Granger, Iowa
Public Emergency Building

University of Iowa

Department of Civil & Environmental Engineering

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Contents

Executive Summary

We are a team of six University of Iowa senior civil engineering, each bringing technical and professional experience relating to building design and development. The team includes Maddie Donavan, Brynn Bailey, Jacqueline Cabañas, Taylor McCabe, Zach Kulisek, and Colin Meehan. It has been through internships, coursework and design projects, which the technical skills necessary to complete this project have been gained.

This project is for the design of a public service building for the City of Granger, Iowa. The design seeks to accommodate the needs of the Fire and EMS and Police departments, and City Hall functions. The project promotes efficient and accessible community aid for all the departments that are stationed there, while having sufficient storage space. In addition, the design accounts for future departmental growth.

Long-term adaptability is a big factor in design. Within ten years, the facility will house a full-time Fire & EMS department and a larger police force. The building should be adaptable to meet the demands of the increase in staffing, as the city hall functions will be relocated.

The layout of the building includes shared spaces for all departments, such as bathrooms, conference and meeting rooms, as well as a kitchen. These spaces have been placed in the design with careful consideration, to account for a swift exit for the emergency responders, and easy access for public visitors.

Each department had specific requirements that were to be contained in this building. It was essential that the Fire and EMS department had a minimum of three apparatus bays, with at least one pull in bay. A decontamination room and separate shower pods were provided next to the apparatus bays. This provides a transition from the apparatus bays, a hot zone, to the office area, a cold zone, to limit cross-contamination of gear and reduce risk to employees. To further reduce contamination, the building includes two air systems, one for the apparatus bay and one for the office area. Two offices and a report room were allocated within the building to serve the Fire and EMS department. Sufficient storage was emphasized, both for the fire fighter gear and any medical devices used by the paramedics.

The police force required several areas to have a higher level of security. This included a secure entrance, a secure storage and evidence room, and an interview room. A parking bay to accommodate at least two police vehicles had to be included within the building limits. Office spaces were provided, each large enough to accommodate future growth of the police department.

City hall required a public entrance and reception area. Two offices and a storage room were included for the functions provided by city hall. These spaces were designed to be converted to dorm rooms for the full-time fire and EMS department as city hall functions relocate. An IT room as well as a janitor's closet were added throughout the building. The structure was designed to comply with the current ADA standards to better serve the employees and visitors.

The project was influenced by several key constraints that significantly shaped the final design. A primary constraint was the required separation between hot, warm, and cold functional zones to maintain health, safety, and contamination control. Hot zones, including apparatus bays and decontamination areas, required distinct isolation from administrative and public spaces through physical barriers and ventilation systems. Warm zones functioned as transitional spaces, while cold zones housed secure and public-facing functions. This requirement limited flexibility in spatial planning and required careful coordination of circulation paths and system designs. Additionally, the fixed building dimensions of approximately 78 feet by 152 feet restricted available space, requiring prioritization of program elements and the incorporation of multi-functional areas.

Site conditions also imposed constraints on the design. The location allows only one primary access point from Broadway Street, restricting entry and exit for emergency vehicles, staff, and the public. Additionally, the presence of an adjacent trucking company driveway limited site circulation options and required clear separation from public use. These constraints required careful planning to ensure safe and efficient traffic flow while maintaining emergency response effectiveness.

Key challenges included site topography, such as elevation changes and drainage features, which required grading and stormwater considerations, as well as existing utilities that limited building placement. Integrating Fire and EMS, Police, and City Hall functions into a single facility also presented challenges due to differing operational, spatial, and security requirements. These factors required careful coordination to achieve and efficient and functional final design.

The proposed facility provides significant benefits to the City of Granger and the surrounding community. By consolidating Fire and EMS, Police, and City Hall functions into a single building, the design improves communication and coordination between departments, resulting in faster and more efficient emergency response. Enhanced response times contribute to improved public safety and may reduce risk and insurance costs for residents and businesses.

The facility is also designed to support future growth, allowing departments to expand staffing and services as the city develops. Public-facing spaces provide opportunities for community outreach, education, and engagement, strengthening relationships between residents and first responders. Additionally, the project is expected to contribute to local economic growth through construction activity and long-term investment, while positioning the city to better serve surrounding areas through expanded emergency services.

Multiple design alternatives were evaluated to determine the most effective solution for balancing efficiency, safety, cost, and client requirements. Each alternative explored different approaches to layout, circulation, and departmental flow while maintaining the overall goal of a unified public service facility.

The first alternative proposed a two-story configuration to maximize usable space within the limited footprint. This approach separated operational and support functions by floor to improve space utilization. However, it introduced delays in emergency response due to vertical circulation, increased construction costs, and did not align with the client's preference for a single-story facility.

The second alternative utilized a single-story layout that centralized all functions to improve accessibility and simplify circulation. While this option aligned with client expectations, it created conflicts between emergency vehicle routes and public parking areas, reducing safety and efficiency. Additionally, the proximity of living and administrative spaces raised noise and privacy concerns.

The third alternative emphasized improved circulation by separating emergency vehicle movement from public and staff areas. This significantly enhanced safety and operational efficiency while providing clear departmental zoning. However, it introduced increased mechanical system complexity and limited opportunities for future expansion, particularly for apparatus bays.

The fourth alternative represented a refined solution that integrated the strengths of the previous designs. It featured clear zoning, efficient circulation, strong contamination control, and a compact footprint that reduced costs. While this alternative provided the best balance of performance and efficiency, it did not meet the client's updated required exterior building dimensions and was therefore not selected.

The final proposed design is a single-story facility of approximately 9,166 square feet that effectively integrates Fire and EMS, Police, and City Hall functions. The building is organized into clearly defined zones to maintain operation efficiency, security, and proper contamination control. Fire and EMS spaces are located to provide direct access to apparatus bays and include decontamination and transition areas. Police functions include secure access points, evidence storage, and controlled interview spaces, while City Hall is positioned near the main entrance to provide accessible public services. Shared spaces are centrally located to support communication and collaboration between departments.

The civil design elements focus on site layout, grading, and circulation. The site was arranged to provide safe and efficient movement for emergency vehicles while minimizing conflicts with public and staff traffic.

Grading and drainage systems were designed to maintain positive drainage and direct stormwater away from the building, supporting long-term site functionality. Parking and pedestrian access were organized to improve safety and accessibility.

The structural design utilizes precast concrete wall systems and a slab-on-grade foundation to provide durability, fire resistance, and cost efficiency. The system was selected to accommodate both the large open apparatus bays and the adjacent office areas while maintaining structural reliability. Design loads were determined in accordance with applicable codes, ensuring the building can safely withstand environmental and operational demands.

The architectural design focuses on functional layout, code compliance, and accessibility. The building incorporates clear zoning between public, secure, and operational spaces, along with required egress, fire protection, and ADA accessibility. Wall systems were selected to meet structural and fire-resistance requirements while maintaining durability.

The estimate cost for design services is $101,760.50, representing approximately 960 hours of professional effort. This includes labor, overhead, and materials required to complete the design but excludes construction costs. Timely implementation is recommended to minimize the impact of rising costs.

In conclusion, the proposed facility provides a practical, efficient, and adaptable solution that meets the needs of the City of Granger.

Qualifications and Experience

Organization and Design Team Description

The student team is made up of six members that are Civil Engineering students attending the University of Iowa, anticipated to graduate in May 2026.

- Maddie Donavan is the Project Manager that has experience in building development, particularly concrete buildings, along with strong client communication and project coordination skills.
- Brynn Bailey has experience delivering public infrastructure projects, coordinating and communicating with agencies and managing construction logistics.
- Jacqueline Cabanas is second text editor and contributes hands-on construction experience, strong drawing conception, and exposure to professional coordination.
- Taylor McCabe has extensive experience in multidisciplinary structural design, including load calculations, foundations, and Revit modeling. This individual combines strong structural design expertise with effective collaboration, communication, and client-facing experience.
- Zach Kulisek offers strong attention to detail, quality control, and documentation skills. Zach’s skills translate to ensure design accuracy, sticking to codes and regulations, and reliable record keeping throughout development.
- Colin Meehan contributes strong expertise in design loads, building codes, and structural modeling.

All members of the group have experience using many software’s that will be utilized for this project, including AutoCAD and Civil3D. Knowledge and extensive experience with Microsoft Word, PowerPoint, and Excel will serve helpful in supporting and completing this design. Additional information on experience and qualifications is in Appendix E where each member's resume can be found.

Proposed Services

Project Scope

This project included the design of a one-story municipal building to house Fire and Emergency Medical Services (EMS), Police, and City Hall functions in Granger, Iowa, a growing community of approximately two thousand residents. The building was designed to support current operational needs while accommodating anticipated community growth and future staffing changes. The project focused on the conceptual planning and integrated design of a facility that promotes efficient emergency response, secure departmental operations, and accessible public service.

Figure 1: City Hall Office

A key requirement for the project was long-term adaptability. The building was designed to accommodate future staffing transitions, including the anticipated shift of Fire and EMS services to a fully professional department within five years and twenty-four-hour staffing within approximately ten years. As Fire and EMS operations expand, City Hall functions are expected to relocate, requiring the building to support flexible space over time. Accordingly, the facility was designed to accommodate future operational, support, and life-safety needs without requiring significant structural modifications. To accommodate this future change, City Hall offices will be transitioned into living spaces for Fire and EMS (Figure 1). Those offices can easily be divided into sleeping quarters once Fire and EMS are fully professional. Other uses of the space may include a Fire and EMS specific lounge space.

