.39		554880	$432,806.40
2010	Stair Construction	Concrete filled metal pan*(6)	FLIGHT	1.52	0.81		130	$395.20
3010	Wall Finishes	60% vinyl wall covering, 40% paint	SQFT SURFACE	1.52	0.81		100000	$304,000.00
3020	Floor Finishes	60% carpet tile, 30% vinyl composition tile, 10% ceramic	SQFT FLOOR	5.23	5.23		554880	$5,804,044.80
3030	Ceiling Finishes	Mineral fiber tile on concealed Z bars	SQFT CEILING	5.11	5.11	16.20%	554880	$5,670,873.60
D. SERVICES								
D10 Conveying								
1010	Elevators & Lifts	Four-geared passenger elevators	EACH	200,000	7.68	5.80%	7	$2,800,000.00
D20 Plumbing								
2010	Plumbing Fixtures	Toilet & service fixtures, supply & drainage	EACH	5622	4.18		470	$5,284,680.00
2020	Domestic Water Distributic	Oil-fired water heater	SQFT FLOOR	0.35	0.35		554880	$388,416.00
2040	Rainwater drainage	Roof drains	SQFT ROOF	2.88	0.18	3.60%	18496	$106,536.96
D30 HVAC								
3010	Biomethane Systems	Anaerobic Digester, Solid Seperator	EACH					$1,374,000.00
3020	Combined Heat and Power	Packaged CHP unit	EACH					$165,000.00
3030	Water	Evaporative Coolers, Absorption Heat Pump, Radient Panels, Boiler, Pump	EACH					$7,918,800.00
3040	Air	AHU's, fans	EACH					$120,000.00
3050	Distribution/Labor		SQFT	12.3			554880	$13,650,048.00
D40 Fire Protection								
4010	Sprinklers	Sprinkler system, light hazard	SQFT FLOOR	2.78	2.78		554800	$3,084,688.00
4020	Standpipes	Standpipes & hose system	SQFT FLOOR	0.54	0.54	2.50%	554800	$599,184.00
D50 Electrical								
5010	Electrical Service & Dist	2400 ampere service, panelboard, & feeders	SQFT FLOOR	0.89	0.89		554800	$987,544.00
5020	Lighting & Brance Wiring	High-efficiency fluorescent fixtures, receptacles, switches, AC, MISC	SQFT FLOOR	11.51	11.51		554800	$12,771,496.00
5030	Communications & Security	Addressable alarm systems, internet, phone wiring, & emergency lighting	SQFT FLOOR	6	5.4		554800	$6,657,600.00
5090	Other Elec	Emergency generator, 200 kilowatts, uninteruptable power supply	SQFT FLOOR	0.54	0.54	13.80%	554800	$599,184.00

TOTAL BASE	$100,933,216.05
CONTRACTOR	$23,214,639.69
ARCHITECT	$7,065,325.12
TOTAL	$131,213,180.87

*(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

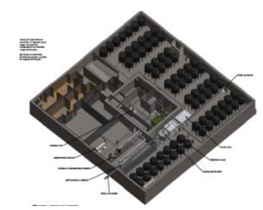


Structural System

Total Cost: $35,322,500

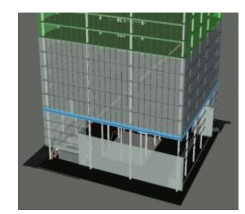
Electrical System

Total Cost: $20,295,400



Mechanical System

Total Cost: $23,240,400

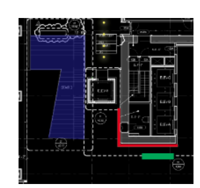


Exterior Façade

Total Cost: $2,409,800

Basic Office Floor

Total Cost: $2,300,800



Lobby Design

Total Cost: $252,690

The foundation of 350 Mission will be primarily composed of a **mat slab** with a thickness of 6' 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** & **external lateral bracing** compose the upper structure. The core and lateral bracing are designed to serve as the primary load paths above.

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.

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**.

The exterior façade will be composed of a **flat, glass curtain** wall system. **Solarban 60™** 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.**

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.

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:

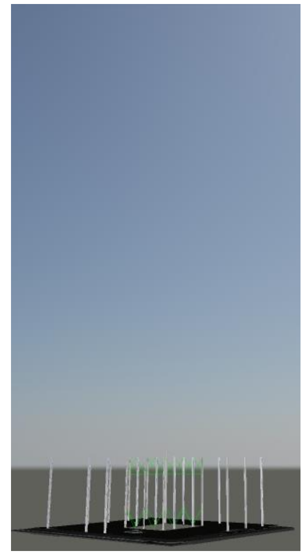
*Additional estimation can be found on **Appendix F.**

$131,213,180

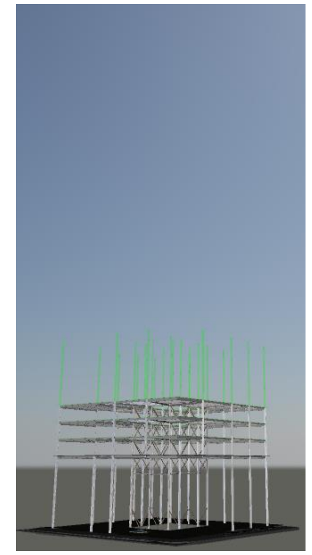
Appendix K- Construction Phasing

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 of building.

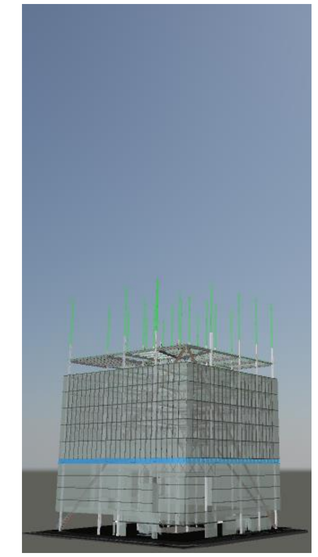
Once construction reaches above ground levels, the construction crew will initiate our "Psuedo-SIPS" concept, where series of repeated activities will round out the building's construction. The following steps highlight progression of the building once construction has begun on the floors above ground.



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.

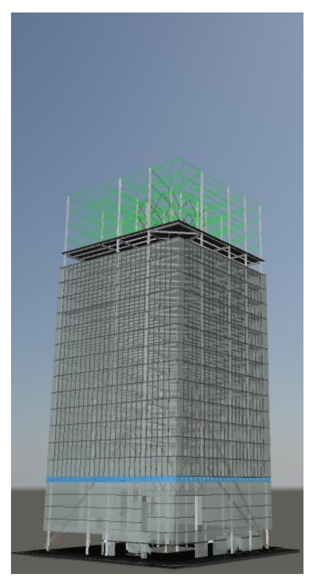


October 29, 2013: The first of the lateral braces are installed prior to facade initiation. Steel is finishing on floors 9-12. Facade work will begin on the lowest four floors and continue through floors 5-8. MEP installations will continue on the subgrade floors and on the lowest above ground floors

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.

JAN 2013

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.

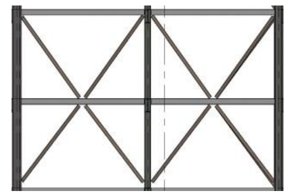
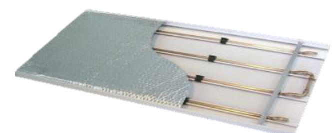
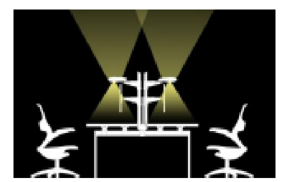
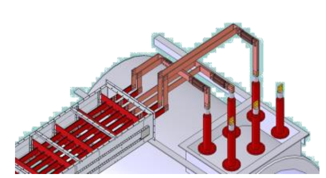
April 19, 2014: Structural columns and core reaches floors 21-24. Beams and girders will be set in place in the coming months. MEP installation commences on floors 13-16.

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.

JULY 2014

Appendix L –Construction Benefits from Building Systems

Construction Benefits from Modularization and Prefabrication		
Item	**Graphic**	**Benefits**
Prefabricated Core Members		• Shortens schedule by at least a week of welding time every four floors • Accelerates schedule in order to delegate work elsewhere onsite • Coordination becomes easier with crane picks because this lessons the amount of picks in a day • Money saved on labor costs
Radiant Ceiling Panels		• Easier trade coordination in the ceiling because they allow for smaller duct sizes • Decreases waste and trash on site
Tambient Desk Fixtures		• Without overhead lighting, it allows for easier trade coordination in the ceiling • Safer installation for trades because of the lack of ladders and scaffolding • Slightly less costly per unit, but for O&M purposes, annual cost is less expensive
Unitized Curtain Wall		• Schedule shortened by 3 weeks because of the smooth installation benefits • Lower field installation costs • Increased quality control because of controlled manufacturing methods
Prefabricated Rebar Cage		• Increased coordination in order to pick off truck and install for shoring/slab purposes • Less field time prepping for pours
Modular Digester Tanks	Image Unavailable	• Allows for easy Operation & Maintenance is something goes wrong with the system • Having multiple tanks allows for easier installation, as opposed to one bulky and heavy system
Lobby Radiant Floor Slab		• Allows for easy Operation & Maintenance is something goes wrong with the system • Having multiple tanks allows for easier installation, as opposed to one bulky and heavy system
Electrical Bus Duct		• Less coordination needed because there are less wires and conduit • Great for Operation & Maintenance purposes so that modular can be easily replaced if fried

Appendix M- LEED

SSc6.1: Stormwater Design. Implement a stormwater management plan that prevents the post development peak discharge rate & quantity from exceeding the predevelopment peak discharge rate & quantity for the 1- & 2-year 24-hour design storms. For additional information, visit the ***Mechanical Report.***

EAc2: On-Site Renewable Energy. Improvements over ASHRAE 90.1 baseline model microdigesterors & internal combustion engine in the basement. Additional information is available in the ***Mechanical Report*** *and* ***Electrical Report.***

MRc2: Construction Waste Management: Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that identifies materials to be diverted from disposal and when materials will be sorted on-site. Additonal information can be found in the ***Construction Report, Appendix D.***

LEED 2009 for New Construction and Major Renovations

Project Checklist

350 Mission
2/1/14

Y	?	N		Sustainable Sites	Possible Points: 26
21					
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
		X	Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Roon	1
3			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Ve	3
			Credit 4.4	Alternative Transportation—Parking Capacity	2
		X	Credit 5.1	Site Development—Protect or Restore Habitat	1
		X	Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
1			Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1

Y	?	N		Water Efficiency	Possible Points: 10
10					
Y			Prereq 1	Water Use Reduction—20% Reduction	
4			Credit 1	Water Efficient Landscaping	2 to 4
2			Credit 2	Innovative Wastewater Technologies	2
4			Credit 3	Water Use Reduction	2 to 4

Y	?	N		Energy and Atmosphere	Possible Points: 35
33					
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
9			Credit 1	Optimize Energy Performance	1 to 19
7			Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
			Credit 4	Enhanced Refrigerant Management	2
3			Credit 5	Measurement and Verification	3
2			Credit 6	Green Power	2

Y	?	N		Materials and Resources	Possible Points: 14
5					
Y			Prereq 1	Storage and Collection of Recyclables	
		X	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		X	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Element	1
2			Credit 2	Construction Waste Management	1 to 2
			Credit 3	Materials Reuse	1 to 2

Y	?	N		Materials and Resources, Continued	
1			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
		X	Credit 6	Rapidly Renewable Materials	1
		X	Credit 7	Certified Wood	1

Y	?	N		Indoor Environmental Quality	Possible Points: 15
12					
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
		X	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Product	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
		X	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
		X	Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

Y	?	N		Innovation and Design Process	Possible Points: 6
4					
1			Credit 1.1	Pilot Credit: Cooling Tower Water Use	1
1			Credit 1.2	Pilot Credit: Sustainable Wastewater Management	1
1			Credit 1.3	Pilot Credit: Occupant Engagement	1
1			Credit 1.4	Innovation in Design: Biomethane Generation	1
		X	Credit 1.5		1
		X	Credit 2	LEED Accredited Professional	1

Y	?	N		Regional Priority Credits	Possible Points: 4
3					
1			Credit 1.1	Regional Priority: On-site Renewable Energy	1
1			Credit 1.2	Regional Priority: Innovative Wastewater Technologies	1
1			Credit 1.3	Regional Priority: Water Use Reduction	1
		X	Credit 1.4		1

Y	?	N	Total	Possible Points: 110
88				

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

MRc4: Recycle content. Use materials with recycled content such that sum of postconsumer recycled content plus ½ of preconsumer content constitutes at least 10% or 20% based on cost, of the total value of materials in the project. Additional information can be found in the ***Construction Report, Appendix D.***

MRc5: Regional materials. Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within a specified distance of the project site for a minimum of 10% or 20%, based on cost, of the total materials value. Additional information can be found in the ***Construction Report, Appendix A.***

IEQc6.1: Controllability of Systems – Lighting. Tambient lighting fixtures at individual workstations provides complete user control. For additional information, visit the ***Electrical Report.***

IEQc8.2: Daylight and Views. The open office, architectural floor plan allows for direct line of site to the outdoors. For additional views, visit ***Drawing I9,*** *or the* ***Electrical Report.***

Appendix N- Life Cycle Analysis

Life Cycle Economic Analysis		
Baseline	Proposed	Simple Savings
$ -	$ 682,000	
$57,164.60	$ 16,993.79	$ 40,170.81
$49,523.49	$ 15,329.42	$ 34,194.07
$55,993.24	$ 17,133.23	$ 38,860.01
$52,048.47	$ 16,332.41	$ 35,716.06
$50,126.85	$ 15,408.77	$ 34,718.08
$50,396.38	$ 16,684.42	$ 33,711.96
$50,968.32	$ 16,846.69	$ 34,121.63
$50,772.95	$ 16,754.37	$ 34,018.58
$49,992.38	$ 17,126.39	$ 32,865.99
$49,584.62	$ 15,376.05	$ 34,208.57
$52,258.68	$ 16,233.56	$ 36,025.12
$59,338.11	$ 18,160.78	$ 41,177.33

Economics were considered from Year 1 through Year 80 using fuel escalation factors

$ 67,868.38	$ 19,054.09	$ 48,814.29
$ 56,552.99	$ 15,984.55	$ 40,568.45
$ 63,955.01	$ 17,940.89	$ 46,014.12
$ 58,105.44	$ 16,752.33	$ 41,353.11
$ 54,933.93	$ 15,737.01	$ 39,196.91
$ 54,857.61	$ 17,049.88	$ 37,807.73
$ 54,979.01	$ 17,216.31	$ 37,762.70
$ 54,829.35	$ 17,121.22	$ 37,708.13
$ 53,902.65	$ 17,504.40	$ 36,398.25
$ 54,086.22	$ 15,701.55	$ 38,384.67
$ 58,597.22	$ 16,699.59	$ 41,897.63
$ 69,883.81	$ 19,840.38	$ 50,043.42

$$\mathrm{NPV} = \sum_{t=0}^{N} \frac{R_t}{(1+i)^t}$$

t = time of the cash flow

i = discount rate

R_t = net cash flow at time t

BioMethane System Savings

$13,646,200 over **50-year LifeCycle**

85,148,815 kWh are *off the grid*

4,463,600 therms stay *underground*

CO_2 *reduced by* **52,100 tons**

114,300

TREES

910

CAR LIFETIMES

AquaCELL System Savings

296,333,500 gallons *of potable water*

Saved over **730 tons** of CO_2

1,600

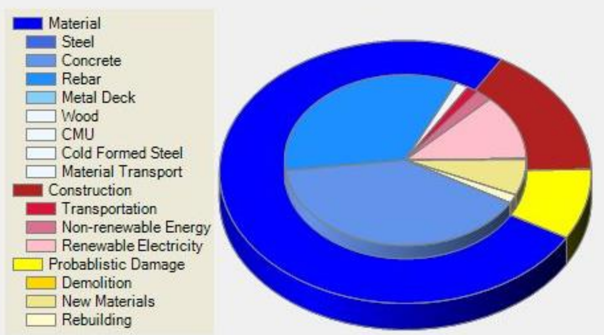
TREES

15

CAR LIFETIMES

Appendix O- Environmental Analysis

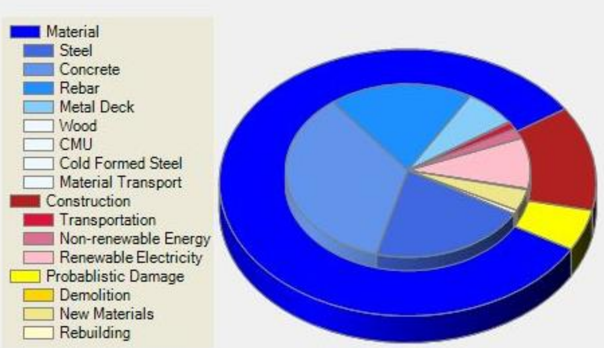
Project Title	350 Mission				
Project Size	371209 sq ft				
Construction - Total Duration	248 days				
	Superstructur	Substructur	Foundatio	Overall	
Material	13,100	1,780	1,110	16,000	tons CO2eq
Construction	3,190	76	138	3,400	tons CO2eq
Probablistic	1,840	0	0	1,840	tons CO2eq
Total	**18,100**	**1,850**	**1,250**	**21,200**	**tons CO2eq**



Emissions equivalents:
- **Power: 1,640 households for one month**
- **Fuel: 3,680 cars on the road for a year**

Carbon footprint; structural concrete building.