Code compliance and life-safety considerations were primary drivers of the design process. The project included a comprehensive review and application of the 2021 International Building Code (IBC) and applicable fire code requirements to inform key design decisions. This included the coordination of egress systems, provision of two emergency exits, and integration of an automatic sprinkler system to meet life-safety standards. Corridor widths, wall assemblies, and spatial organization were carefully developed to meet code requirements while also accommodating mechanical, electrical, and plumbing systems. Egress paths were designed to provide safe and efficient occupant movement, and all spaces were planned to align with occupancy classifications and code-mandated separations.

Figure 2: Wash Room

The design addressed the operational requirements of Fire and EMS, Police, and City Hall functions while prioritizing safety, efficiency, and adaptability. Fire and EMS requirements included apparatus bays capable of accommodating a fire engine, ladder truck, brush truck, and ambulance, with a minimum of three bays and at least one pull-through bay located on the west side of the building. The design incorporated secured storage for medical equipment and designated gear storage areas to reduce cross-contamination. Additional Fire and EMS spaces include laundry facilities (showed in Figure 2), shower facilities, report rooms, and associated office space.

Police spaces were designed as secure, access-controlled areas and included offices, interview rooms, evidence storage, secure storage, and garage access for two vehicles. City Hall spaces included a public entry and reception area, administrative offices, a meeting room, and designated information technology and storage spaces. Additional shared spaces included public restrooms, a conference room that also functions as a training space for Fire and EMS, a kitchenette that serves as a staff day room, and a mechanical room. The overall building design supports efficient circulation, clear separation between public and secure zones, and safe access for emergency response operations.

The project included professional design services across four primary disciplines: architectural planning and design, structural engineering, site planning and design, and building systems design. Architectural services included the development of the overall building layout, spatial organization, and interior planning based on the client's operational needs. This included programming of Fire and EMS, Police, and City Hall spaces, ensuring appropriate adjacencies, and separation between public and secure areas, while also addressing code compliance, accessibility, aesthetics, functionality, and long-term flexibility.

Structural design included the selection and development of an appropriate structural system to support the building program, including apparatus bays and large-span spaces. The system was designed to accommodate current structural loads while allowing for future adaptability without requiring significant modifications and was coordinated with architectural and building system requirements.

Site planning and design included the development of emergency vehicle access, circulation, and maneuverability, as well as overall site layout. This included the design of access points, separation of public and emergency traffic, accommodation of future site development, and the delineation between public and staff parking areas. The site design supports safe and efficient entry and exit for emergency response vehicles.

Building systems design included the coordination of heating, ventilation, and air conditioning zoning. Additional considerations included life-safety systems, code compliance, egress requirements, and the integration of mechanical, electrical, and plumbing systems within wall assemblies and ceiling spaces to support overall building performance and operational efficiency.

Work Plan

The project work plan is organized into three primary phases: pre-design, design development, and final submittals and documents. Tasks are scheduled in a logical timeline with overlapping subitems to represent design workflow. Each task is assigned to a designated team leader to ensure accountability, coordination, and effective task management.

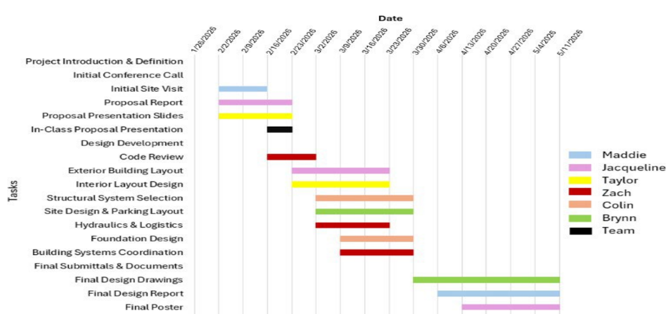


Figure 3: Project Work Plan Schedule

Constraints, Challenges, and Impacts

Constraints

A primary constraint of this project is the required separation of hot, warm, and cold functional spaces to ensure health, safety, and contamination control. Hot spaces, including Fire and EMS apparatus bays, gear storage, washer/dryer rooms, and any areas exposed to contaminants. These areas must be physically separated from administrative and public areas through appropriate barriers, ventilation, and circulation controls. Warm spaces, such as locker rooms, showers, training rooms, report rooms, and kitchens, must function as transitional zones that prevent cross-contamination while maintaining efficiency within the facility. Cold spaces, including Police and City Hall offices, reception areas, conference rooms, IT rooms, and secure interview spaces, must remain isolated from operational zones. This is to ensure public safety, security, and indoor environmental quality. The separate zones required constrained the building layout, limiting the ability to freely locate spaces based solely on convenience.

The proposed building dimensions measured at 78 feet by 152 feet and presented a significant spatial constraint for accommodating all the required functions. The fixed dimensions limit the total usable square footage available for apparatus bays, offices, training facilities, storage, and public spaces. Given the number and complexity of required spaces, the fixed building size restricted the ability to accommodate all programmatic needs. Moreover, throughout the design process, the outer shell shape was set by the client. This required the design to be reworked, so the hot, warm, and cold zones function within the new shape and size. As a result, not all programmatic needs were fully achievable within the existing building envelope without prioritization or multi-use space planning.

The site is located southwest of the intersection of Broadway Street and Oak Street. Due to the location of the site, the only direct vehicular access is along Broadway Street. This restricts entry and exits for emergency vehicles, staff, and the public, potentially affecting response times and traffic control planning. Additionally, a trucking company, located next to the site, has a private driveway along the eastern boundary. This added a constraint to the layout design to limit public use of the private driveway. With these restrictions considered, the layout of the design provides effective circulation for emergency vehicles and clear public access points.

Challenges

The project site is generally level except for a significant elevation increase off centered from the middle of the site, as well as a drainage ditch running along the roadway frontage of Broadway Street. These topographic features constrained building placement, grading, and required additional earthwork and site mitigation measures. Additionally, existing waterlines located within the site area were accounted for, which led to further challenges with the building's placement. To ensure adequate access and protection of the waterlines, a utility plan was developed. Together, these site conditions limit flexibility in site layout, building orientation, and infrastructure design.

The building supports three distinct user groups with Fire and EMS, Police, and temporary City Hall. Each group has unique operational, security, and spatial requirements. Fire and EMS operations required large apparatus bays, decontamination facilities, training areas, and sleeping spaces. Police operations required controlled-access points, evidence storage, interview room, and administrative offices. City Hall required a public entrance with a reception area, administrative offices, conference space, IT infrastructure, and secure records storage. Integrating these diverse functions into a single facility was challenging. Planning, circulation design, security zoning, and system integration had to be carefully thought out and revised to achieve a design that would meet the criteria set by the client.

Societal Impact within the Community

The focus of the project is to develop a space where multiple public services will function. The fire and EMS department along with the police department will be housed in this building to serve the city of Granger, Iowa. The roles they fulfill in the community include providing medical care, firefighting, responding to emergencies, and ensuring the safety of the community.

The design for this project will be for a facility which prioritizes functionality and performance to ensure that the safety of the community is the main priority. It will contain capacity for future growth of the workforce. Residents will have more opportunities for public service careers. A fully staffed station will reduce the response time and lead to more efficiency within the community. A swift response time mitigates risk, which can lower insurance rates for businesses and personal property owners.

A portion of the new facility will house the necessary resources for city officials to perform their duties as smoothly and quickly as possible. Having important departments in one building will allow for better and faster communication between all the sectors. With dedicated conference areas, topics impacting the community can be explored and decisions can be reached in person. The community will have an appropriate area for public outreach. Public events will give residents a chance to learn about fire safety and build relations with the local fire and police departments. The development of trust between the citizens and first responders can build a sense of safety and lead to a decrease in petty crime.

The project will allow the community to rely on the services it houses, as a focus for the building is adaptability for future expansion. As the city grows, the fire, EMS, and police departments can match the growth within the space of the building. With a professional fire department, the City of Granger could provide additional services within the current mutual aid agreement it holds with surrounding counties.

Capitalizing on the construction of the project will have to be swift. The cost of materials and labor will only increase in the future, just as the need for this project will increase. Implementing this project can be expected to provide an economic boost to the city of Granger. The construction of the project will create job opportunities and grant a chance at developing mutually beneficial relationships with construction companies. The project can be used to promote the construction of future projects, as well to generate private investors to stimulate their economy.

Alternative Solutions Considered

Alternative I

The first alternative explores a two-story arrangement to maximize usable floor space by separating operational areas and support functions. As shown in Figure 2, the exterior layout incorporates pull through apparatus bays to support efficient vehicle movement and emergency response. Public and administrative parking is located along the side of the building; however the Police secure access point requires personnel to move through public areas, creating potential security concerns.

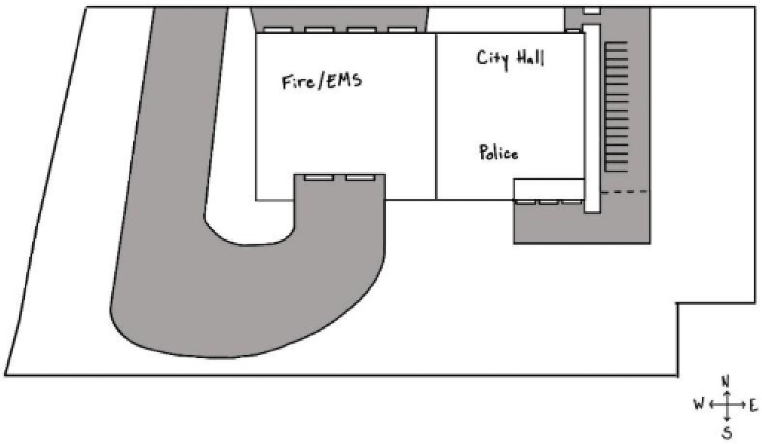


Figure 4: Design Alternative #1 – Site Plan

Internally, Fire and EMS living quarters and storage are located on the second floor, allowing the first floor to be dedicated to operational, administrative, and public facing spaces. This maximizes the space for operational functions, but the second level introduces circulation challenges, particularly during emergency response. Additionally, dispersed office layouts and the closeness between meeting and administrative areas may reduce efficient communication and introduce noise and distraction concerns.

While this alternative demonstrates efficient utilization of space, it does not align with the client's preference for a single-story facility. The added cost and reduced response efficiency associated with a two-story design ultimately led to this option being eliminated in favor of single-story alternatives.

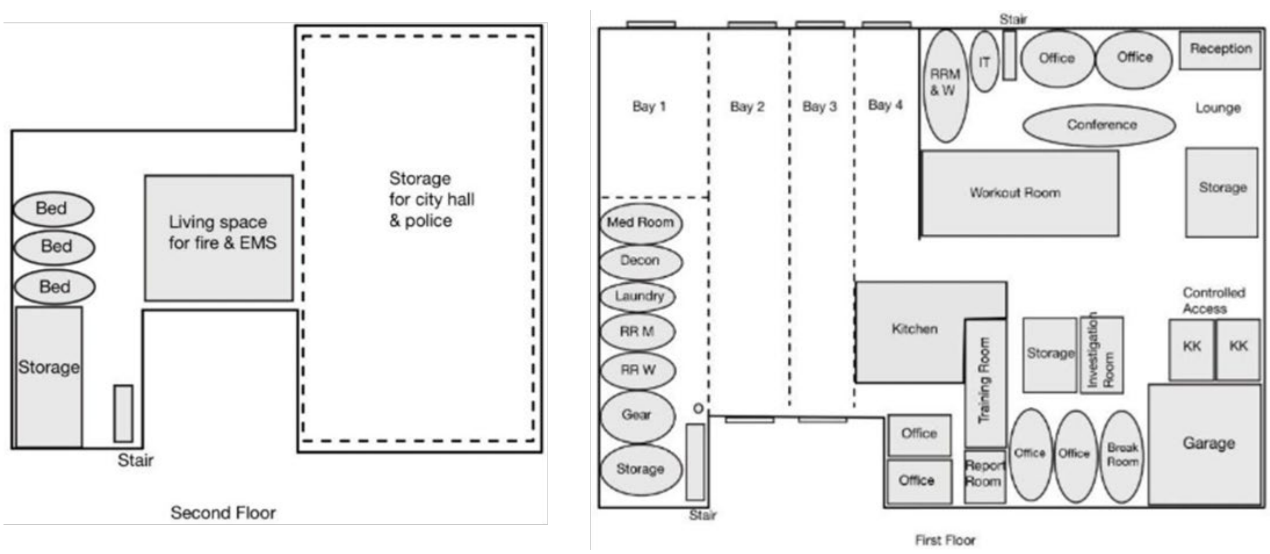


Figure 5: Design Alternative #1 – Floor Plan

Alternative II

The second alternative shifts to a single-story design that centralizes all functions to improve accessibility and simplify circulation. As shown in Figure 4, the exterior separates public and staff parking areas, but emergency vehicles must travel through portions of these areas to access apparatus bays, creating potential safety conflicts and less efficient response paths. The interior organizes the rooms into a compact layout with defined zones for City Hall, Fire and EMS, and secure Police functions. This improves accessibility and meets the client's preference for a single-story facility, however the proximity of dormitory spaces to administrative areas introduce concerns related to privacy, noise, and operational efficiency. Additionally, the shared circulation between emergency vehicles and parking areas presents a safety risk that conflicts with the project's priority for efficient and unobstructed emergency response. While this alternative improves overall accessibility and zoning clarity, it demonstrates the need for better separation of emergency circulation and more intentional placement of living spaces.

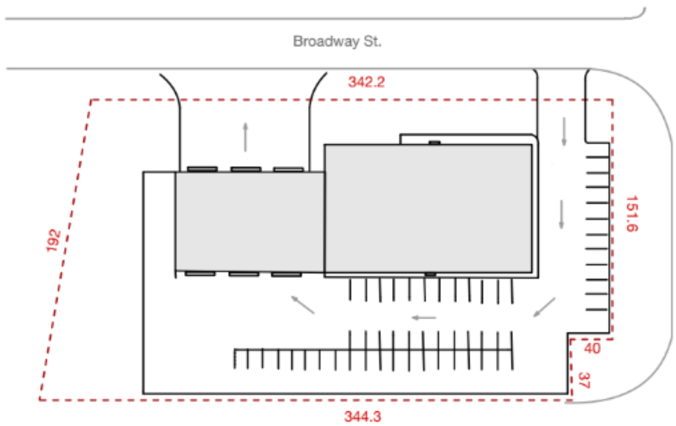


Figure 6: Design Alternative #2 – Site Plan

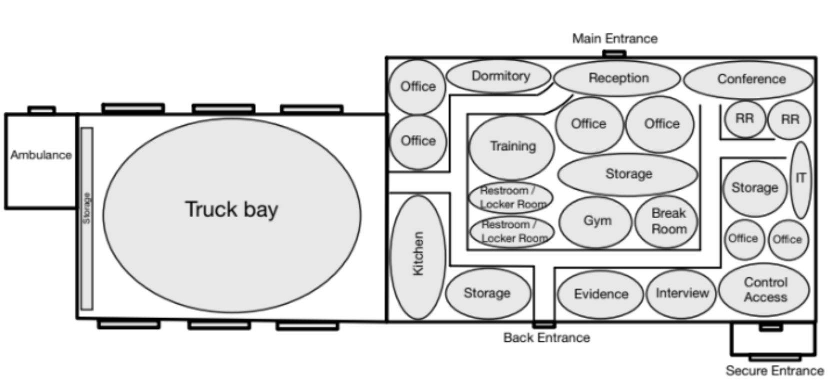


Figure 7: Design Alternative #2 –Floor Plan

Alternative III

The third alternative prioritizes clear separation between departments and dedicated emergency vehicle circulation. As shown in Figure 6, the exterior layout allows emergency vehicles to maneuver independently from public and staff parking, significantly improving safety and response efficiency, though at the cost of reduced public parking availability.

Internally, this design consolidates office spaces and provides distinct zones for Fire/EMS, Police, and City Hall functions, along with dedicated storage for each department. This improves organization and supports long-term adaptability, however the distance between conference and administrative areas remains less efficient. Additionally, the separation created by the apparatus bays introduces challenges for mechanical zoning, likely increasing HVAC system complexity and cost, while also limiting exterior space for future apparatus bay expansion.

While this alternative represents a strong solution for better circulation and zoning, these limitations led to further refinement in the final design.

Figure 8: Design Alternative #3 – Site Plan

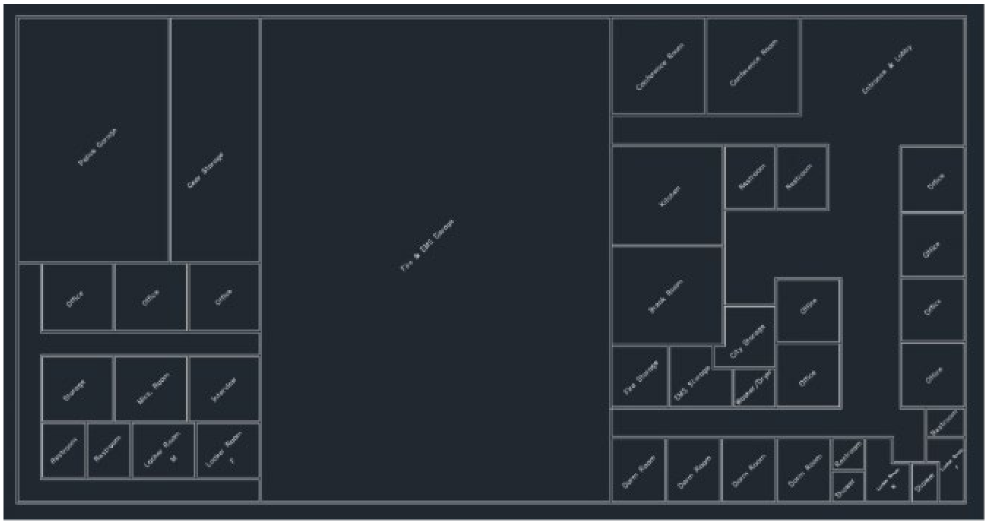


Figure 9: Design Alternative #3 –Floor Plan

Alternative IV

The fourth design alternative represents a refined solution that integrates key strengths from the previous concepts while prioritizing operational efficiency, code compliance, and a compact building footprint. This alternative was developed to meet all client requirements while minimizing overall square footage, resulting in a more cost-effective design.

Internally, the building is organized into distinct zones for City Hall, Fire/EMS, and Police functions, improving both security and functionality. Fire and EMS spaces are arranged to support a direct flow from apparatus bays to decontamination, washer/dryer, and locker rooms, creating a clear transition between hot, warm, and cold zones to reduce contamination risks. Police areas are secure and access-controlled, with dedicated spaces for offices, evidence storage, and interviews. City Hall is located at the main entrance for direct public access.