Project Title	350 Mission				
Project Size	515200 sq ft				
Construction - Total Duration	168 days				
	Superstructur	Substructur	Foundatio	Overall	
Material	11,100	3,820	1,580	16,500	tons CO2eq
Construction	2,010	155	362	2,530	tons CO2eq
Probablistic	997	0	0	997	tons CO2eq
Total	**14,100**	**3,980**	**1,940**	**20,000**	**tons CO2eq**



Emissions equivalents:
- **Power: 1,540 households for one month**
- **Fuel: 3,470 cars on the road for a year**

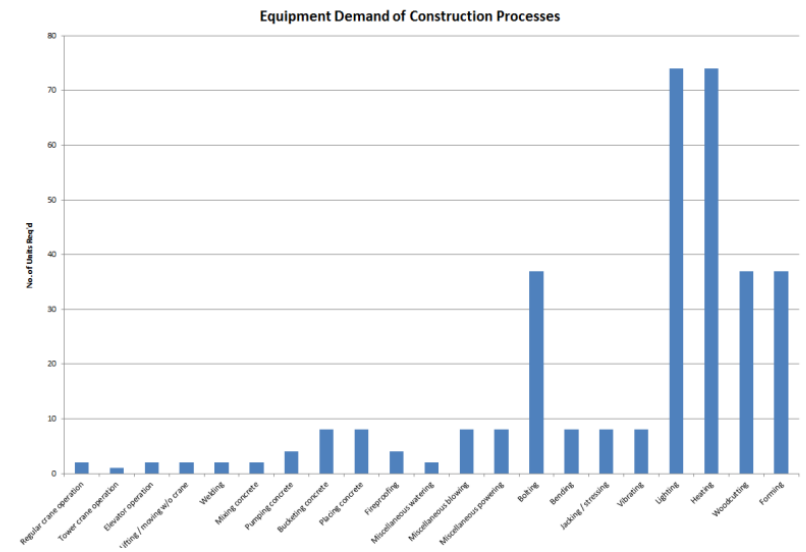
Carbon footprint; structural steel building.

Utilizing SOM's Environmental Analysis tool, the team investigated 350 Mission's total carbon footprint. The analysis included embedded carbon in building materials, as well as the carbon associated with the construction process.

For the sake of understanding how carbon is embedded in building materials, we developed two trials of calculations. The first was representative of a structural concrete building; the second represented our final design for 350 Mission which utilized steel in the structure.

The team noticed carbon differences in both the material aspects and construction decisions. Our design which utilizing structural steel produced a total carbon output of **16,500 tons.** This was approximately **500 tons** over the structural concrete design. However, the embedded concrete of the structural steel was **less** than that of the structural concrete building. Embedded carbon was most prevalent in the **foundation wall** and **mat slab** systems. This carbon is associated with the considerable concrete and rebar composing the subterranean structure of the building.

To lessen our environmental impact due to carbon emissions, the team developed a plan to utilize local materials and contractors to lower the carbon offset from transportation to and from the building site. Carbon associated with the construction processes and transportation of materials was restricted to approximately **2,530 tons.** Furthermore, we expect our workforce to produce approximately **1,250 tons** of carbon in transportation during construction. By connecting with construction personnel, we sought to instill work habits in the workforce which lowered personal carbon emissions. Further information may be found in **Appendix O.** Additional information on the environmental impact of construction can be found in the **Construction Report**.



Equipment demand for construction; produced by Environmental Analysis Tool.

350 MISSION CARBON FOOTPRINT			
	ORIGINAL BUILDING DESIGN	OUR TEAM	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	

Comparison: structural concrete verses structural steel & associated impacts.

	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	

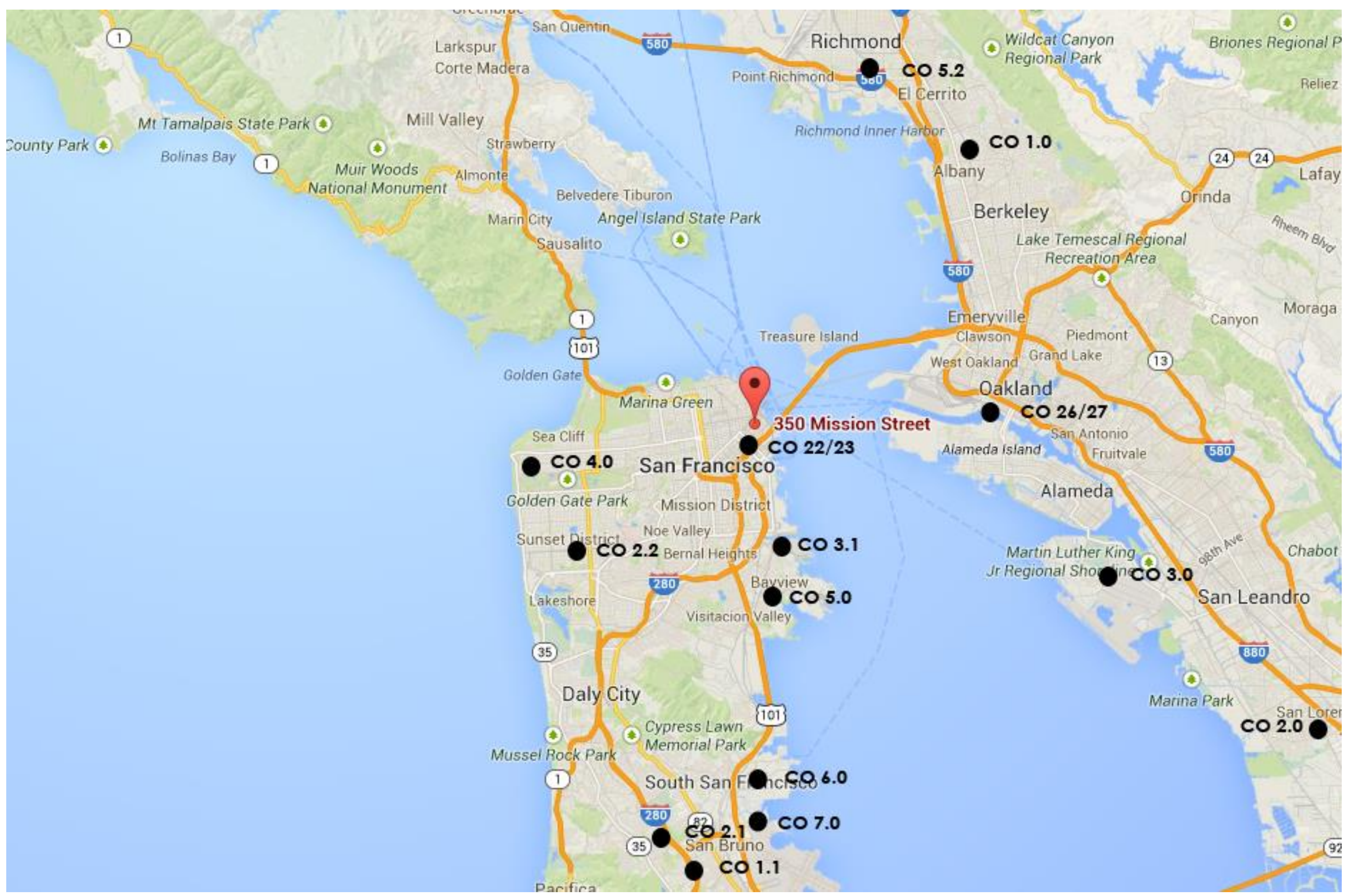
Estimated Cost-Benefit Tool; SOM.

Equipment impact was considered in analyzing the environmental impact of construction. Following the outlining of the construction schedule, durations in respect to specific pieces of equipment were developed. These durations were then inputted into the Environmental Analysis Tool before calculating total carbon footprint. As the circle graph at bottom left, and bar graph at top right identify, the total carbon attached to construction equipment equated to **2,530 tons.** The biggest impacts of this footprint were related to **electric and heat consumption**.

In total, we expect that the carbon both embedded in construction materials, and produced by the construction process equate to the **power required for 1,540 households for one month,** or the **fuel required for 3,470 cars for one year!**

The Environmental Analysis Tool also allowed us to see the immediate paybacks associated with installing enhanced building systems. In total, our enhanced building systems added a total of **20 million dollars** to the project budget. In the long run, we expect the total net benefit of installing these systems to be **$3,350,000.** As illustrated, our equivalent benefit/cost ratio sits at 0.2. This simulation, however, did not consider the full advantages associated with our mechanical building systems powering the building. The biomethane digester will pay for itself within **6 years** of installation. Operation and maintenance of this system alone will amount to **$484,773.** Fortunately, we expect a payback of **$3,481,690** from the digester's operations.

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



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].

SUBCONTRACTOR & WORKFORCE IMPACT

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.

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.

CARBON SUMMARY

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**.

Appendix P- Building Education

During Construction-Signage

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.

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.

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.

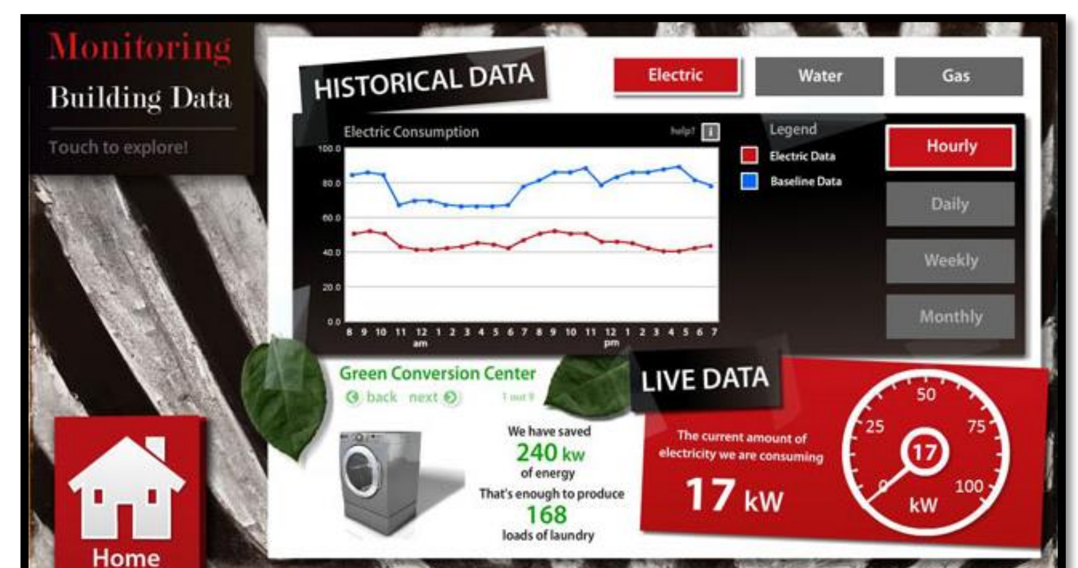
Post Occupancy-Energy Education

After putting so much effort into making 350 Mission the most sustainable building possible, the integrated project team sought to spread their stewardship. The team believes that education is an important part of green building that is often overlooked. Many buildings have sustainable features that occupants may not see or understand. 350 Mission will be a landmark that will attract building tenants and visitors for years to come. The project team wanted these building occupants to know how the building was waste and sewage powered. Spreading knowledge is the first step in producing a generation of people that will take responsibility in preserving the resources of our world.

QA graphics is a company that produces Energy Efficiency Dashboards. This dashboard will manifest itself in the form of a 50" touchscreen in the lobby atrium area. The screen will have 2:

- interaction demonstration
- an interactive quiz
- Tips about green living
- Information about color changing lights under the reception desk
- Chart and gauge showing water, electrical and biogas consumption.

Figure O1 : Sample Dashboard from QA that would display electrical usage



Appendix Q-References

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Solar Analysis

Preliminary solar research was conducted in order to test the building's site for possible photovoltaic usage for the purpose of power generation. Ecotect Analysis was used to perform this solar analysis for panels laid flat on the roof grid. As seen in Figure 1, the southern corner of the roof received the least amount of radiation due to the shading from the soon to be constructed, much taller, Transbay Tower. PV panels were later ruled out of the design, due to inadequate power generation required for this near net zero building.

Shown in Figure 2, prominent buildings surround 350 Mission St., including 45 Fremont St., 50 Fremont Center, and 50 Beale Street. As previously stated, the future structure, the Transbay Tower, will stand over 350 Mission St. by nearly 615 ft, to be known as the tallest building in San Francisco.

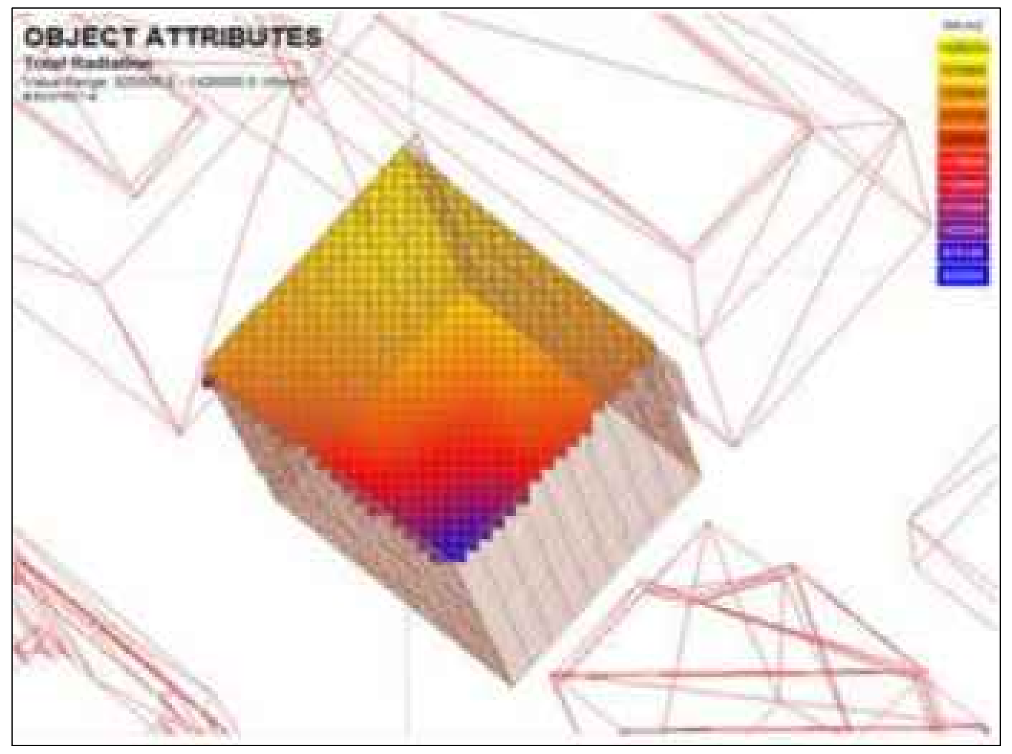


Figure 1: Ecotect Solar radiation Analysis

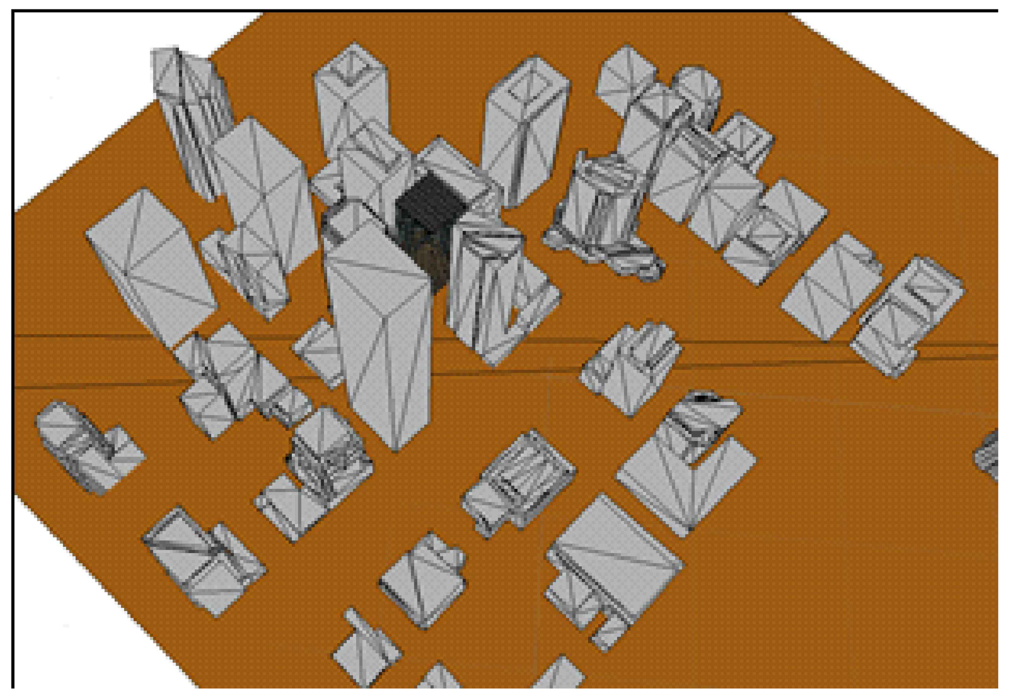


Figure 2: Ecotect surrounding buildings model

Geotechnical Analysis

Before any ground can be broken, and any structural design can be performed, a geotechnical report was compiled, which determined the structural stability of the site. A main conclusion taken from this report was the presence of the "Colma Sand" layer, which is known to be poorly consolidated and not ideal for structural support. These conditions drove the design of 350 Mission's structural foundation system

With San Francisco being located relatively close to the bay, it retains a high ground water level, requiring construction to spend more time coordinating dewatering strategies in order to accommodate for a water table level between -3 to -17 feet. Using an Eductor Dewatering system, groundwater will be easily mitigated in order to allow for excavation to occur.