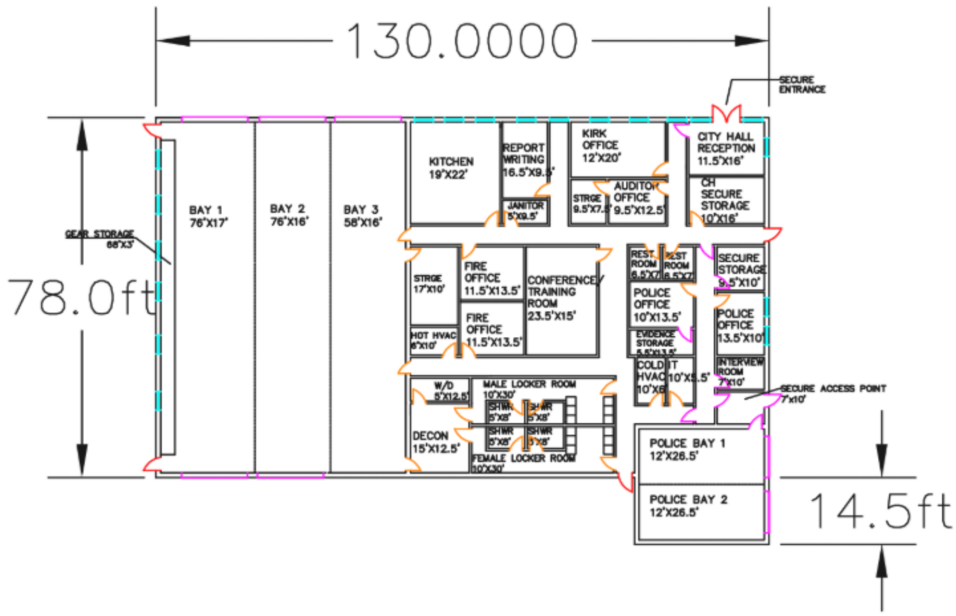


Figure 10: Design Alternative #4 – Floor Plan

Shared spaces, such as the conference room, are centrally located to support communication across departments. Additionally, this design was developed in accordance with 2021 International Building Code requirements, incorporating sufficient egress, ADA accessibility, corridor widths, and fire safety considerations to ensure a safe and functional facility.

A key advantage to this alternative is its reduced building shell, which lowers construction costs while still meeting all operational needs. The layout also supports future adaptability as Fire and EMS services expand. Overall, this design effectively balances efficiency, safety, and cost, and served as a strong foundation for the final proposed solution. Despite these strengths, this alternative was not selected due to constraints related to the required exterior building dimensions specified by the client. While the internal organization was efficient and compact, the overall building form did not align with dimensional requirements.

Final Design Details

This section presents the final design details for the one-story Fire and EMS, Police, and City Hall facility. Each design element is described in terms of method used for sizing, material selection, and quantity estimation, along with the resulting design decisions. Supporting calculations and assumptions are provided in Appendix B, while this section summarizes final outcomes. References to corresponding plan, section and site drawings are included to clearly identify the location and configuration of each design component.

Civil Design Elements

Site Layout and Grading

The site layout was developed to minimize the overall project footprint and reduce construction cost while still meeting the operational needs of the facility. Building placement was selected to make efficient use of the site, preserve flexibility for future expansion, and accommodate existing utility lines as effectively as possible within the site constraints. The layout also organized the site to support clear circulation for emergency personnel, staff, and visitors while reducing conflicts between pedestrians and moving vehicles wherever practical.

Emergency vehicle access was a major consideration in the final arrangement of the site. Access drives and maneuvering areas were positioned to support efficient ingress and egress for apparatus while limiting interaction with public and staff parking. Parking areas were arranged to provide sufficient capacity for current operations and anticipated future needs, with adjacent pedestrian routes placed to create safe and direct access to the building. Accessible routes were incorporated throughout the site to provide practical connections between parking, entrances, and other site features.

Grading was coordinated with the overall layout to maintain positive drainage, user comfort, and accessibility across developed areas of the site. Parking and pedestrian surfaces were designed with slopes between 0.5% and 2.0% where feasible in order to promote drainage while supporting ADA-compliant access. Runoff was directed away from the building and paved areas toward stormwater management structures and ultimately toward the nearby creek, consistent with the natural drainage pattern of the site. By integrating circulation, grading, drainage, and utility coordination into a single layout strategy, the final site design supports safety, functionality, constructability, and future growth. This can be found on Sheet C-001.

Utilities

Utility coordination was an important part of the final design to the presence of existing buried infrastructure within the project area. A buried electric cable will need to be relocated to accommodate the proposed development and reduce conflicts with the final building and site layout. Building placement was selected to avoid imposing additional foundation loading on the existing buried stormwater pipe, which reduces the risk of structural or utility related issues. In addition, the water service line was routed to enter the building through the apparatus bay area to limit a large pipe run and so the tender can be refilled more easily and efficiently during operations. This can be found on Sheet C-002.

Structural Design Elements

Structural System Selection

The structural system for the building was selected to best accommodate the interior layout and support its role as a reliable public emergency building. All bearing walls utilize pre-cast concrete paneling.

Interior bearing walls are 6-inches thick. Exterior walls and the wall dividing the Apparatus Bay from the office spaces are 12-inches thick. It is important to note that the designated safe zone walls within the interior include two bearing walls to effectively protect this area in extreme situations. The roof framing is composed of a steel truss system. From Figure 12, the load takedown can be visualized as gravity loads applied to the roof members would be taken down through the walls to the foundations. Lateral loads would be resisted by the walls as well. This selection was found to be the most cost-effective while providing effective separation between the different interior zones. No site constraints influenced the system's selection.

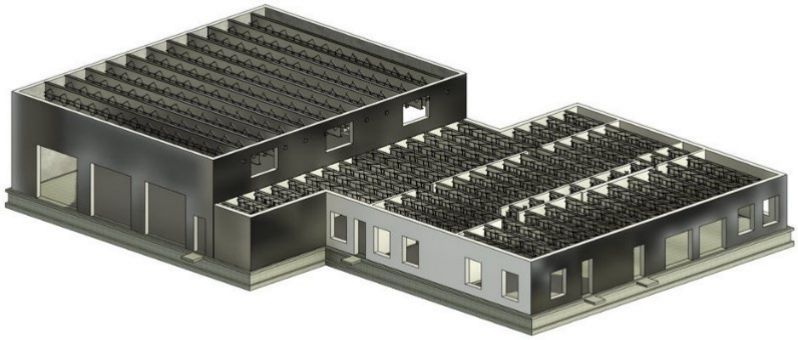


Figure 12: Structural Model

Load Calculation

ASCE 7-16, ASCE Hazard Tool, and IBC requirements were used to determine gravity and lateral loads. The Hazard Tool reported a snow load of 20 psf and a design wind speed of 118 Vmph. The resulting dead loads of roof members were between 90-107 plf on each member. Dead load of walls ranged from 267-402 plf. Resulting snow loads measured to be 125-150 plf on each member. Wind loads ranged from 69-84 plf on roof members and 1628-2000 plf on walls. Seismic loading was not considered controlling due to project location. All load combinations were calculated following Load and Resistance Factor Design methods. All load and combination calculations can be found in Appendix C.

Foundation Design

The foundation design consists of 1’-6” wide and 24-inch-thick continuous wall footings supporting the pre-cast concrete walls. 6 #8 bars are used for reinforcement of these foundations. A slab-on-grade supports the apparatus bay and the office areas, with a thickness of 8 feet in the bay and 4 feet elsewhere. This design was based on an allowable soil bearing pressure of 1,500 psf, a soil type B, and a frost depth of 42 inches as provided by the National Weather Service. All concrete was specified as having a strength of 4,000 psi. All foundation design calculations can be found in in Appendix C. Plan is located on Sheet S-101.

Roof Framing Design

The roof framing design is made up of a system of different steel trusses selected from the Vulcraft Joist Catalog. Member calculations result from coordination with ASCE 7-16 load requirements and, when applicable, AISC Steel provisions. In the lower roof / office spaces, Vulcraft 12K1, 12K5, and 14K4 joists are used based on different span lengths. The thickness of these joists ranges from 12-14.4 inches. Spacing for the lower roof joists is 5 feet for all except the 14K4 joists on the east side of the plan. In the apparatus bay, Vulcraft 32LH07 members are used for their long spans and durability to provide a large unobstructed space within the bay. The thickness of this joist is 32.4 inches, and the spacing of the joists is 6 feet. Structural member design calculations can be found in Appendix C. Roof Framing Plan is located on Sheet S-102 and S-103.

Architectural Design Elements

Building Layout and Programming

The final architectural layout was developed based on the operational needs of Fire and EMS (red), Police (blue), and City Hall (green) functions along with shared spaces (purple) in between. Required spaces were identified through client communication and included apparatus bays, administrative offices, secure areas, and public spaces. A comprehensive space program was established and translated into a one-story building layout totaling approximately 9,166 square feet, as shown in the architectural plan, Sheet A-101. The building was organized into three primary zones; emergency response area with contamination control for Fire and EMS, controlled-access law enforcement for Police, and public municipal services dedicated to City Hall. Fire and EMS functions were located on the west side of the building to provide direct access to apparatus bays and emergency response circulation. Police spaces were placed on the East side of the building with secure access from the West side and through the Police Bays. Secure access was incorporated into the entrance of the building, evidence and storage spaces as well as an investigation room. This area is secured from the other part of the building to ensure the space is contained. City Hall functions were positioned on the North side of the building to provide clear public entrance away from Police and Fire and EMS. This entrance includes a defined entry sequence including vestibule, reception, and administrative offices. Spatial relationships were designed to improve operational efficiency while maintaining separation between departments as well as public and secure areas. This zoning strategy also supported code-compliant egress and circulation paths, as shown in Sheet G-002.

Figure 16: Architectural Plan with department zoning

Exterior Wall Assembly

The exterior wall assembly was designed to satisfy structural, thermal, and fire-resistance requirements in accordance with the 2021 international building code (IBC). Based on the type II-B construction classification, exterior load-bearing walls were designed to meet a minimum two-hour fire-resistance rating in accordance with code requirements. Two primary exterior wall types were utilized, as defined in Sheets A-501. Wall Type E01 consists of a 1’-0” precast concrete panel, exterior metal panel finish, rigid insulation, and interior type X gypsum wallboard. Wall Type E02includedd a similar precast concrete system with increased insulation thickness (1 3/8” rigid insulation) and interior type X gypsum board, as shown on Sheet A-501. These assemblies were selected to provide structural properties, fire resistance, and continuous thermal insulation while maintaining constructability through prefabricated components. The use of precast concrete panels also supports durability and is used for aesthetic purposes. Wall details, including full layer composition and thickness are provided in Sheets A-501, with supporting calculations included in Appendix C.

Figure 17: Exterior wall rendering

Interior Wall Assembly

Interior wall systems were designed using multiple wall types to accommodate varying functional, structural, and acoustic requirements. The primary interior wall types identified in the design include I01, I02, and B02, as shown on sheet A-501. Wall Type I01 consists of cold formed metal studs with fiberglass insulation and type x gypsum wallboard on both sides, providing standard partition separation for offices and administrative areas. Wall Type I02 includes additional rigid insulation layers to improve thermal and acoustic performance, particularly in areas requiring greater separation such as report rooms, offices (Figure 18) and storage spaces. This Wall Type I02 also serves as a load bearing interior to support the building. It is constructed using precast concrete rather than metal studs. Interior load-bearing walls were designed to meet a one-hour fire-resistance rating in accordance to Table 601 in the 2021 IBC, while non-load bearing partitions were permitted to have no rating were allowed by code. The selection of wall types was coordinated with programmatic needs, ensuring proper separation between secure, public, and operational spaces. Wall type B02 represents a heavier assembly incorporating precast concrete elements with insulation and gypsum board, used around the Police Bays. This is used in areas that require additional structural support and fire resistance. Wall type locations and applications are shown in Sheet A-101, with detailed assemblies provided in sheet A-401.

Figure 18: Office Space

Fire and Life Safety Design

The building was designed as a fully sprinklered facility, and the incorporation of an automatic fire sprinkler system was a central component in determining fire-resistance requirements and egress allowances. The sprinkler system was designed in accordance with applicable provisions of IBC as identified in the project code analysis in Appendix A. The presence of a sprinkler system permitted reductions in certain fire-resistance requirements and increased flexibility in egress design. Egress requirements were established based on occupant loads derived from IBC Table 1004.5, which defines occupant load factors by space function. These calculations were performed for each room. Within the building, and informed the overall egress strategy, including the number of exits. Based on IBC Table 1006.3.3, a minimum of two exits per story was required for the building, and this requirement was incorporated into the design. Travel distance limitations were determined in accordance with IBC table 1017.2, which establishes a maximum allowable travel distance of 300 feet for sprinklered Group B occupancy. Additionally, the common path of egress travel was limited to 100 feet as defined by IBC Table 1006.2.1. These criteria were applied throughout the building layout to ensure that all occupied spaces complied with safety requirements. Exit access and corridor design were also governed by code requirements. Corridor widths were designed to meet the minimum clear width of 44inches as required by IBC Table 1020.3. in accordance with IBC Table 1020.2 corridors in group B occupancies were not required to have a fire-resistance rating when serving spaces with only a single means of egress, which was applicable to several areas within the building. Exit separation distances were evaluated in accordance with IBC Section 1007.1.1. Because the building is fully sprinklered, the minimum separation between exits was permitted to be one-third of the maximum overall diagonal dimension of the building. This allowance was incorporated into the placement of exits to ensure compliance while maintaining efficient circulation paths. All information can be found in Sheets G-001 and G-002

Apparatus Bay Design

The apparatus bay design (Figure 20) was developed to support Fire and EMS operational requirements while maintaining compliance with building code provisions and functional efficiency. The apparatus bay area comprises a significant portion of the building and was sized to accommodate emergency vehicles, associated equipment, and operational circulation. The design includes multiple apparatus bays, including a pull-through configuration that allows vehicles to enter and exit the building without reversing. This configuration improves response times, reduces maneuvering complexity, and enhances overall operational safety. The location of the bays along the exterior of the building provides direct access to emergency response routes and supports efficient deployment. The apparatus bays were separated from adjacent occupied spaces by fire-rated wall assemblies. As identified in the project code analysis in Appendix A, the wall between the bays and office areas are classified as an exterior load-bearing wall and was therefore designed to meet a two-hour fire-resistance rating in accordance with IBC Table 601. Storage areas for equipment and gear were integrated into the bay layout to support operational efficiency and organization. The design incorporates gear storage and wash areas to facilitate proper equipment handling and reduce the spread of contaminants. Occupant load calculations for the apparatus bay area were performed using IBC Table 1004.5, with the bay space supporting approximately 21 occupants based on its square footage. The pull-through bay is located on the far west side of the building and is expected to have a fourth bay added in the future.

Figure 20: Fire Bay

FEMA Considerations

FEMA related considerations were incorporated into the building layout through the inclusion of designated reinforced safe room spaces within the centralized portion of the building and will function as a FEMA P-361 Community Safe Room. These areas were identified to provide increased occupant protection during severe weather events and were located within interior zones of the building to reduce exposure to exterior wall failure and wind-borne debris, as shown in Figure 21. The safe room areas are identified in the architectural plan by the reinforced wall assemblies highlighted in green and include portions of the meeting room, storage, restroom, and IT spaces. Locating the safe room near the center of the building minimizes exterior pressure and improves structural protection during extreme weather events. Safe room wall assemblies were coordinated with the buildings fire-rated wall systems and structural layout to maintain continuity of protection throughout. The safe room core was designed to resist tornado wind speeds up to 250 mph using reinforced concrete wall assemblies, impact resistant openings and hardened structural connections. Although the bays are not classified as life-safety rooms, they were designed using reinforced wall assemblies and high-wind-rated doors to resist structural failure. This approach protects critical emergency vehicles and equipment while supporting continued emergency operations following a disaster. The design includes provisions for protected backup generator capable of maintaining emergency operation during extended power outages or severe weather conditions. Together, these measures establish the facility as a resilient public safety hub capable of maintaining critical municipal services during extreme events.

Cost Estimate

The cost estimate was calculated using the square footage of the preliminary design and unit costs. The cost was separated into categories pertaining to the project: civil, architectural, structural, mechanical/electrical/plumbing (MEP), and fixtures/furniture/equipment (FFE). Each category contained a detailed list of the materials needed to complete the construction of the design.

The majority of unit costs were obtained from the Iowa Department of Revenue's *Analyzed Unit Cost Schedule*. A smaller selection of the unit costs were sourced from the Iowa Department of Revenue's *Commercial and Industrial Schedule Short Form* or the *Square Foot Costs with RSMeans data*. Unit prices obtained from the Iowa Department of Revenue sources included construction overhead and labor installation costs. Unit prices from the alternative sources required a location factor, and an additional contractor and administrative fee to be included.

The location factor applied for the Granger, Iowa area is 0.93, while the contractor and administrative fees are about 35%. The *Square Foot Costs with RSMeans data* contained cost where the unit price was outdated. To match the amount with current day values, an inflation rate of 3.5% per year was included.

The specific material quantities were gathered from the project plans. Building wide systems needed for a functional space, such as plumbing and electricity, were accounted for by using the entire building square footage. Costs associated with unique features or specific rooms were applied to the areas that required it.

The total construction cost was estimated to be $2,429,000, a breakdown by subject can be seen in Figure 18. However, as a new construction project in a relatively low risk area, a five percent contingency was added to the cost. Therefore, the total cost of the project was estimated to be $2,550,500.