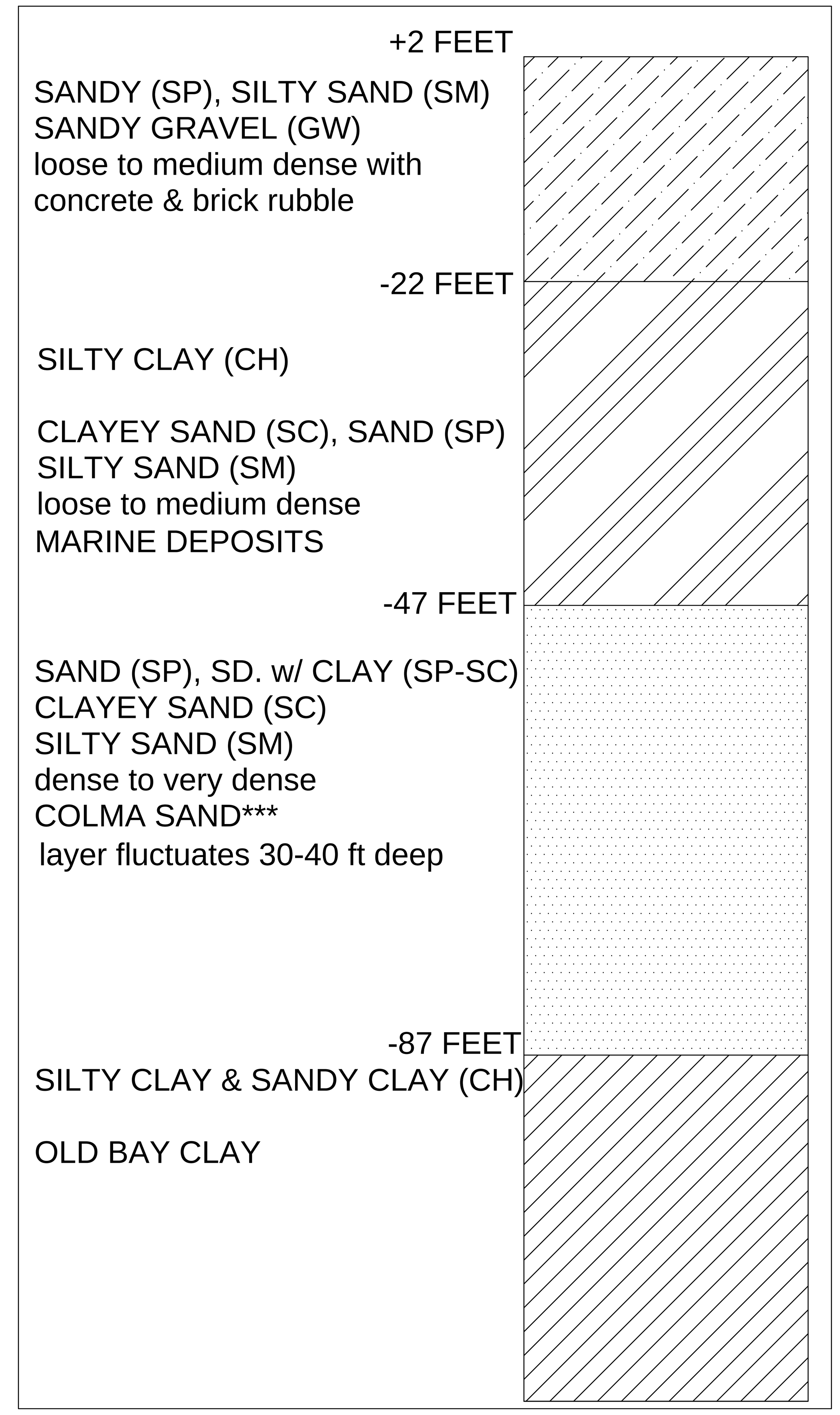


Figure 3: 350 Mission St. soil hiarchy diagram

Wind Analysis

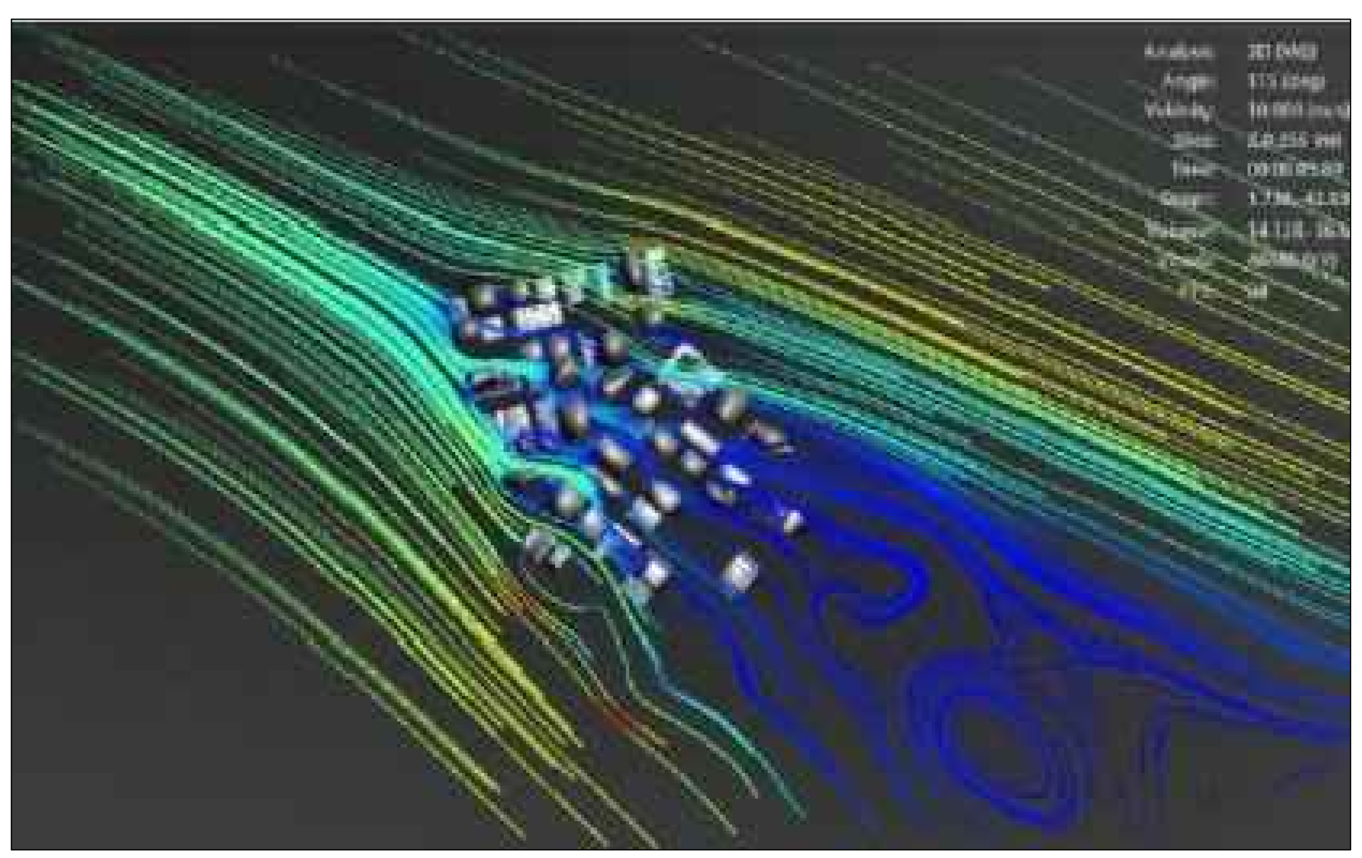


Figure 3: A wind simulation study was performed to test the effectiveness of wind turbines.

In order to assess the potential for using building-integrated wind turbines for power generation, Large Eddy CFD simulations were used to analyze predominant wind directions. As previously shown in the solar analysis, the density of the San Francisco urban environment proved inadequate for usable wind. Therefore wind turbines were discarded as an energy-generation strategy.

Traffic Analysis

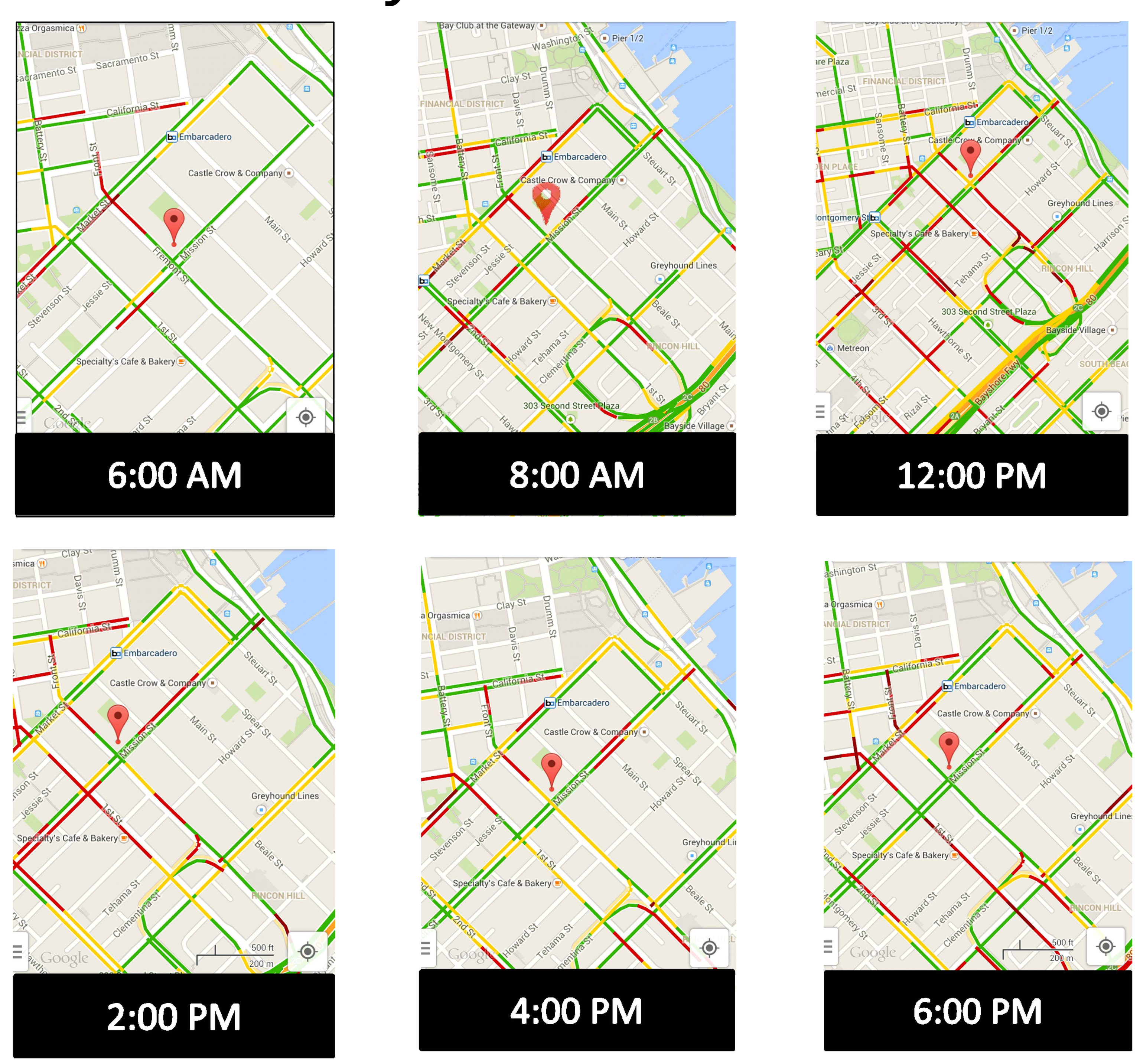


Figure 4: A Google Maps traffic study helped to determine traffic densities and street familiarity.

In order to gain vital knowledge pertaining to material deliveries and street block-offs, a traffic study was performed on a typical Wednesday work day. Using Google Earth, "Traffic Mode", one can determine the traffic densities of different streets surrounding 350 Mission St. Color densities vary from light, medium, and heavy, using corresponding colors of green, yellow, and red, shown in Figure 4.

The main streets of concern were Fremont St. and Mission St., which were primary access routes to the construction site. Mission St. showed more traffic density throughout the day, which proved that Fremont St. would allow more space for site logistic purposes. Also, an entrance gate and exit gate could be accessed coming off of Fremont St., hopefully avoiding the daily traffic on Mission St.

Studying these results proved that the best times for material delivery were between 6:00 AM - 9:00 AM, while it is still early, and 3:00 PM - 6:00 PM, while people are leaving the city for home. This traffic analysis allowed information to be gained on a city of unfamiliarity.

PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

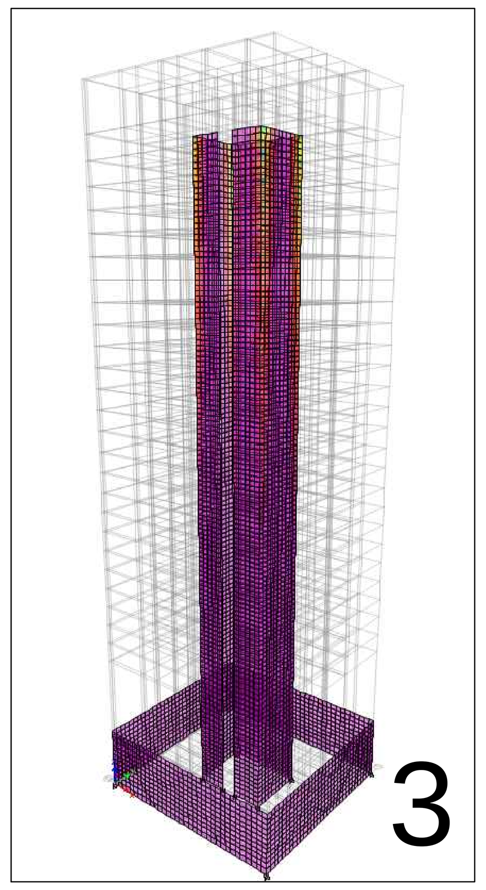
PURPOSE

ASCE STUDENT COMPETITION
AEI 2 - 2014

DRAWING TITLE

INTEGRATION -
SITE ANALYSIS

SCALE:	N/A
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	AEI 2 - 2014
SHEET NUMBER:	I1



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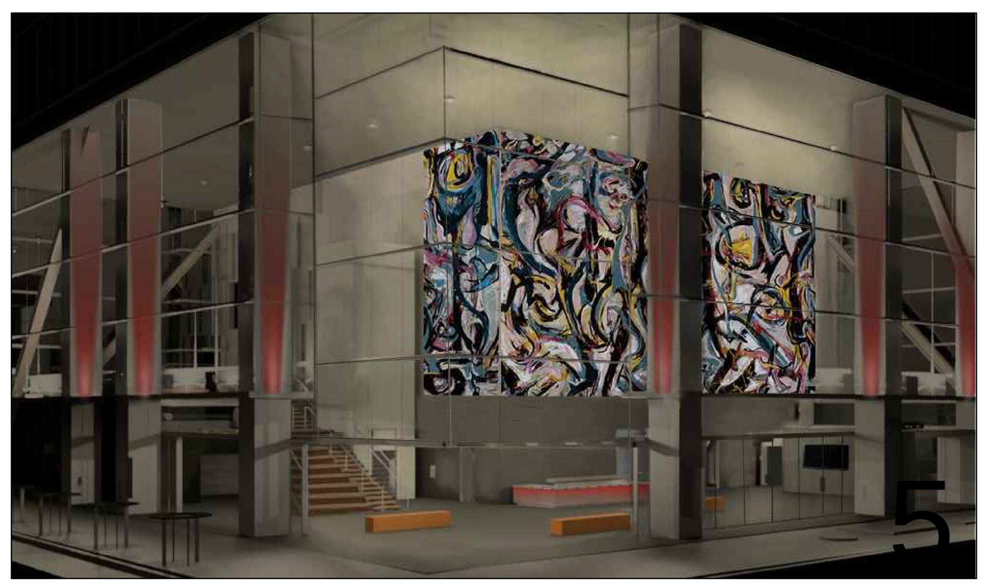