Estimate of Probable Construction Cost

ITEM	QUANTITY	UNIT	UNIT PRICE	TOTAL
CITE				
EXCAVATION	2262.0	CY	$ 7.50	$ 16,965.15
GRADING	69369.9	SF	$ 0.30	$ 20,810.96
PAVING	20937.0	SF	$ 5.00	$ 104,684.90
CURB	136.0	LF	$ 14.50	$ 1,972.00
LANDSCAPING-GRASS	39139.53	SF	$ 0.05	$ 1,956.98
STRUCTURAL				
FOUNDATION FOOTINGS	643.9	PLF	$ 171.85	$ 110,657.08
FOUNDATION WALLS	643.9	LF	$ 171.85	$ 110,657.08
SLAB ON GRADE	53442.9	CF	$ 5.90	$ 315,313.23
REINNFORCEMENT	1719.3	LB/FT	$ 1.15	$ 1,977.15
PRECAST CONCRETE PANELS	10376	PSFSA	$ 16.00	$ 166,016.00
ROOF FRAMING	1	Total	$ 94,514.00	$ 94,514.00
COLD-FORMED STEEL	7436	PSFSA	$ 3.15	$ 23,423.40
ARCHITECTURE				
ROOFING	9166	PSFSA	$ 17.45	$ 159,946.70
CEILING	4560	PSF	$ 3.25	$ 14,820.00
RIGID INSULATION	8231	PSF	$ 3.00	$ 24,693.00
METAL PANELS	5123	PSFSA	$ 14.50	$ 74,283.50
TYPE X GYPSUM	23547	PSFSA	$ 1.55	$ 36,497.85
FLOORING	1	TOTAL	$ 34,164.00	$ 34,164.00
DOORS & FRAMES	677	PSFSA	$ 42.50	$ 28,772.50
EXTERIOR DOORS	144	PSFSA	$ 32.50	$ 4,680.00
FIRE BAY DOORS	576	PSFSA	$ 26.50	$ 15,264.00
POLICE BAY DOORS	112	PSFSA	$ 15.00	$ 1,680.00
WINDOWS	539	PSFSA	$ 14.50	$ 7,815.50
PAINT	4980	PSFSA	$ 0.75	$ 3,735.00
FENCING	40	PLF	$ 19.25	$ 770.00
MEP				
HVAC SYSTEM	9166	PSFSA	$ 25.41	$ 351,392.98
PLUMBING	9166	PSF	$ 16.67	$ 230,528.18
ELECTRICAL	9166	PSF	$ 14.25	$ 197,062.18
BACKUP GENERATOR	1	Total	$ 18,500.00	$ 23,226.75
WATER SUPPLY	9166	LF	$ 3.51	$ 48,539.53
SANITARY SYSTEMS	340.8	LF	$ 18.25	$ 6,218.82
SPRINKLER WET PIPE SYSTEM	4560	PSF	$ 3.75	$ 17,100.00
SPRINKLER DRY PIPE SYSTEM	4606	PSF	$ 4.50	$ 20,727.00
INLET	3	EA	$ 1,850.00	$ 5,550.00
ELECTRIC OPERATED POLICE DOOF	2	EA	$ 1,350.00	$ 2,700.00
ELECTRIC OPERATED FIRE DOOR	4	EA	$ 1,650.00	$ 6,600.00
BUILT IN STEREO SYSTEM	4936.96	PSF	$ 1.95	$ 9,627.07
INTERCOM SYSTEM	190.17	PSF	$ 0.95	$ 180.66
FFE				
INTERIOR LIGHTING	1	Total	$ 15,310.0	$ 20,360.77
EXTERIOR LIGHTING	10795.5	PSF	$ 0.75	$ 9,595.12
IT EQUIPMENT	54	PSF	$ 150.00	$ 10,169.55
OFFICE FURNITURE	1	Total	$ 27,963.00	$ 37,187.99
CONFERNCE ROOM EQUIPMENT	2	Total	$ 8,486.00	$ 21,308.35
KITCHEN APPLIANCES	1	Total	$ 9,085.00	$ 12,082.14
EMS FIRE STORAGE EQUIPMENT	1	Total	$ 4,095.00	$ 5,445.94
SECURITY SYSTEMS	9166	PSF	$ 1.00	$ 9,166.00
DOWNSPOUTS	119.7	PLF	$ 9.40	$ 1,124.87
GUTTERS	233.3	PLF	$ 6.75	$ 1,575.00
Miscellaneous	1	Total	$ 5,000.00	$ 5,000.00
SIGNS	3	EA	$ 106.25	$ 318.75
TOTAL				$2,428,857.62

Figure 21: Cost Estimate

Appendices

Appendix A

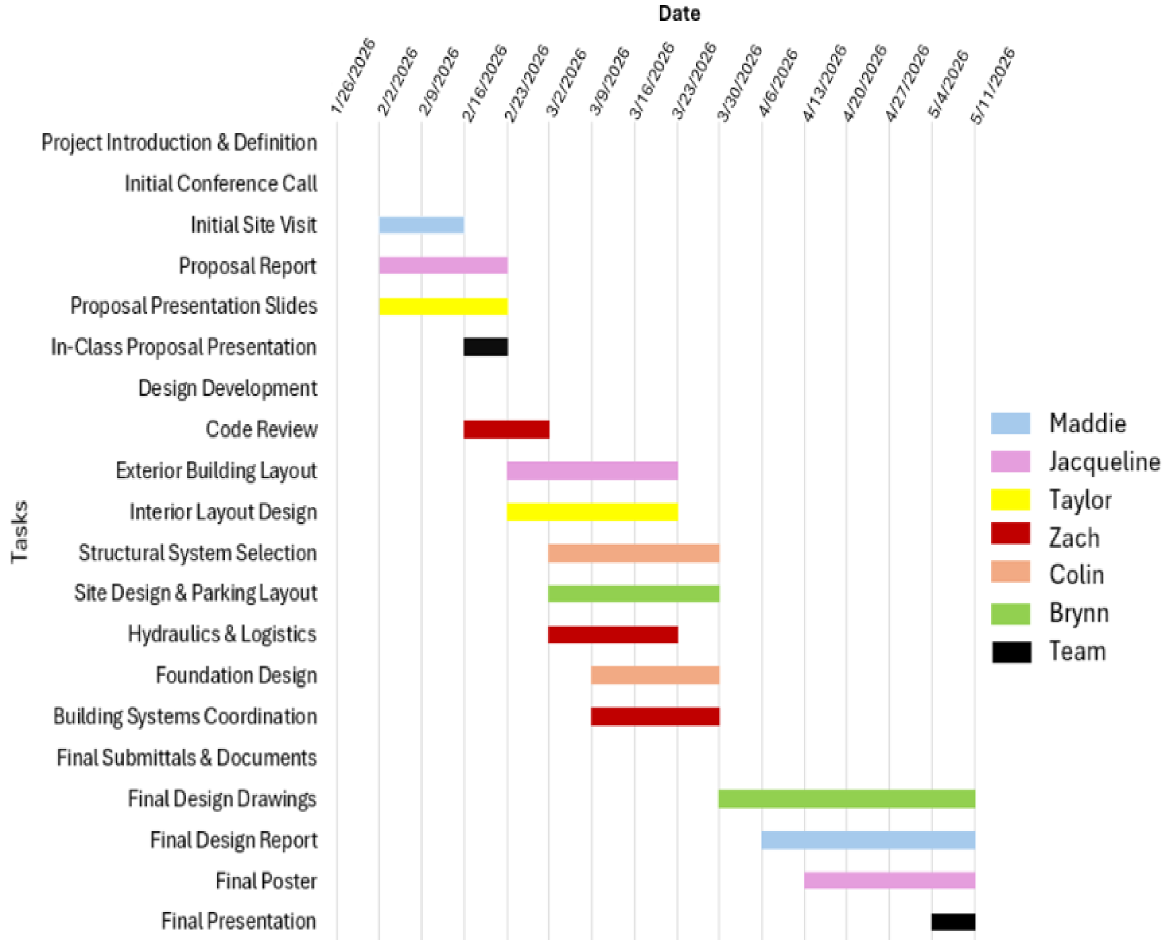


Figure 22: Project Work Plan Schedule

Appendix B: Code Review

Table 1: Occupancy and Construction

Occupancy and Construction Type			
Occupancy Group	B Business	CHAPTER 3	
Construction Type	TYPE 3B	TABLE 601	
Occupant Load			
Total Occupant Load	9166 GSF	150 GSF/OCCUPANT	61

Table 2: Means of Egress

Means of Egress		
Number of Exits	TABLE 1006.3.3	2 MINIMUM PER STORY
Common Path of Travel	TABLE 1006.2.1	100'-0" MAX
Travel Distance Limit	TABLE 1017.2	300'-0" MAX
Corridor Width	TABLE 1020.3	44" MIN
Dead End Corridor	1020.5	50'-0" MAX

Table 3: Fire Resistance Rating Requirements For Building Elements

Fire Resistance Rating Requirements For Building Elements		
Structural Frame	TABLE 601	0 HOURS
Load Bearing Walls - Exterior	TABLE 601	2 HOURS
Load Bearing Walls - Interior	TABLE 601	1 HOUR
Non-Load Bearing Walls & Partitions Exterior	TABLE 705.5	0 HOURS
Non-Load Bearing Walls & Partitions Interior	TABLE 601	0 HOURS
Floor Construction Including Supporting Beams & Joists	TABLE 601	0 HOURS
Roof Construction Including Supporting Beams & Joists	TABLE 601	1 HOUR
Corridors At B Occupancy Only (1st Floor)	TABLE 1020.2	0 HOURS
1st Floor Ceiling Assembly	TABLE 601	0 HOURS
Incidental Use Areas: Laundry > 100 SF	TABLE 509.1	PROVIDE AUTOMATIC SPRINKLER

Table 4: Maximum Area of Wall Openings At Exterior Walls

Max Area of Wall Openings At Exterior Walls		**TABLE 705.5**
Unprotected, Sprinkled	**Separation Distance**	**Percent of Wall Allowed for Opening**
Building West (G3 Upper)	>30'-0"	NO LIMIT
Building North (GD)	>20'-0"	NO LIMIT
Building East (G4)	>30'-0"	NO LIMIT
Building South (GB)	>30'-0"	NO LIMIT
Bay East (G3 Lower)	>30'-0"	NO LIMIT
Bay South (GA)	>30'-0"	NO LIMIT
Bay West (G1)	>30'-0"	NO LIMIT
Bay North (GC)	>30'-0"	NO LIMIT

Table 5: Building Height and Area

BUILDING HEIGHT AND AREA		
HEIGHT ALLOWED	TABLE 504.3	75' ABOVE GRADE PLANE
NUMBER OF STORIES ALLOWED	TABLE 504.4	3 STORIES ABOVE GRADE PLANE
ALLOWABLE AREA FACTOR	TABLE 506.2	76,000 SF ARE PER FLOOR (NO INCREASE)
ACTUAL HEIGHT: 20'-0"		
ACTUAL FLOOR AREA:		
BUILDING AREA:		
TOTAL BUILDING AREA		= 9,166 SF.
BUILDING VOLUME:		
BUILDING =	4,980 SF x 12'0"	= 59,760 CU. FT.
BAYS =	4,186 SF x 20'-0"	= 83,720 CU. FT.
TOTAL CUBIC BUILDING AREA		= 167,440 CU. FT.