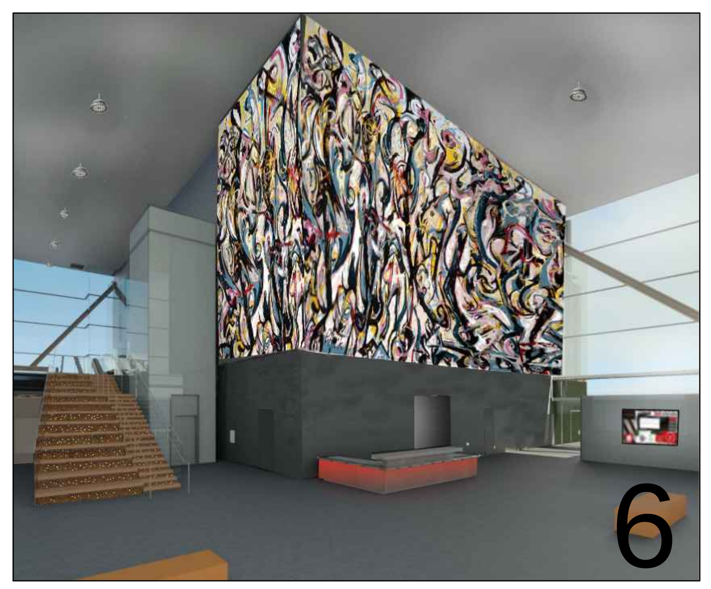

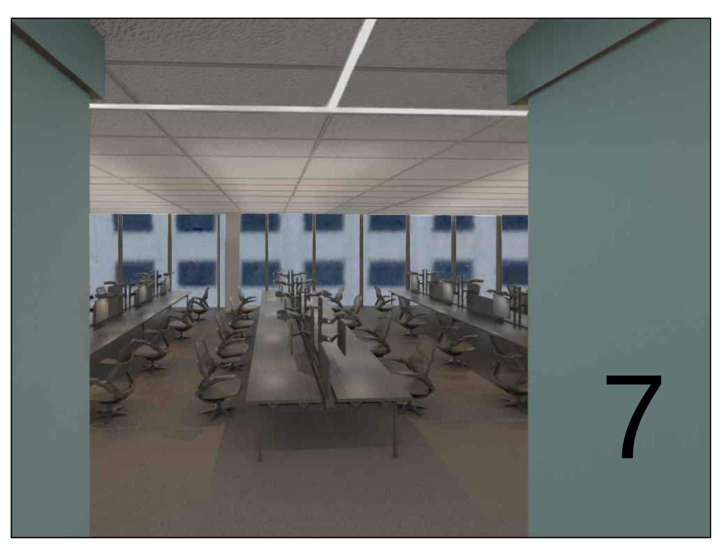

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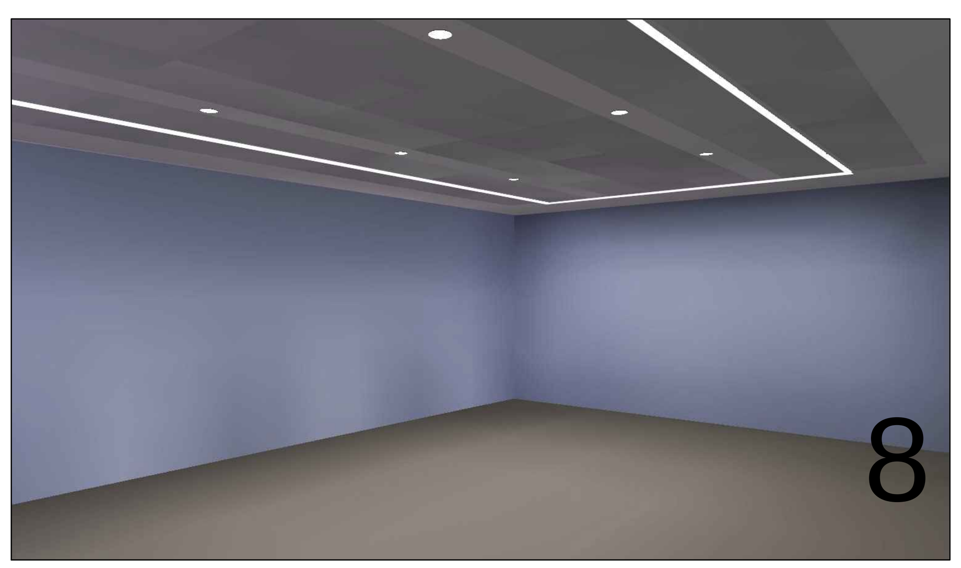
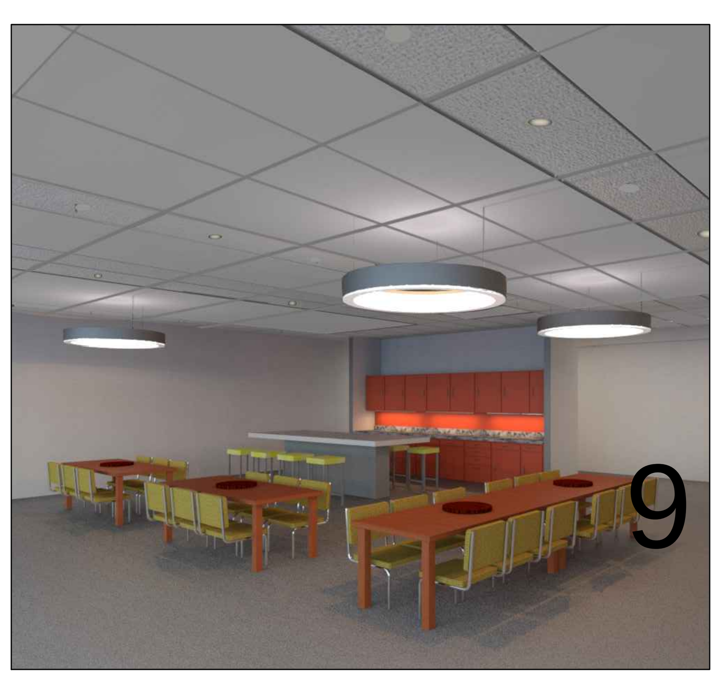
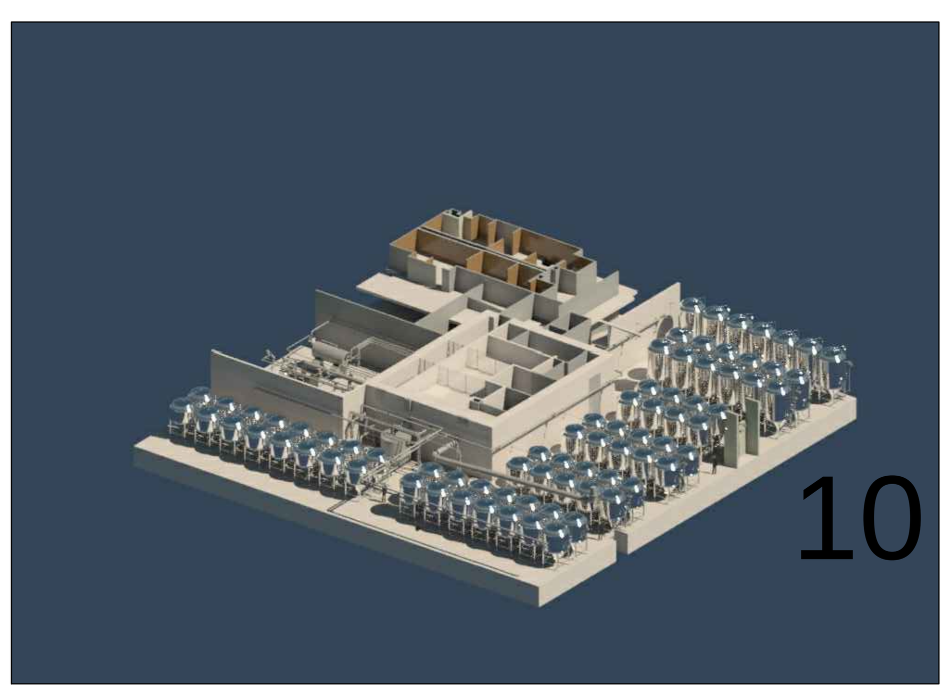






350 MISSION

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

AEI 2 - 2014 TEAM 2

DRAWING TITLE

INTEGRATION-
BUILDING
OVERVIEW

SCALE: N/A

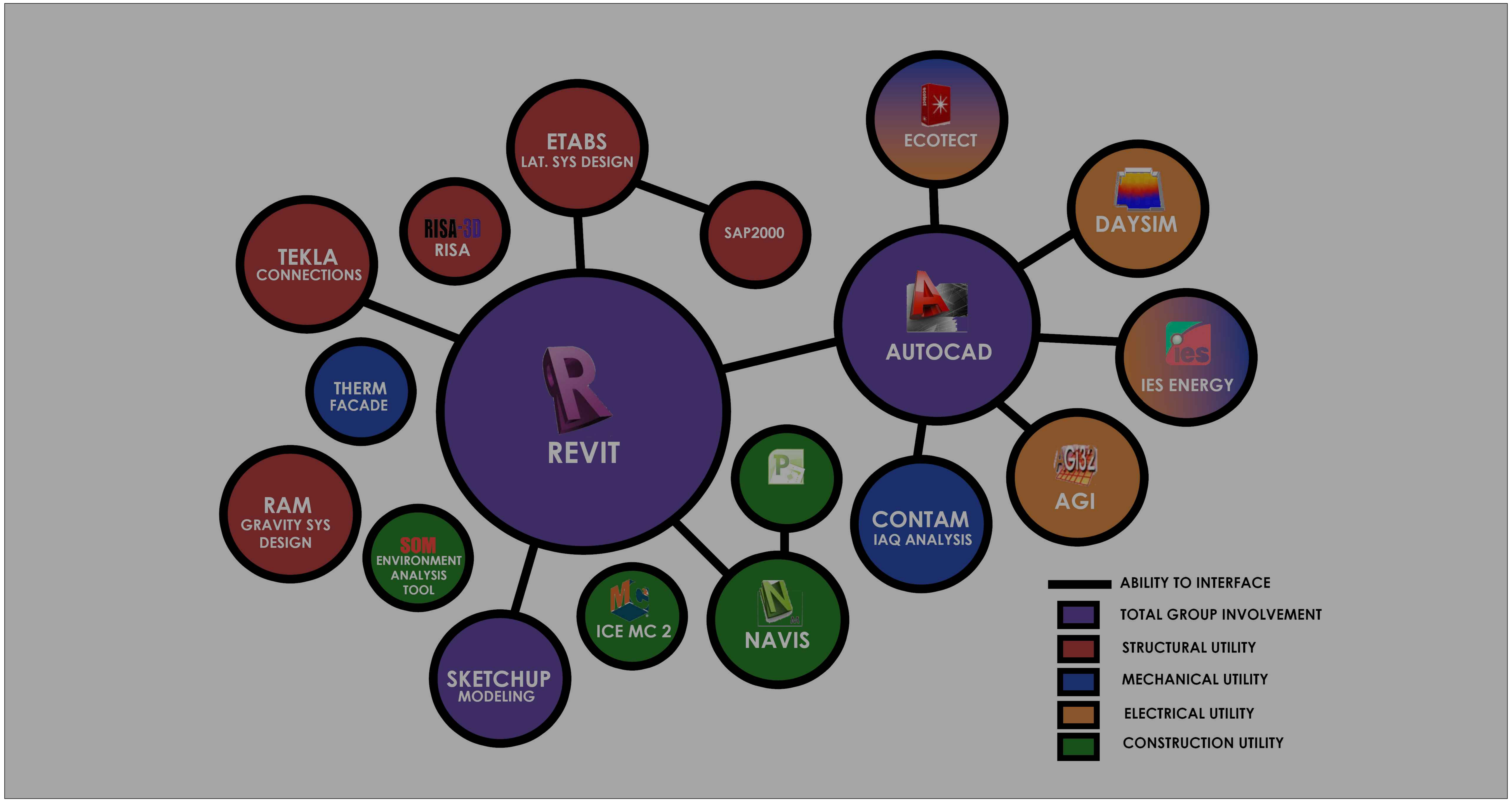
JOB NUMBER: 350 MISSION

DATE: 02/17/2014

DRAWN BY: AEI 2 - 2014

SHEET NUMBER:

I2



STRUCTURAL UTILITIES

RAM Structural System: RAM was used in gravity system analysis and design. RAM provides a cohesive method for analyzing and designing member sizes of the gravity system. The software interfaces directly with Revit which streamlines model building and design updates.

TEKLA: Tekla was used in modeling structural connections for the structural designers. The software was used simply as a tool to model detailed lateral system connections in order to help the designer visualize and describe the connection requirements. TEKLA can interface with Revit, however this feature was not used for this iteration of the design phase.

RISA: Risa was primarily used for quick analysis of typical members and simplified frames. The designers often used RISA to quickly verify more complex model results from other programs or hand calculations.

ETABS: ETABS was used to perform lateral system analysis and design, as well as full building system analysis. ETABS provides the opportunity to complete in-depth, complex analyses and gives the designer accurate, useful output in order to streamline design.

SAP2000: SAP was used for two-dimensional analyses of the cantilevered beams and their interaction with the supporting columns. SAP provided the structural engineers with a program that could do in-depth analyses without building a large, complex model.

MECHANICAL & ELECTRICAL UTILITIES

ECOTECT: Ecotect was used in studying the potential for photovoltaic technology in the building's design. Ecotect can directly interface with AutoCAD.

DAYSIM: Daysim was used to analyze the effects of daylight on the interior spaces of the building and make decisions to dim those spaces. Furthermore this program was used to identify shading on the 350 Mission. Daysim is directly compatible with AutoCAD.

IES: IES was used to optimize the facade's composition. The team used IES to identify direct sunlight hours throughout the year on the building. IES is compatible with AutoCAD.

AGI: AGI was used to monitor and prepare power density and illuminance levels in the interior building spaces. AGI can directly interface with AutoCad.

CONTAM: Multizone modeling tool to assess containment migration in the indoor environment. AEI 2 used this software to justify lobby design strategies.

CONSTRUCTION UTILITIES:

PROJECT: Microsoft Project was used to outline the total building schedule. As described earlier, the project schedule was divided into two primary halves: subterranean construction and above ground construction. Project helped the team develop a comprehensive schedule which physically organized the separate 4-floor phases of the above ground construction. Project was then able to interface with Autodesk Navisworks. Microsoft Project activities were then linked to individual pieces of the building model from Autodesk Revit.

ICE MC2: ICE MC2 was used to estimate individual building assemblies. The program was critical in developing an estimate for the mat slab and foundation wall systems. These values were then integrated into a comprehensive estimate. The building budget pulls together numbers from ICE MC2, RS Means Estimating publications, and product details.

NAVISWORKS: Autodesk Navisworks interfaced with both Revit models, and Project scheduling. The team linked pieces of the Revit model to items on the project schedule, to produce a 4D construction schedule. This schedule provided team members with a three dimensional view of building progression. Furthermore, it better allowed the team to develop a phased construction schedule, especially in the rapid development of the office floors .

SOM ENVIRONMENTAL ANALYSIS TOOL: The team utilized SOM's Environmental Analysis tool to understand the carbon impacts from building construction and material utilization.

Furthermore, the tool allowed the team to analyze the payback associated with installing enhanced building systems.

TOTAL GROUP UTILITIES:

REVIT: Autodesk Revit was used to model entire building systems. Individual models were conceived for electrical, mechanical, structural, and architectural systems. They were then linked together in a central Revit file. Alterations were made after coordinating building systems in Autodesk Navisworks. Revit could directly interface with Etabs, Tekla, Sketchup, and Navisworks.

AUTOCAD: System details and diagrams were developed using Autodesk AutoCAD. CAD was used to provide further details which were not identified in the Revit Model. AutoCAD was also used to model electrical and lighting plans, both in two dimensions and three dimensions. AutoCAD files could interact with Ecotect, Daysim, IES, AGI, Contam, and Revit.

SKETCHUP: Sketchup was used to simply model building systems. This program was critical in early conceptual design and design development. Sketchup interfaces with Autodesk Revit.

PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE

ASCE STUDENT COMPETITION

AEI 2 - 2014

DRAWING TITLE

INTEGRATION -
SOFTWARE FLOW

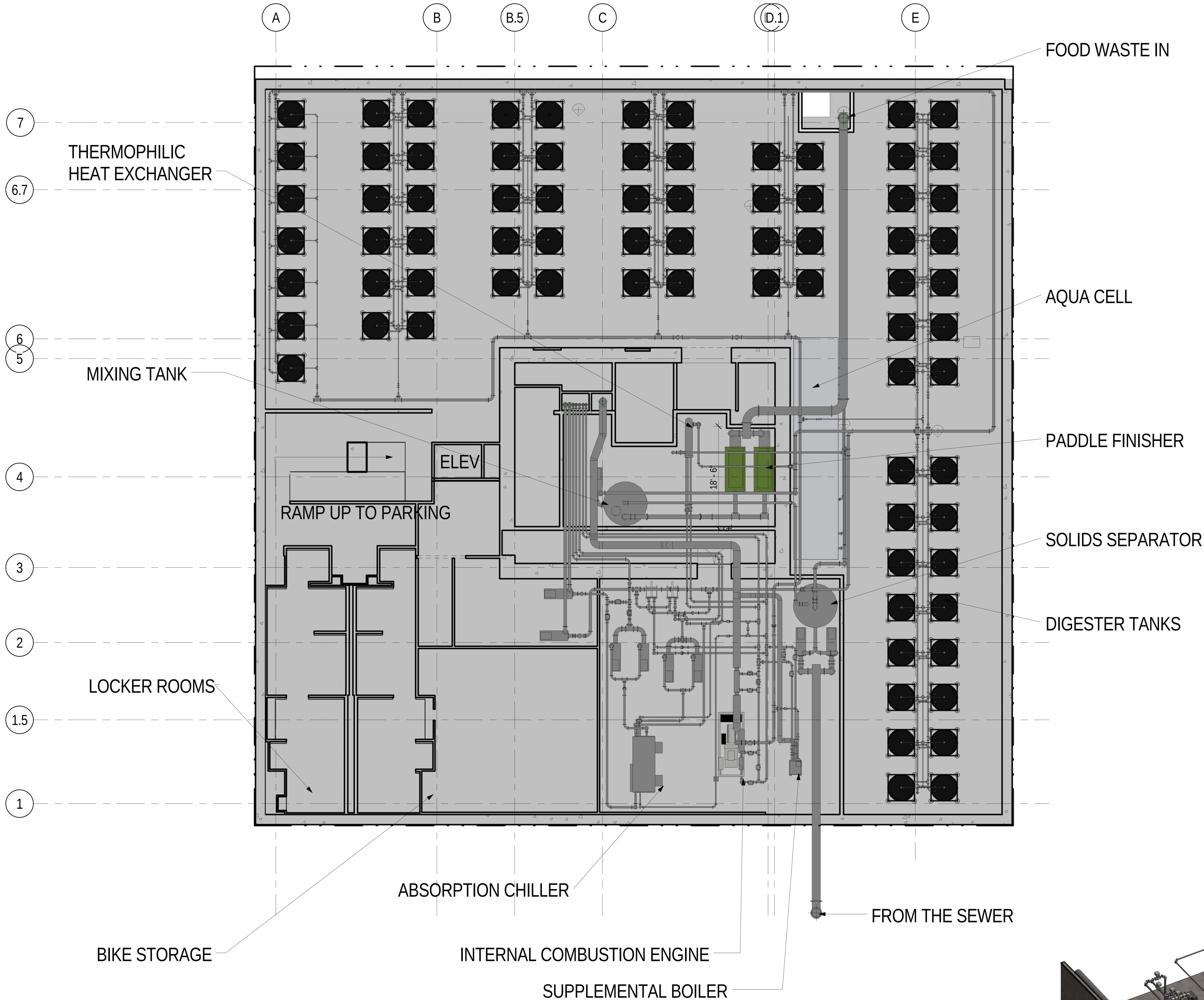
SCALE: N/A

JOB NUMBER: 350 MISSION

DATE: 02/17/2014

DRAWN BY: AEI 2 - 2014

SHEET NUMBER: I3

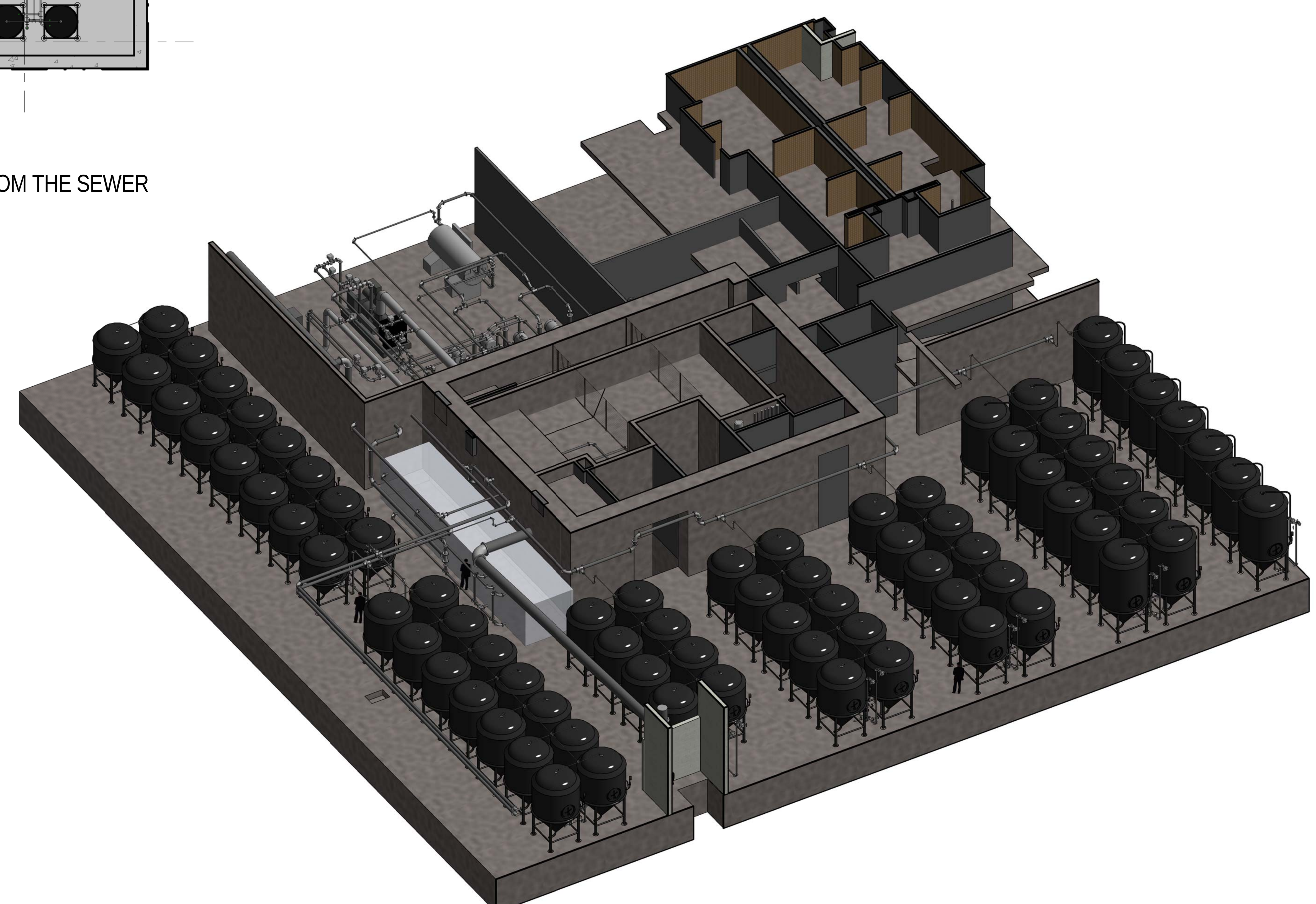


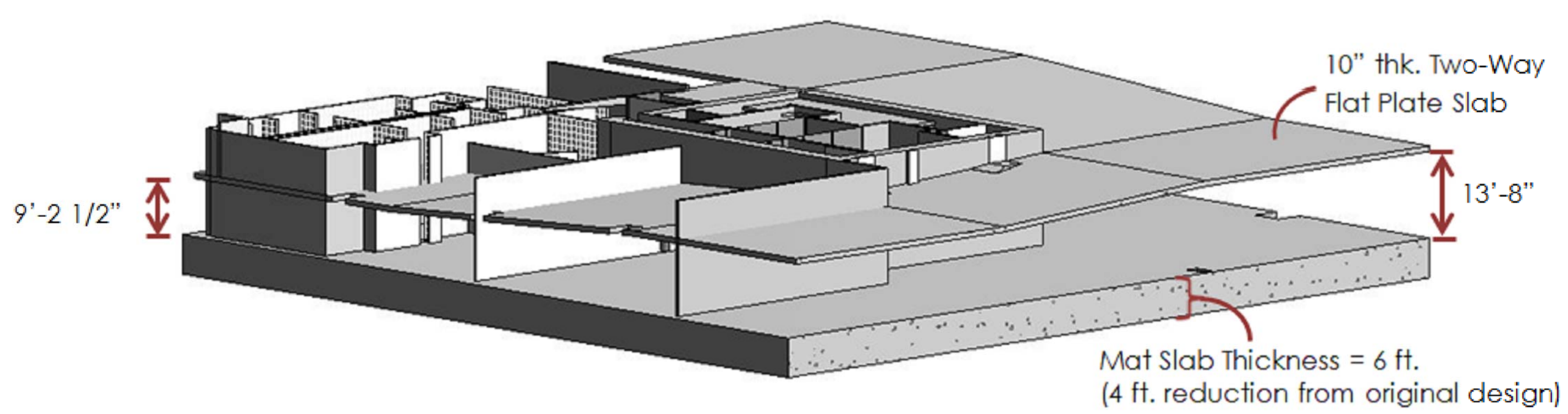
Level B4 was redesigned to accommodate the sustainability plant. By reducing the mat slab thickness the basement floor-to-ceiling height was able to increase, making room for digester tanks. The locker room entrance and bike storage room were moved from the original design.

Much of the equipment for the mechanical system is located just above the 5' thick mat slab in the 4th sub-basement floor. In order for the Biomethane system to be operational as soon as possible, these digesters and other equipment will be brought on to site right after the basement is poured, in order to limit staging time and accelerate mechanical operation.

The basement is the location of the bio methane plant, the main source of on site, self-generated energy. Compost waste from surrounding businesses, as well as sewage from both the building and municipality are collected and transformed via anaerobic digestion into usable methane gas. This gas is combusted within an internal combustion combined heat and power cycle, generating the necessary heat and electricity to power 350 Mission simultaneously. As well as generating building thermal and electrical load, the waste water from the sewer is collected and treated to handle the non-potable water demand of the whole building.

The structural teams efficient gravity system design allowed for an estimated 48% reduction in the weight of the structure. While this not only helps to alleviate seismic demands and increase the buildings performance from an earthquake standpoint, it allowed for a 4ft reduction in thickness of the foundation mat slab. This reduction in thickness not only reduced excavation amount but also increased the usable volume of the subgrade levels in order to house a high performing mechanical system. The structural team also designed and detailed the subgrade perimeter foundationwalls. These walls had to be designed and detailed not only to act as effective retaining structures but also as special shear walls to complete the lateral load path into the foundation mat slab (see Structural report for more details).





1 INTEGRATION - BASEMENT LEVEL B4
1" = 10'-0"

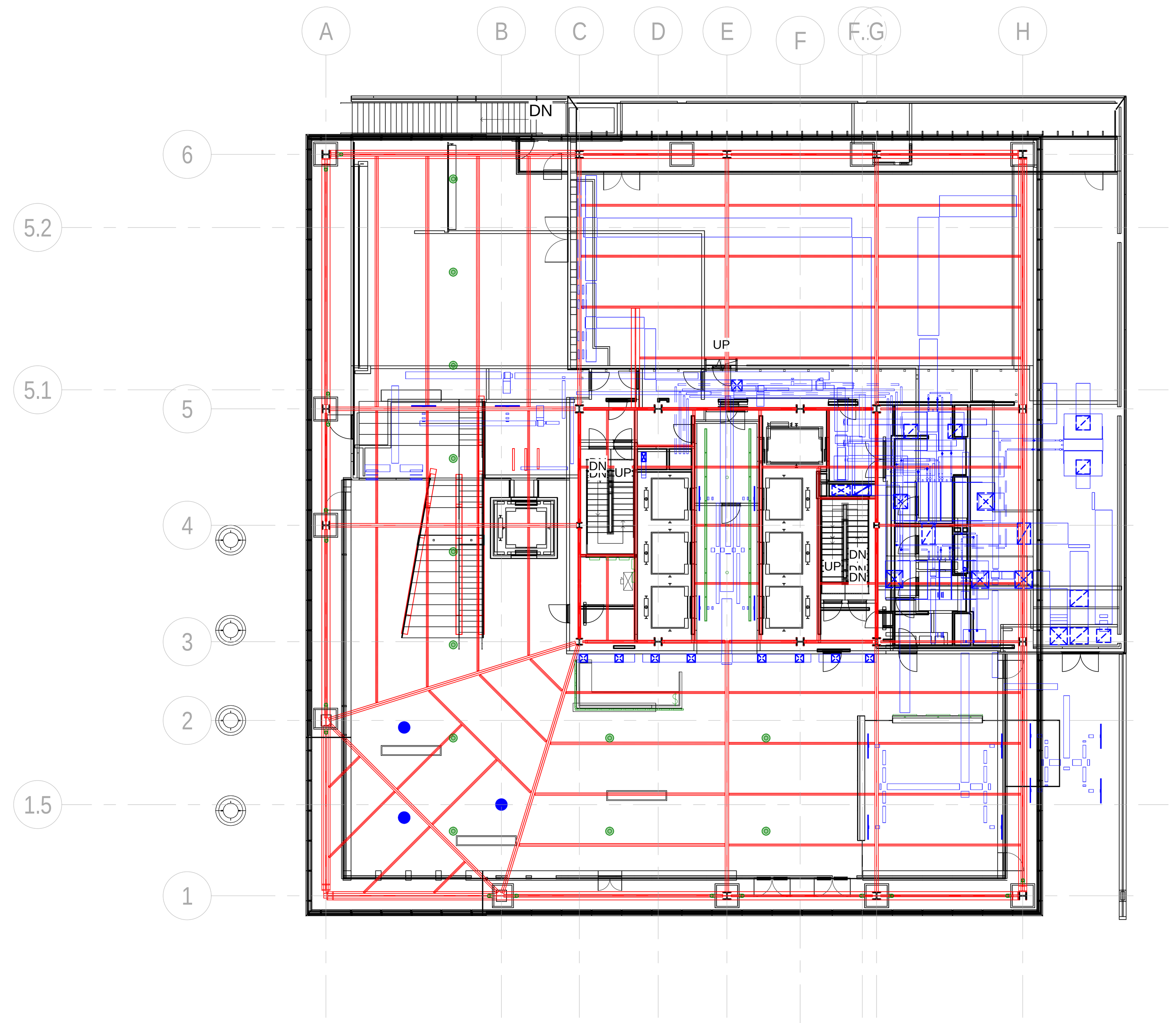
2 DO NOT OPEN- 3D VIEW FOR SHEET

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

PURPOSE
ASCE STUDENT COMPETITION
AEI 2 - 2014

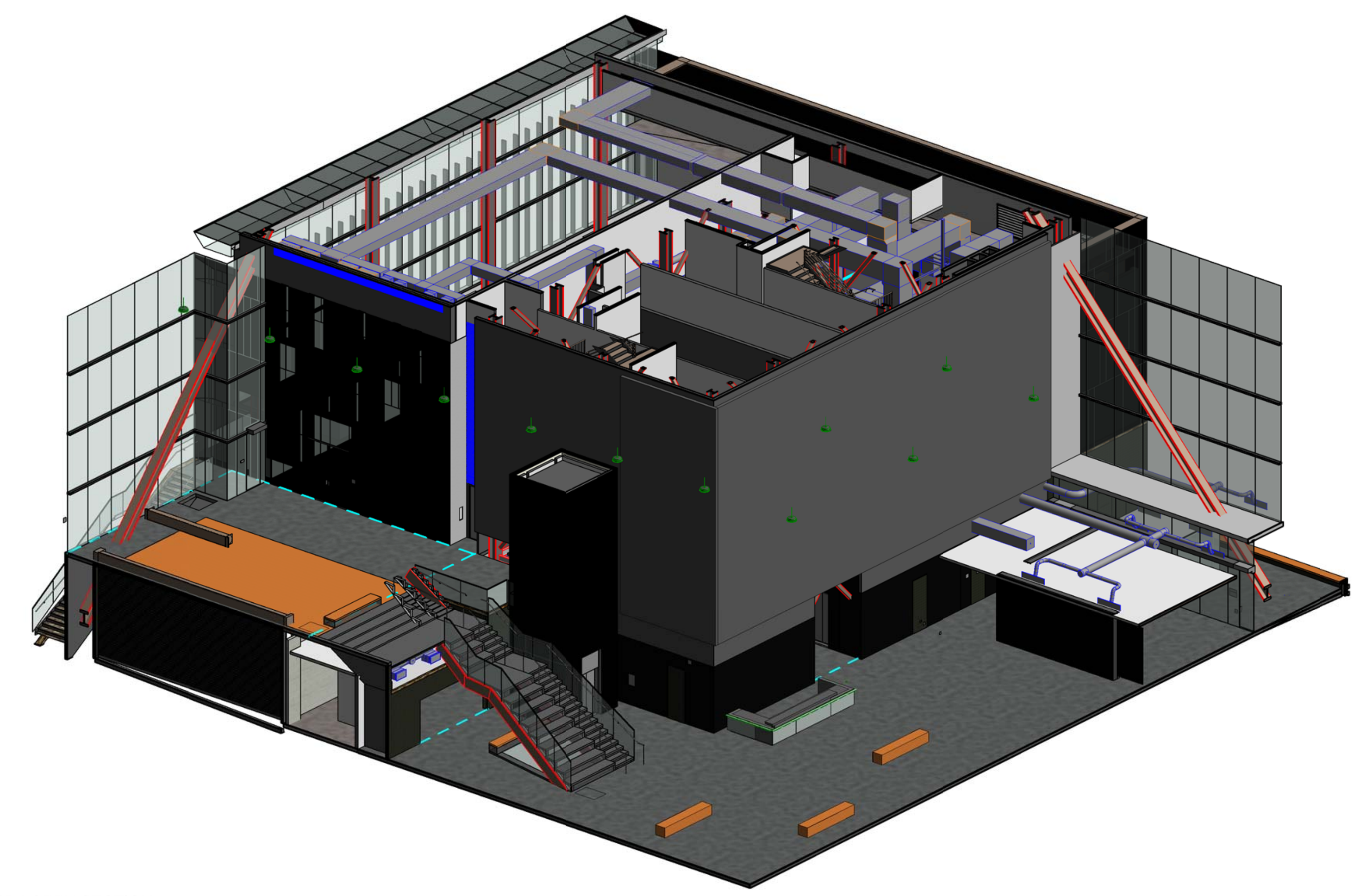
DRAWING TITLE
INTEGRATION - BASEMENT B4

SCALE: 1" = 10'-0"
JOB NUMBER: 350 MISSION
DATE: 02/17/2014
DRAWN BY: AEI 2 - 2014
SHEET NUMBER:
I4



1 INTEGRATION - LOBBY LEVEL
1/16" = 1'-0"

NOTE: The images to the left and right highlight the coordination between disciplines:
Red: Structural
Blue: Mechanical
Green: Electrical



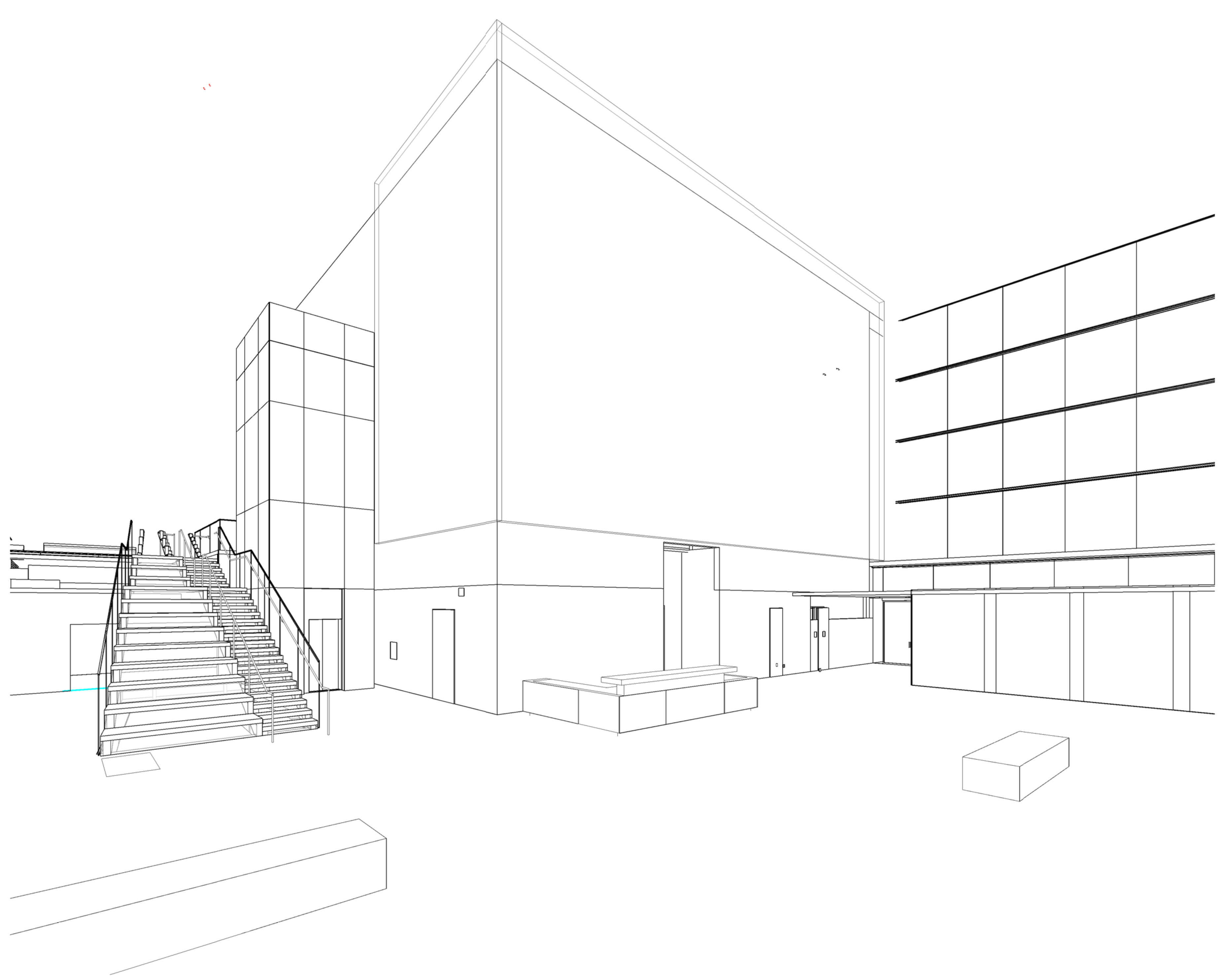
5 3D LOBBY SECTION

The lobby space is radiantly conditioned with a thermally active slab due to the large opening to the outdoor environment utilized at the one corner. The design decision to use a radiant system eliminates the possible issues that could arise with a convective conditioning system due to the fluctuations that occur with the space being open to ambient conditions. Ventilation air is supplied via linear diffusers located behind the centerpiece L.E.D screen, providing the necessary outdoor air while remaining unobtrusive and positively pressurizing the lobby to aid in the expulsion of ambient air that may enter the space.

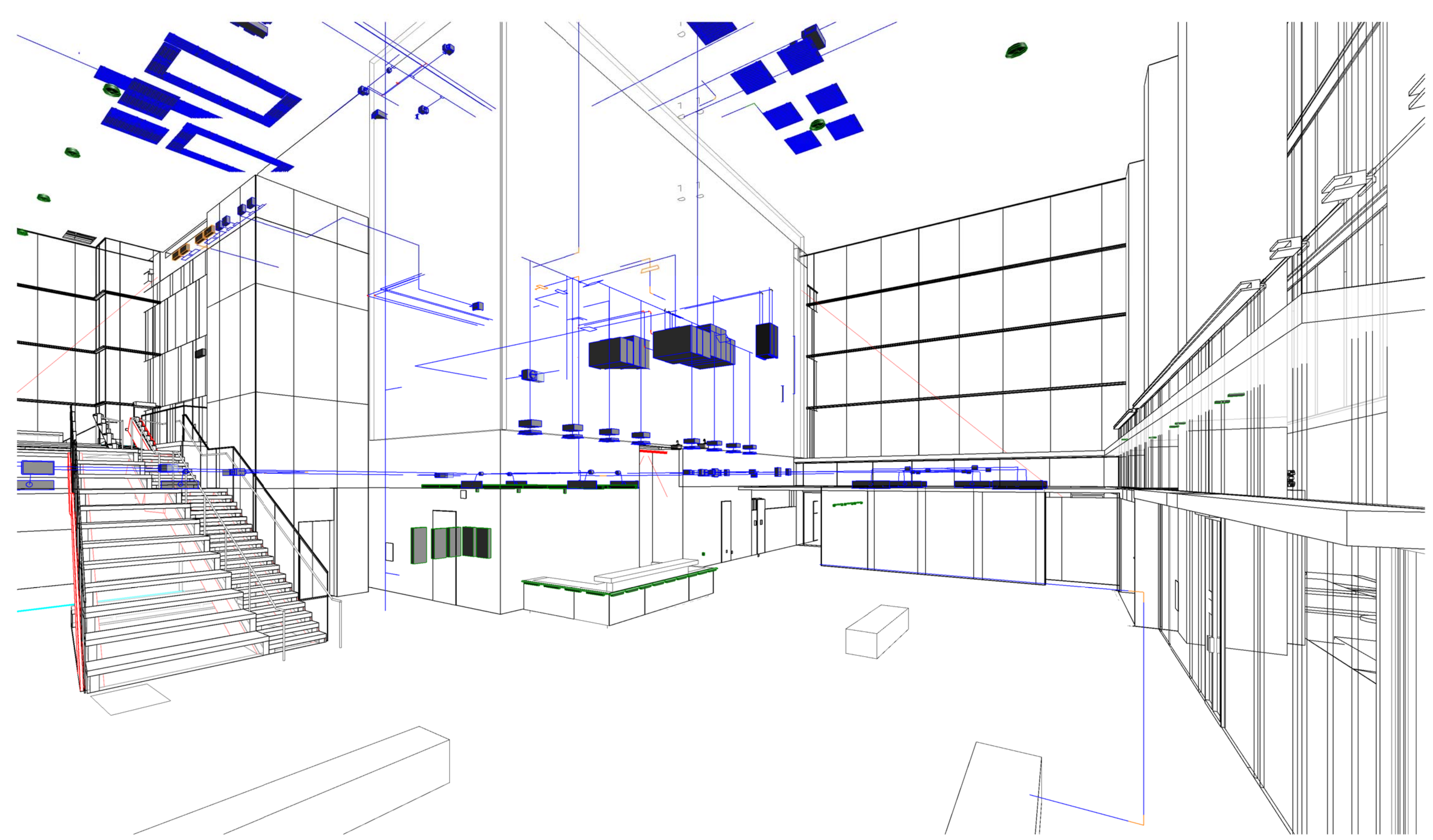
The lighting design in the lobby space is meant to bring about a sense of interaction. Sensitile is placed along the stairs, which creates a shimmering effect as visitors walk over the material. The reception desk and columns are illuminated with color changing LED wall grazers. The color changing LEDs change color throughout the day based on were the building receives it's power. A large LED screen wraps around the corner of the lobby, displaying public art.

A major structural consideration in the lobby was the potential for soft story behaviors created by the 5-story high space. Built-up sections were designed in order to handle the 54 foot unbraced column length. The design required custom sections consisting of a W14x730 with 1-inch steel plates welded between the flanges. This shape was designed and optimized in SAP2000. The structural team also This cantilever opens 350 Mission in the southwest direction, further highlighting its connection to its urban environment. It helps enhance the architecture of the building by allowing for an extremely open lobby at the corner of Mission St and Fremont St. This dramatic cantilever effectively engages the streetscape and public in the key direction of the future Transbay Terminal.

As the most public space of the whole building, this is what people in the street will focus on as a selling point. Consisting of mostly high-end finishes, the lobby will take the longest out of all 30 stories to complete. Using extra time built into the schedule, these high-end materials will be brought in and installed by their respective subcontractors to give the public a positive first glimpse of 350 Mission.



2 LOBBY ISOMETRIC



3 LOBBY ISOMETRIC - TRANSPARENT WALLS

The drawing above and to the left shows a view of the lobby space. The drawing above and to the right is a view of the lobby with transparent walls. These images show the coordination that took place between all disciplines to provide a sleek lobby area. See Drawing I9 for more renders.

PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE

ASCE STUDENT COMPETITION
AEI 2 - 2014

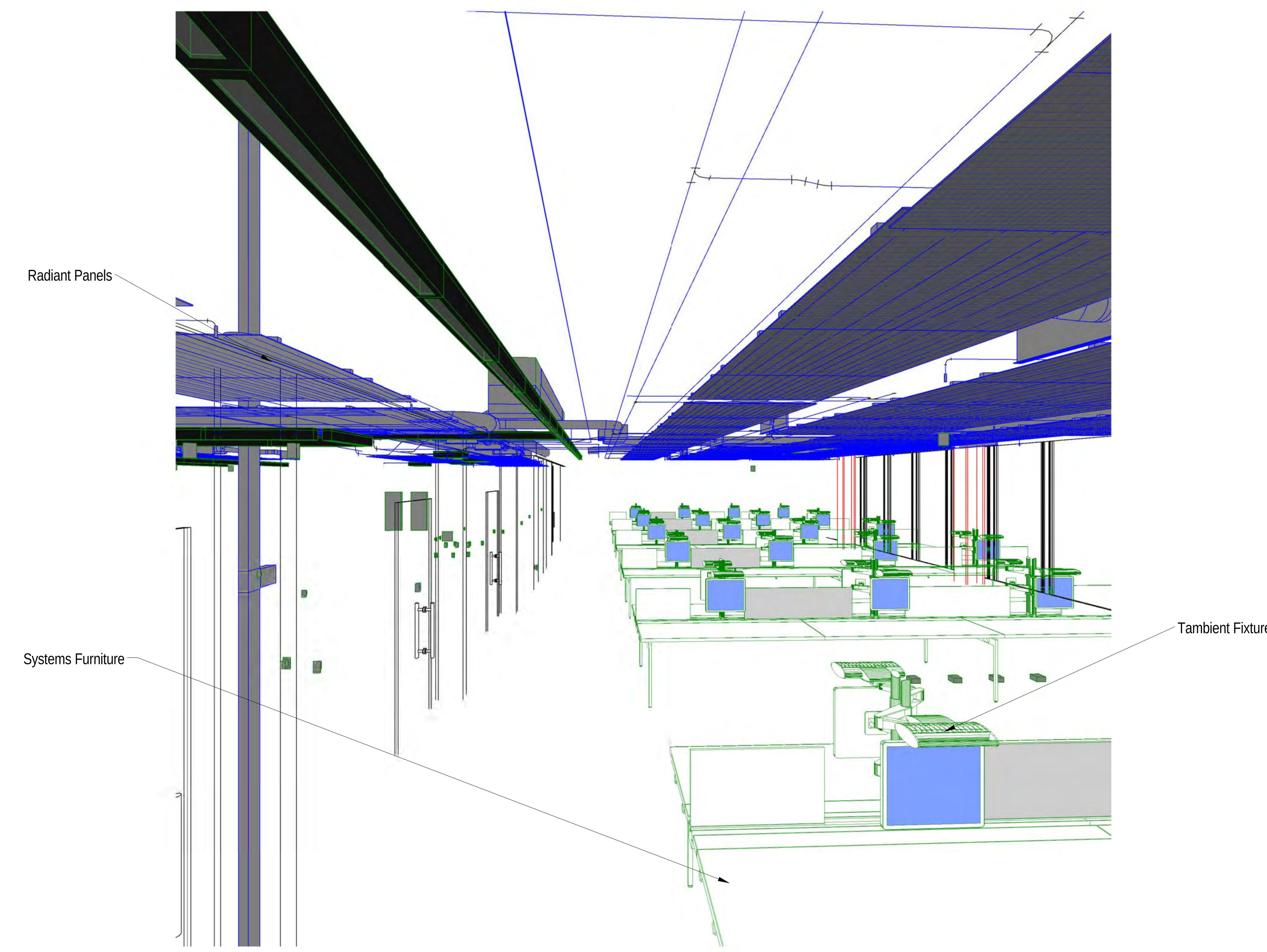
DRAWING TITLE

INTEGRATION - LOBBY

SCALE:	1/16" = 1'-0"
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	TEAM 2
SHEET NUMBER:	I5

*NOTE:
Red: Structure
Blue: Mechanical
Green: Electrical

1 INTEGRATION - TYP. OFFICE
3/32" = 1'-0"



2 INTEGRATION - TYPICAL OFFICE OPEN AREA

The typical office floor is conditioned with a radiant system, utilizing radiant panels in the ceiling to provide the necessary thermal comfort to the occupants. A reverse return hydronic loop was designed to provide an approximately equal distance distribution among the 147 radiant panels installed within the ceiling grid. Along with the radiant system, a Dedicated Outdoor Air System (DOAS) provides necessary outdoor air to the floor via demand ventilation in conjunction with the radiant system to minimize energy usage. An automatic sprinkler and smoke exhaust system are installed as well to provide the necessary life safety functions.

A 4000A bus duct delivers power to the designated receptacle, lighting and mechanical panels. Systems furniture are placed throughout the open office and recieve power through an underfloor furniture whip. The lighting design of a typical office floor plan was done with a task/ambient solution, *Tambient. Tambient* is fixed to the systems furniture with seperate controls for the up and downlight. The downlight portion of *Tambient* is user controlled. The uplight is dimmable with photosensors. This approach allowed the electrical team to design a lighting solution with a power density of 0.6W/sf. Additionally, removing the fixtures from the ceiling in the open office area allowed for much easier layout of the radiant panels. The lighting design used on the office floor promotes worker collaboration.

The gravity system was a multidisciplinary effort to design an efficient structure while ensuring the other systems present would not be limited. An efficient gravity system was formulated that limited beam and girder depths to a maximum of 24 inches with infill beams with 12 inches of depth. This allowed for a large floor-to-ceiling height of 9'-10" in the open office and 9'-0" in the enclosed spaces. Optimized member sizes and placement create open views which enhance working conditions for the tenant and cement the building as part of the urban fabric

Careful coordination of trades was taken into consideration when installing system rough-ins and distributions. Using a SIPS scheduling tactic, trades were able to be layered one after the other in a circular sequencing pattern to produce the most effective and productive final product.