Appendix C: Design Calculations

Table 6: INFO (DIM)

BUILDING DIMENSIONS		
GRIDS		
A-B	22.28125	ft
B-C	51.05729	ft
C-D	23.30	ft
1-2	58.17	ft
2-3	10.21	ft
3-4	13.667	ft
2-4	23.88	ft
4-5	19.58	ft
2-5	43.46	ft
3-5	33.25	ft
5-6	4.75	ft
5-7	27.38	ft
6-7	22.63	ft
N/S	96.64	ft
E/W	129.00	ft
HEIGHTS		
UPPER	18	ft
LOWER	12	ft
LOADS (ASCE 7-16)		
RISK CAT.	IV	
SOIL	B	
WIND	118	Vmph
SNOW	25	psf

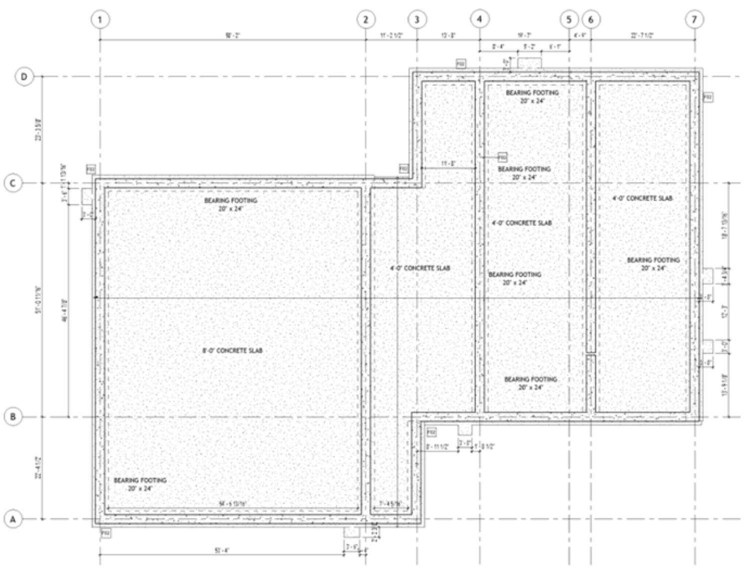


Figure 23: Grids referenced in Table

Table 7: Roof Dead Load

ROOF DEAD LOAD				
Metal Roof Deck:		3	psf	
Roof Membrane:		1.5	psf	
Coverboard:		0.75	psf	
Insulation:		9	psf	
Vulcraft 12K1 Joist:	depth:	1	ft	
	weight:	5	plf	
Vulcraft 36LH07 Joist:	depth:	2.7	ft	
	weight:		16	plf
Vulcraft 12K5 Joist:	depth:	2.7	ft	
	weight:	16	plf	
Vulcraft 14K4 Joist:	depth:	1.17	ft	
	weight:	6.7	plf	

Table 8: Roof Members

ROOF MEMBERS					
GRID	LENGTH (ft)	SELF WT (plf)	TRIB WIDTH (ft)	LOAD (plf)	TOTAL (plf)
1-2	58.2	16.0	6	85.5	101.5
2-3	10.2	5.0	5	71.25	76.3
3-4	13.7	5.0	5	71.25	76.3
2-4	23.9	7.1	5	71.25	78.4
4-6	24.3	5.0	5	71.25	76.3
6-7	22.6	6.7	6	85.5	92.2

Table 9: Roof Member Spacing

ROOF MEMBER SPACING					
BAY (UPPER) ROOF:			LOWER ROOF:		
1-2	6	ft	2-3	5	ft
			3-4	5	ft
			2-4	5	ft
			4-6	5	ft
			6-7	6	ft

Table 10: Wall Dead Load

WALL DEAD LOAD		
Studs:	8.2	psf
Gypsum board:	5.5	psf
Insulation:	8.6	psf
Concrete Pre-Cast:	10	psf

Table 11: Wall Info

WALLS

GRID	HEIGHT (ft)	LENGTH (ft)	TOTAL (plf)
A	18	68.4	581.4
B	12	70.8	387.6
C	18	68.4	581.4
D	12	60.6	387.6
1	18	73.3	581.4
2	18	73.3	581.4
3	12	96.6	387.6
4	12	74.4	387.6
6	12	74.4	387.6
7	12	74.4	387.6

Table 12: Floor Live Load

FLOOR LIVE LOAD		
Corridors:	100	psf
Truck Bay*:	250	psf
*(AASHTO)		

Table 13: Slab Info

SLAB

GRID	LENGTH (ft)	TOTAL (plf)
A	68.4	3119.5
C	68.4	3119.5
1	73.3	8725.0
2	73.3	12091.7
3	96.6	6008.3
4	74.4	5204.2
7	74.4	1368.8

Table 14: Slab Thickness

SLAB THICKNESSES

TRUCK BAY:	8	ft	8'-0"
CORRIDOR:	4	ft	4'-0"

Table 15: Slab Distribution

SLAB DISTRIBUTION				
TRUCK BAY:	1.26	TWO-WAY		
	SHORT AREA (ft^2)	LONG AREA (ft^2)	SHORT LOAD (lbs)	LONG LOAD (lbs)
	853.2	2559.5	213292.9	639878.8
CORRIDOR:		ONE-WAY		
	TRIB AREA (ft^2)	LOAD (lbs)		
	266.0	26598.2		
CORRIDOR:	1109.4	110943.2		
CORRIDOR:	387.4	38739.7		
CORRIDOR:	1017.8	101779.4		
CORRIDOR:	0.0	0.0		

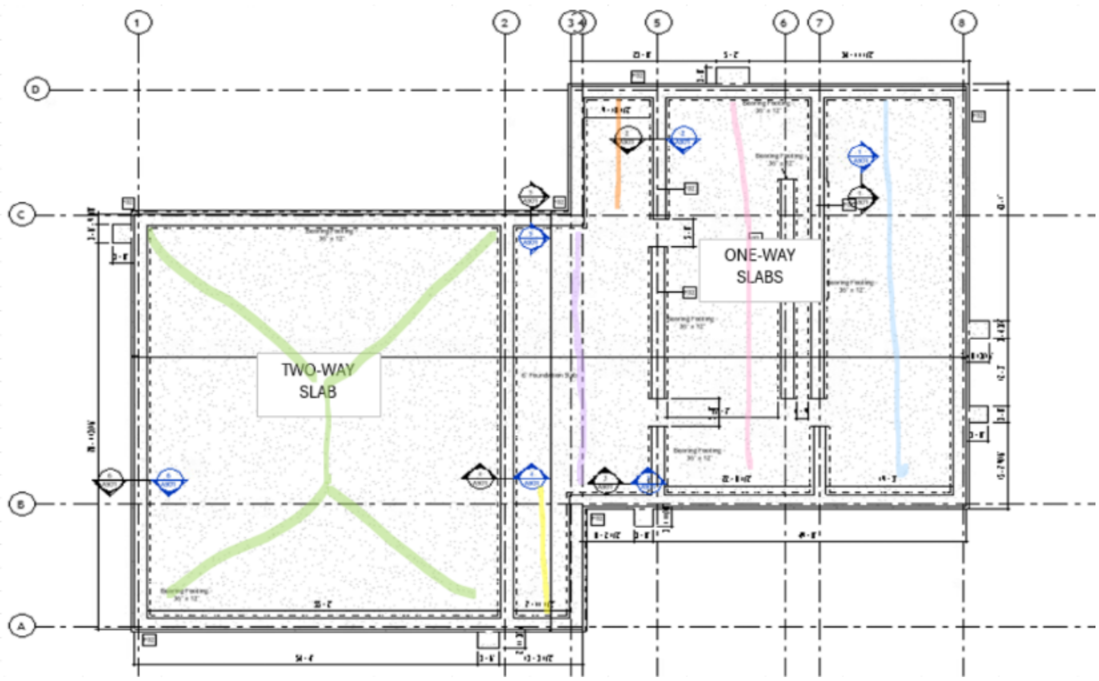


Figure 24: Figure referenced in Table 15

Table 16: Snow Load

SNOW LOAD		
LOAD:	25	psf

Table 17: Roof Members

ROOF MEMBERS		
GRID	TRIB WIDTH (ft)	TOTAL (plf)
1-2	6	150.0
2-4	5	125.0
3-4	5	125.0
2-4	5	125.0
4-6	5	125.0
6-7	6	150.0

Table 18: Wind Load

WIND LOAD		
LOAD:	118	Vmph
Height:	<60*	ft
Exposure:	B	
Roof Type:	Monoslope	
Upper Roof Height:	22.5	ft
Upper Roof Drainage Height:	22	ft
Lower Roof Height:	12.5	ft
Lower Roof Drainage Height:	12	ft
Upper Roof Bldg Width:	70.5	ft
Upper Roof Bldg Length:	74.8	ft
Lower Roof Bldg Width:	62.1	ft
Lower Roof Bldg Length:	75.5	ft
Topographic Factor, kzt	1	
Upper Roof Angle, ϴ	5	deg
Lower Roof Angle, ϴ	5	deg
Upper Mean Roof, h	22.25	ft
Lower Mean Roof, h	12.25	ft
Adjustment Factor, λ	1	
Importance Factor, I	1.15	
Upper End Zone Width, a	17.8	ft
Lower End Zone Width, a	9.8	

*utilizing simplified envelope MWFRS for low-rise

Table 19: Vertical Wind Load on Roof

WIND LOAD ON ROOF (VERTICAL)

GRID	TRIB WIDTH (ft)	TOTAL (plf)
1-2	6	-83.49
2-3	5	-69.575
3-4	5	-69.575
2-4	5	-69.575
4-6	5	-69.575
6-7	6	-83.49

Table 20: Horizontal Wind Load on Roof

WIND LOAD ON WALLS (HORIZTONAL)

GRID	LENGTH (ft)	TOTAL (plf)
A	68.4	1792.7925
B	70.8	1857.25
C	68.4	1792.7925
D	60.6	1589.5875
1	73.3	1922.9366
3	96.6	2533.9172
7	74.4	1949.7028