Large conference room rendering

PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

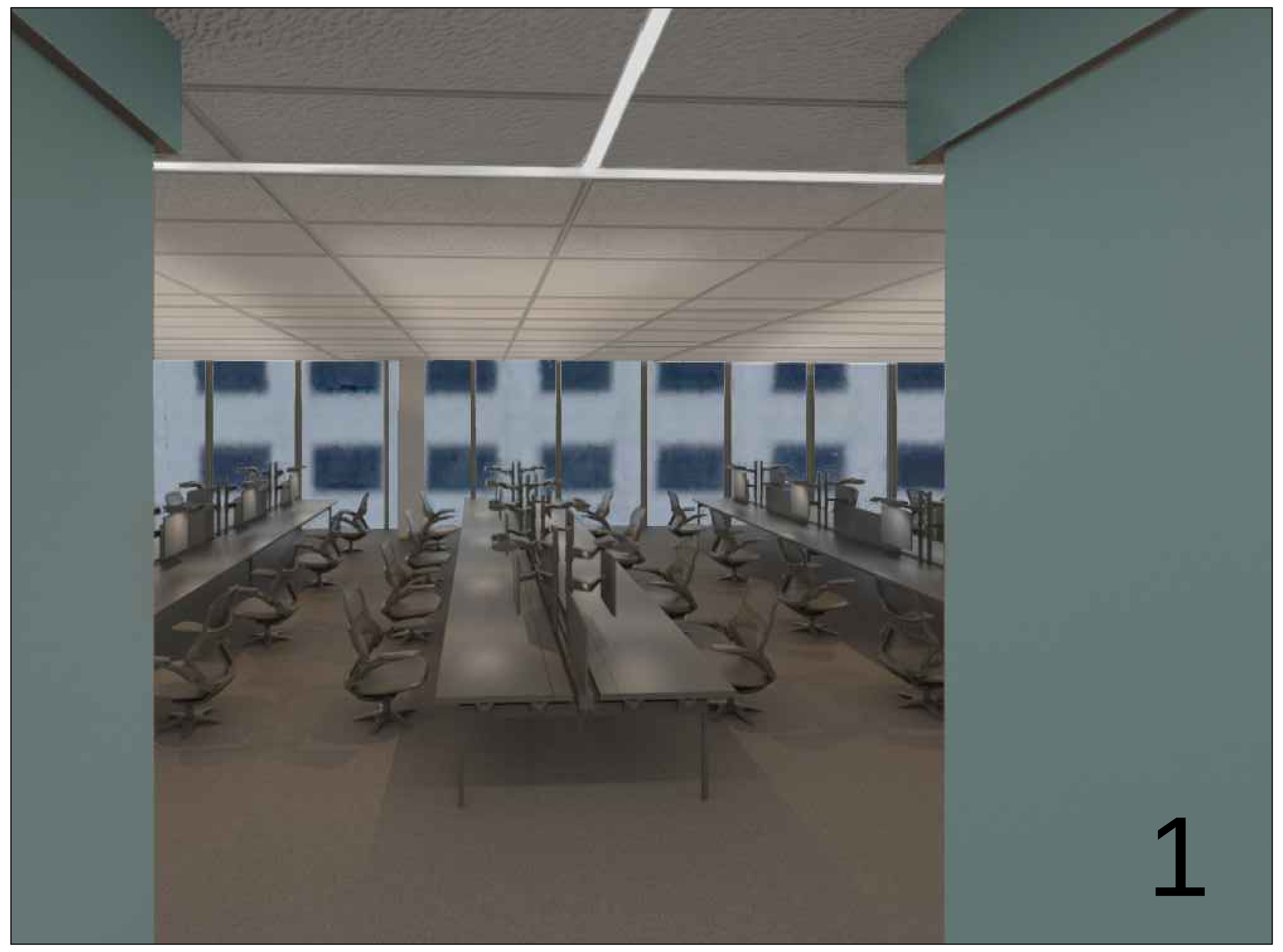
PURPOSE

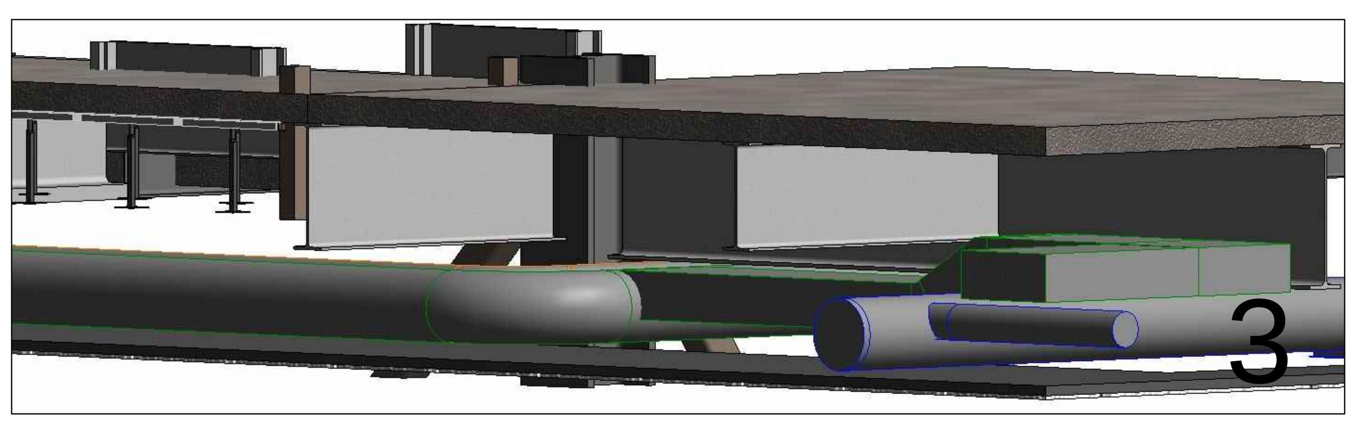
ASCE STUDENT COMPETITION
AEI 2 - 2014

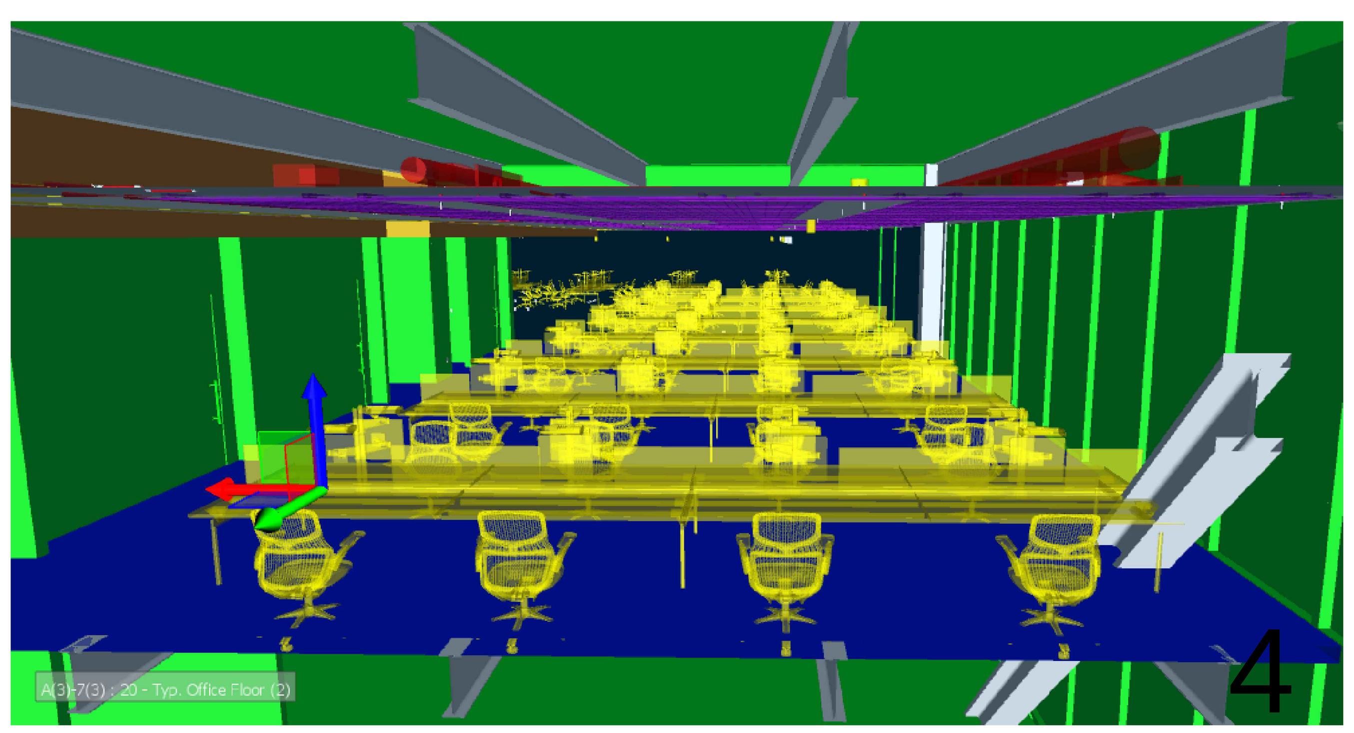
DRAWING TITLE

INTEGRATION - TYP. OFFICE

SCALE:	3/32" = 1'-0"
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	TEAM 2
SHEET NUMBER:	I6







Design Coordination

Structural, mechanical, electrical, and architectural elements impacted the typical office floor design. Primary building systems were housed in a gridded drop ceiling on each office level. 44.5" of space were available between the floor slab and acoustic panel system.

Within this space, beams and girders, mechanical ductwork and piping, and electrical equipment all shared available space. Devising a spacing plan early in the building design was critical to success in outfitting the building.

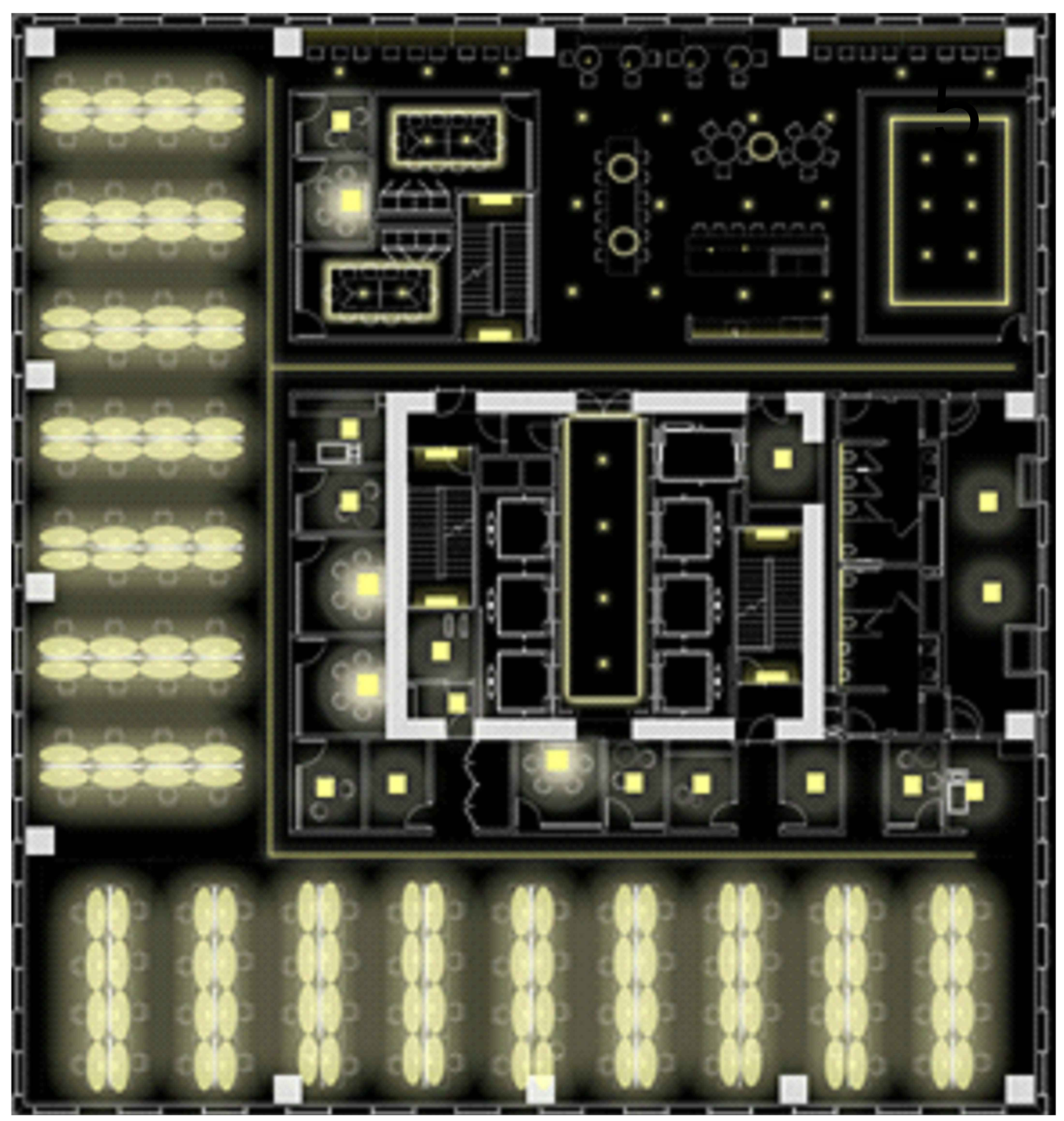
Structural elements were first designed to provide adequate support. The gravity system's beams and girders stem out from the building's core.

350 Mission's core is the structural "spine" of the building. Vertical runs of the building extend upwards along the building's core.

At a typical office floor, W12X14's extend off of larger W24X55's. This permits 32.5" of available above the ceiling space below the W12X14's, and 20.5" below the W24X55's. The mechanical and electrical runs were installed to maneuver within these constraints.

Radiant panels and lighting fixtures are integrated into the ceiling's grid system. An illustration of the space above the acoustical ceiling panels is depicted in image 3.

Autodesk Navisworks was utilized in identifying how these various building systems interacted with one another. Major building clashes could be adjusted in Revit based on analysis in Navisworks. Image 4 illustrates how Navisworks was manipulated to observe building systems. Structural, mechanical, electrical, and architectural systems were linked into a single Navisworks file. By identifying systems individually with specific colors, and then overlaying each, the team identified potential flaws in coordinated design.



Images:
1 - Typical office floor layout; view looking out towards the 350 Mission's outer perimeter.
2 - Typical office floor layout; view looking in towards the building's core.
3 - Three dimensional section of available above-the-ceiling space on a typical office floor.
4 - System coordination within Autodesk Navisworks.
5 - Lighting layout for the typical office floor.

PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE

ASCE STUDENT COMPETITION

AEI 2 - 2014

DRAWING TITLE

INTEGRATION - COORDINATION

SCALE: N/A

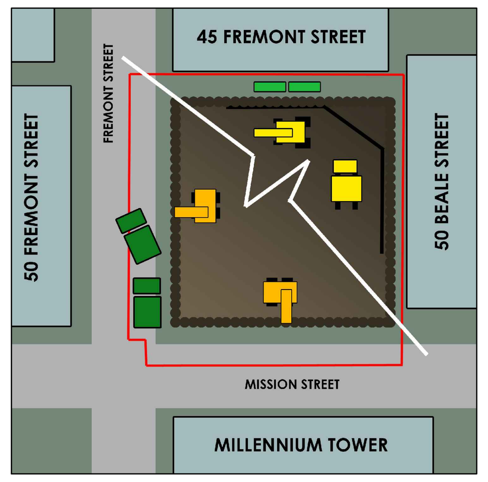
JOB NUMBER: 350 MISSION

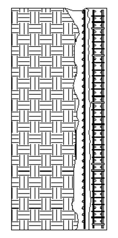
DATE: 02/17/2014

DRAWN BY: AEI 2 - 2014

SHEET NUMBER:

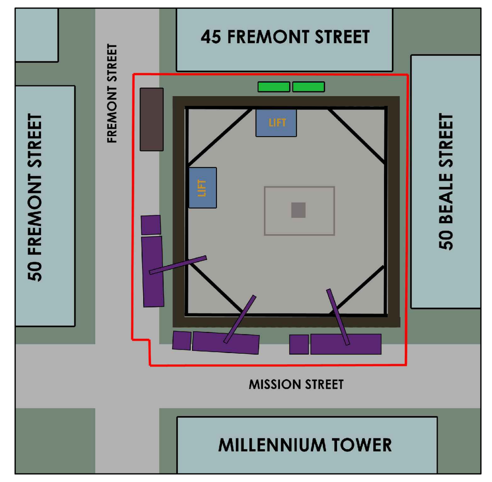
I7

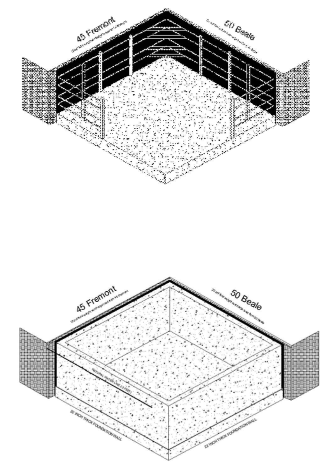





January 2013 - April 2013: Shoring & Excavation. Following demolition of the existing building at 350 Mission, and preparation of the building site, work will begin on establishing the perimeter's cement-soil wall. Hollow stemmed augers will be used to dig concentric borings along the southern and western 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.

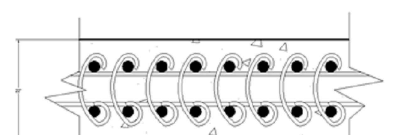


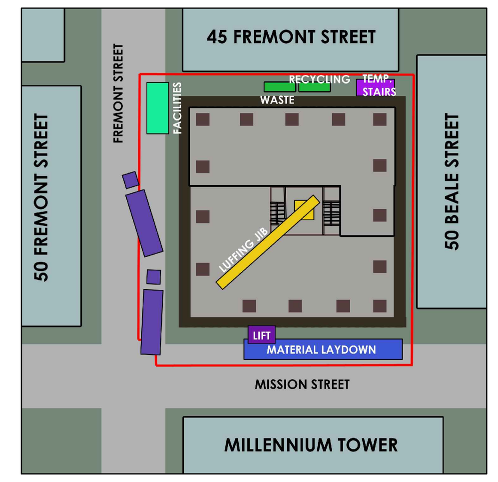


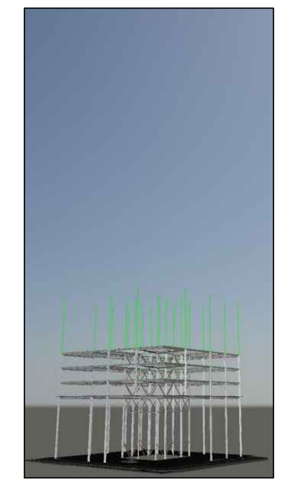
April 2013 - July 2013: Building Foundations & Subterranean Construction. Once excavation has reached a depth of -47 feet, soil conditions will be monitored. If the Colma Sand layer at -47 feet is not consistently stable, the site will be overexcavated and lightweight concrete will be poured to right 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.



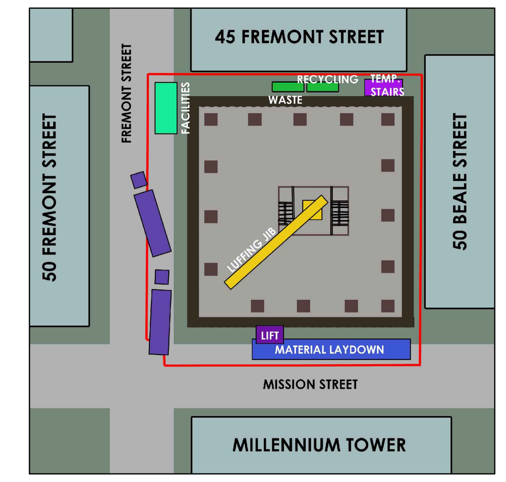


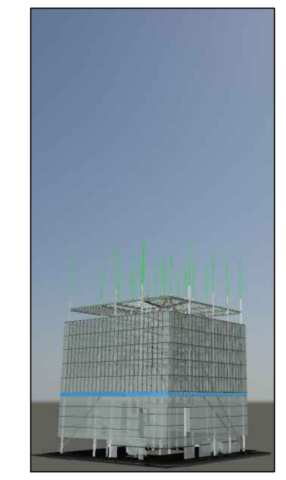


July 2013 - September 2013: Floors 1-4. The crane will be installed upon the central concrete key following mat slab curing. Once construction arrives at street level, a temporary stair will be developed at the northeastern corner of the building footprint. This temporary stair will provide access to 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.



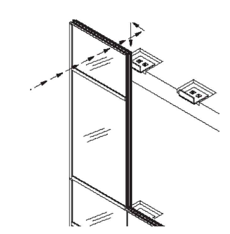


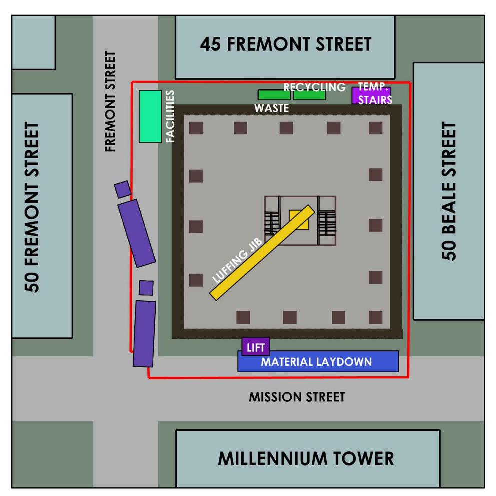
September 2013 - December 2014: Floors 5-8. The majority of the superstructure is divided into 4-floor phases. Work will be completed by repeating short interval tasks per each floor. Structural steel columns will be spliced every two floors. Beams and girders will follow, and then floor decking.

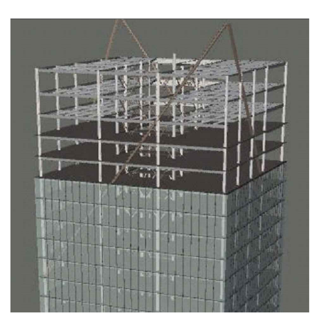
The central crane will complete primary work during this stage of construction. A lift will be installed at the southern perimeter of the building to move project personnel and materials.

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.

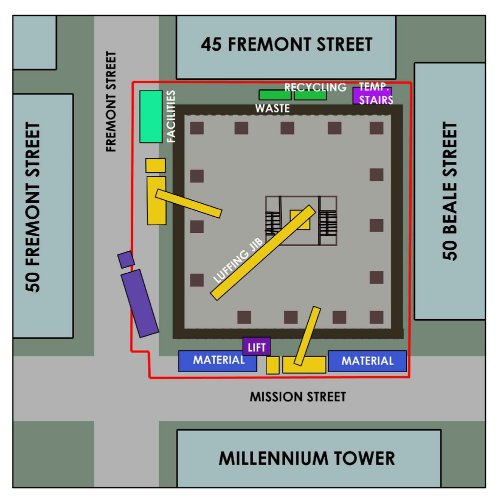






December 2013 - April 2014: Exterior Lateral Beams. Along the exterior of the building, three externally-bracing structural pieces span the height of each building face. These structural pieces can only be installed once each end of the element may be set in place.

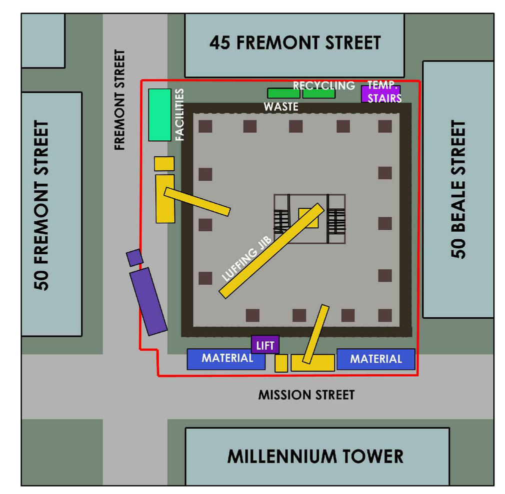
These exterior braces will be visible to the public, a key piece of our building's exterior design.



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.

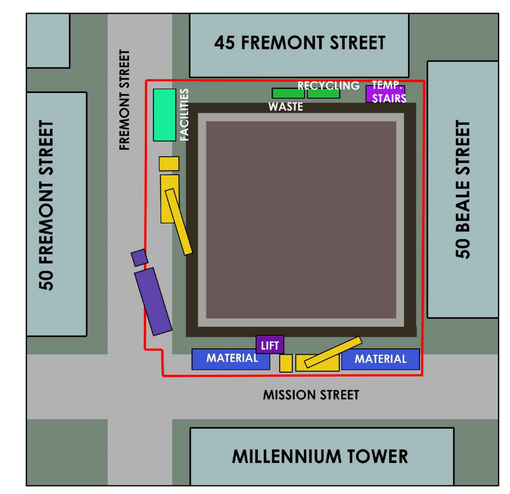
The second will not be placed until floors 21-24 begin installation. Not only will these cranes install pieces of 350 Mission, but will also be used to remove segments of of the tower crane as it is removed.

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

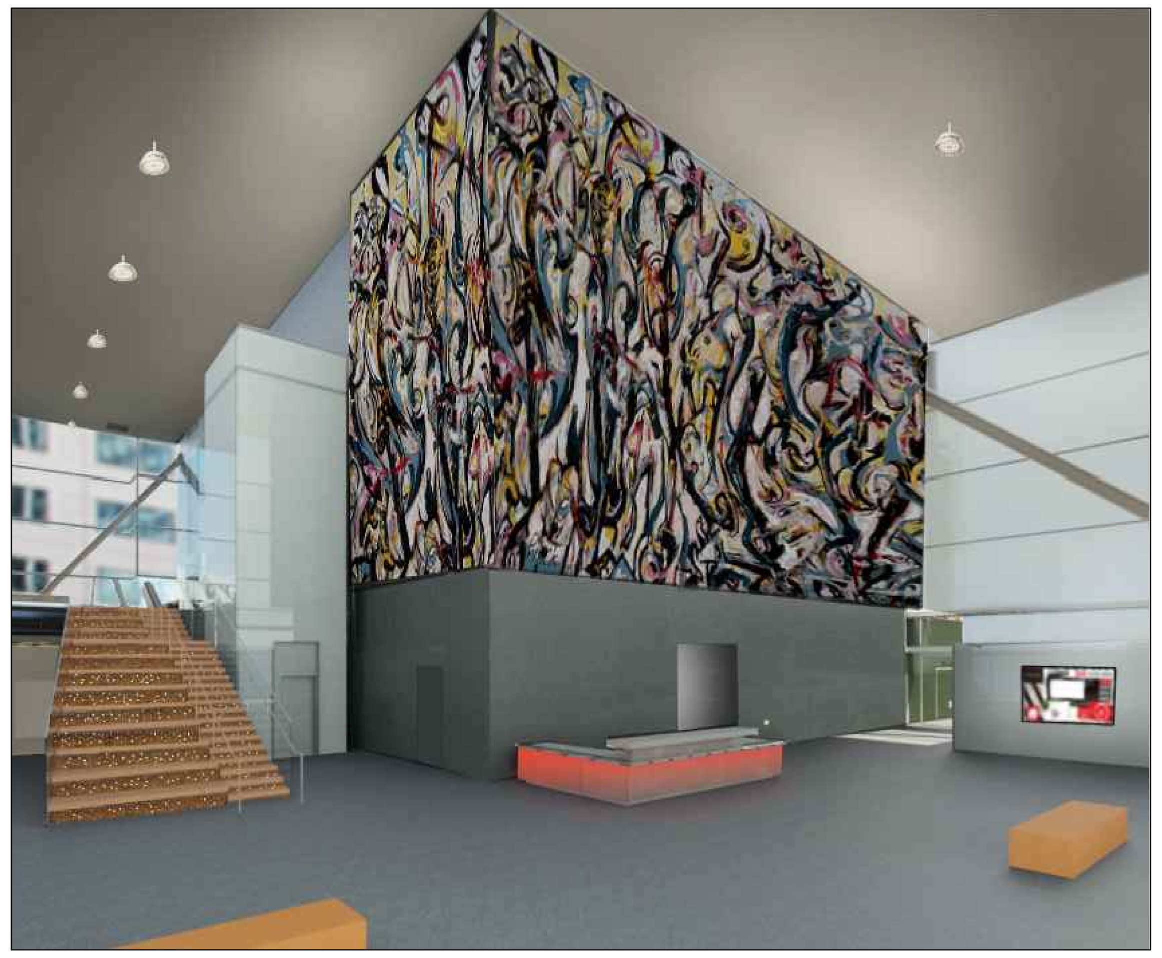
ASCE STUDENT COMPETITION

AEI 2 - 2014

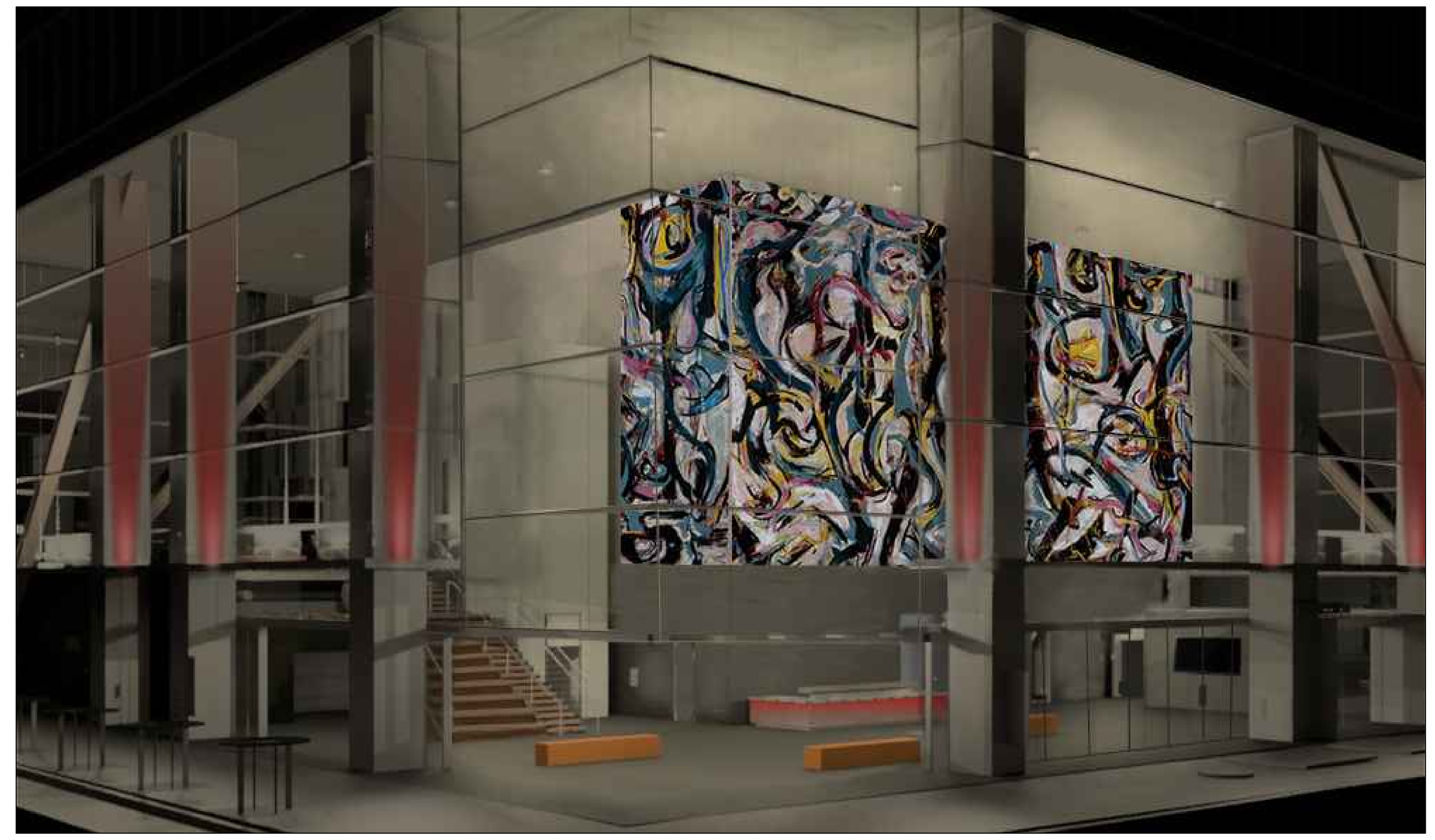
DRAWING TITLE

INTEGRATION - SEQUENCING

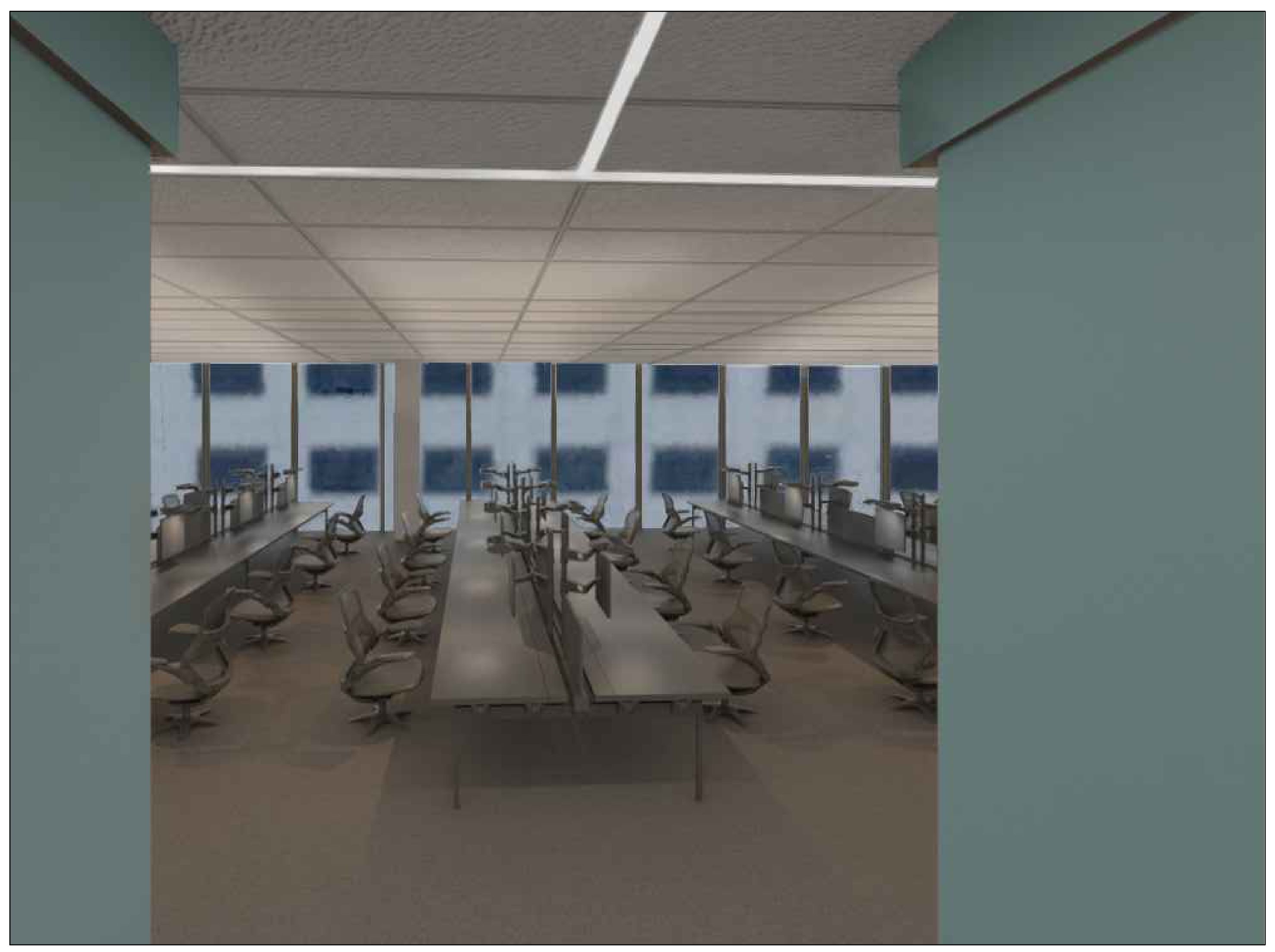
SCALE:	N/A
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	AEI 2 - 2014
SHEET NUMBER:	18



Left: Lobby area rendering during day. View taken from cantilevered corner of building. Large LED screen and Sensitile on the stairs create an interactive lobby space.

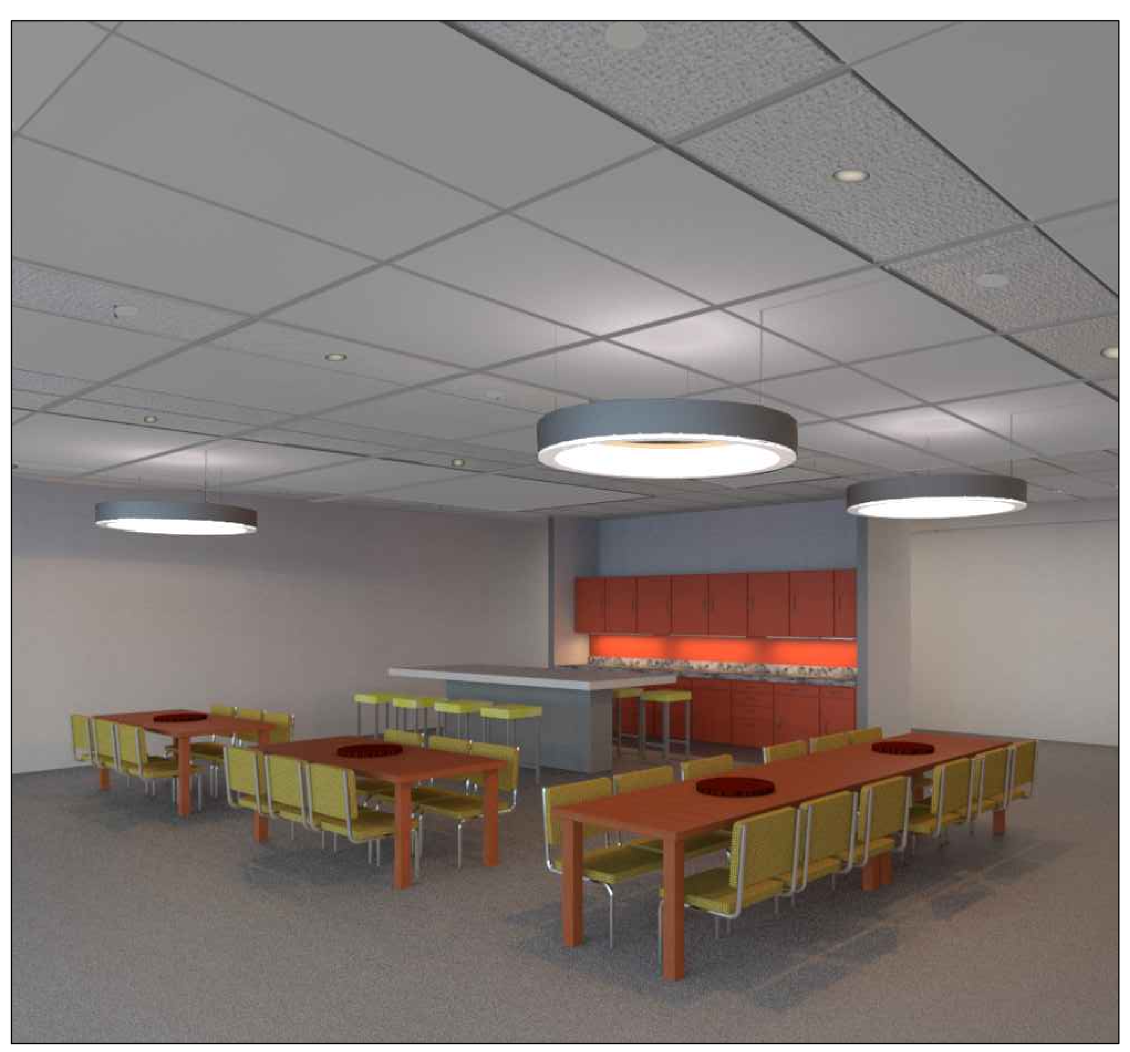


Left: Lobby rendering during night. Color changing LED's uplight the column and attract the public.



Left: Typical floor open office area. View taken from adjacent corridor. Furniture mounted lighting fixtures allow space for radiant panel layout.

Left: Typical floor open office area looking towards core of building. Enclosed glass meeting rooms surround the core.



Left: Kitchen/eating area on typical office level.

Left: Typical floor office elevator lobby.

PROJECT

AEI STUDENT COMPETITION
350 Mission Street, San Francisco, CA

PURPOSE

AEI 2 - 2014

DRAWING TITLE

INTEGRATION - RENDERINGS

SCALE:	N/A
JOB NUMBER:	350 MISSION
DATE:	02/17/2014
DRAWN BY:	AEI 2 - 2014
SHEET NUMBER:	I9