Table 21: Transverse MWFRS Net Pressures

TRANSVERSE MWFRS NET PRESSURES					
GRIDS	ZONE DESCRIPTION	DIRECTION	ps30 UPPER (psf)	UPPER ROOF 1 (psf)	MAX (psf)
1,4	A (wall end zone)	horizontal	22.8	26.22	
1,4	B (roof end zone)	horizontal	-11.9	-13.685	
1,4	C (wall interior)	horizontal	15.1	17.365	
1,4	D (roof interior)	horizontal	-7	-8.05	26.22
A,C,1,4	E (ww roof end)	vertical	-27.4	-31.51	
A,C,1,4	F (lw roof end)	vertical	-15.6	-17.94	
A,C,1,4	G (ww roof interior)	vertical	-19.1	-21.965	
A,C,1,4	H (lw roof interior)	vertical	-12.1	-13.915	-13.915
GRIDS	ZONE DESCRIPTION	DIRECTION	ps30 LOWER (psf)	LOWER ROOF 1 (psf)	
3,8	A (wall end zone)	horizontal	22.8	26.22	
3,8	B (roof end zone)	horizontal	-11.9	-13.685	
3,8	C (wall interior)	horizontal	15.1	17.365	
3,8	D (roof interior)	horizontal	-7	-8.05	26.22
B,D,3,8	E (ww roof end)	vertical	-27.4	-31.51	
B,D,3,8	F (lw roof end)	vertical	-15.6	-17.94	
B,D,3,8	G (ww roof interior)	vertical	-19.1	-21.965	
B,D,3,8	H (lw roof interior)	vertical	-12.1	-13.915	-13.915

*entire roof will either be windward or leeward

Table 22: Longitudinal MWFRS Net Pressures

LONGITUDINAL MWFRS NET PRESSURES					
GRIDS	ZONE DESCRIPTION	DIRECTION	ps30 UPPER (psf)	UPPER ROOF 1 (psf)	
A,C	A (wall end zone)	horizontal	22.8	26.22	
-	B (roof end zone)	horizontal	0	0	
A,C	C (wall interior)	horizontal	15.1	17.365	
-	D (roof interior)	horizontal	0	0	26.22
A,C,1,4	E (ww roof end)	vertical	-27.4	-31.51	
A,C,1,4	F (lw roof end)	vertical	-15.6	-17.94	

A,C,1,4	G (ww roof interior)	vertical	-19.1	-21.965	
A,C,1,4	H (lw roof interior)	vertical	-12.1	-13.915	-13.915
GRIDS	ZONE DESCRIPTION	DIRECTION	ps30 LOWER (psf)	LOWER ROOF 1 (psf)	
B,D	A (wall end zone)	horizontal	22.8	26.22	
-	B (roof end zone)	horizontal	0	0	
B,D	C (wall interior)	horizontal	15.1	17.365	
-	D (roof interior)	horizontal	0	0	26.22
B,D,3,8	E (ww roof end)	vertical	-27.4	-31.51	
B,D,3,8	F (lw roof end)	vertical	-15.6	-17.94	
B,D,3,8	G (ww roof interior)	vertical	-19.1	-21.965	
B,D,3,8	H (lw roof interior)	vertical	-12.1	-13.915	-13.915

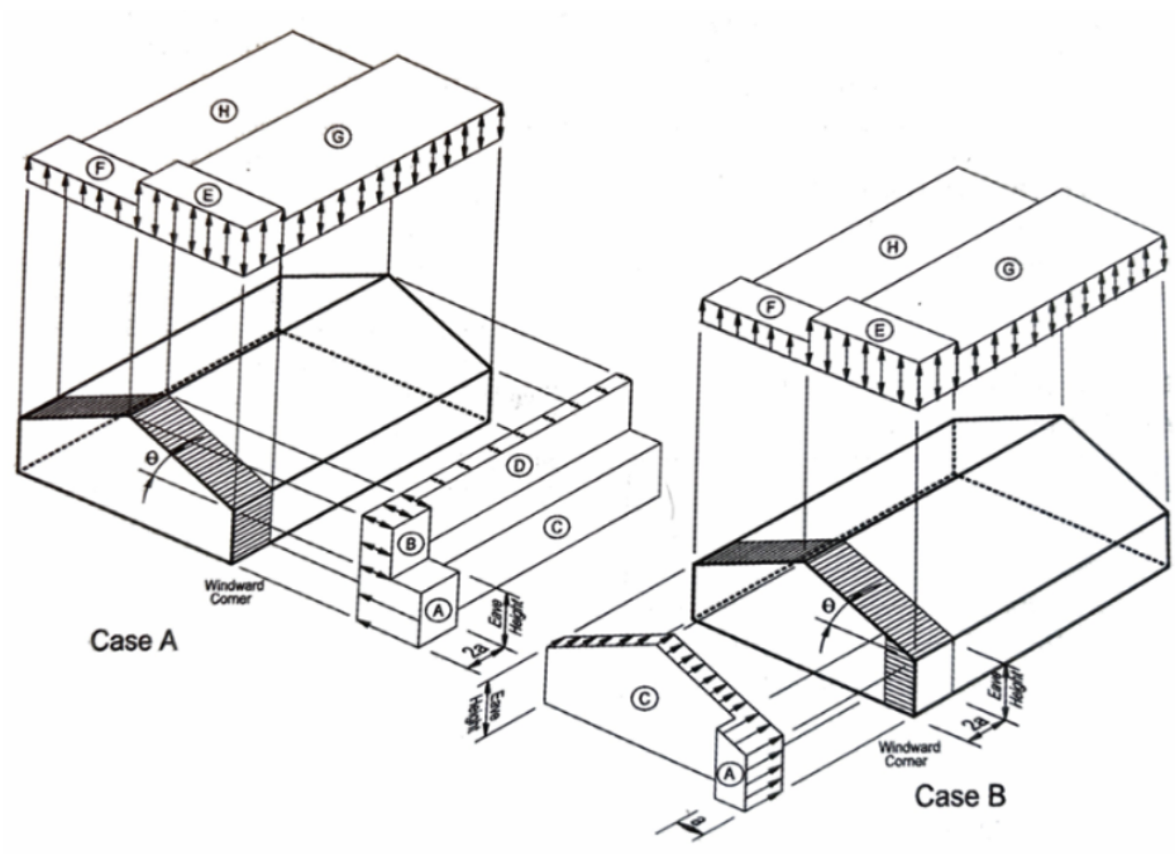


Figure 25: Transverse and Longitudinal Cases

Table 23: LRFD Load Combinations

LRFD LOAD COMBINATIONS

ROOF MEMBERS

GRID	1.4D	1.2D+1.6L+0.5S	1.2D+1.6S+L	1.2D+1.0W+L+0.5S	0.9D+1.0W	MAX (plf)
1-2	142.1	196.8	361.8	113.31	7.86	361.8
2-3	106.75	154	291.5	84.425	-0.95	291.5
3-4	106.75	154	291.5	84.425	-0.95	291.5
2-4	109.69	156.52	294.02	86.945	-0.94	294.02
4-6	106.75	154	291.5	84.425	-0.95	291.5
6-7	129.08	185.64	350.64	102.15	-0.51	350.64

Table 24: Wind and Slab Loads

WALLS AND SLAB

GRID	1.4D	1.2D+1.6L+0.5S	1.2D+1.6S+L	1.2D+1.0W+L+0.5S	0.9D+1.0W	MAX (plf)
A	813.96	697.68	697.68	2490.4725	2316.0525	2490.4725
B	542.64	465.12	465.12	2322.37	2206.09	2322.37
C	813.96	697.68	697.68	2490.4725	2316.0525	2490.4725
D	542.64	465.12	465.12	2054.7075	1938.4275	2054.7075
1	813.96	697.68	697.68	2620.616563	2446.1966	2620.616563
2	813.96	697.68	697.68	697.68	523.26	813.96
3	542.64	465.12	465.12	2999.037188	2882.7572	2999.037188
5	542.64	465.12	465.12	2414.822813	2298.5428	2414.822813
6	542.64	465.12	465.12	465.12	348.84	542.64
7	542.64	465.12	465.12	465.12	348.84	542.64

Table 25: Roof Members

ROOF MEMBERS							
GRID	LENGTH (ft)	UNIFORM LOAD (plf)	MOMENT OF INERTIA (in^4)	MOMENT OF INERTIA (ft^4)	MAX DEFLECTION (ft)	DL DEFLECTION (ft)	DEFLECTION (in)
1-2	58.2	240.0	1262.1	0.0609	0.2	0.140726176	1.688714114
2-3	10.2	550.0	15.5	0.0007	0.0	0.024896297	0.298755569
3-4	13.7	425.0	28.8	0.0014	0.0	0.033248627	0.39898353
2-4	23.9	132.0	47.9	0.0023	0.1	0.057903764	0.694845174
4-6	24.3	142.0	54.5	0.0026	0.1	0.05901074	0.708128875
6-7	22.6	129.0	39.8	0.0019	0.1	0.054884744	0.658616927

Table 26: Foundation Design

FOUNDATION DESIGN

Frost Depth:	3.5	ft
Soil Bearing Capacity, q_{all}:	1500	psf
fc':	576000	psf
γ_{c}:	150	pcf
fy:	8640000	psf
Clear Cover, cc:	0.25	ft
Clear Cover Top, cc_{top}:	0.125	ft
Effective Depth, c1:	1.333333333	ft

Table 27: Foundation Width and Thickness

GRID	LOADS, P (plf)	WIDTH, B (ft)	CHOSEN WIDTH, B (ft)	FACTOR, f (ft)	FACTORED MOMENT, Mu (lbf*ft)	THICKNESS t, (ft)	EFFECTIVE DEPTH, d (ft)	REINFORCEMENT	NUMBER OF BARS	BAR DIAMETER, db (ft)	BAR AREA, Ab (ft^2)	STEEL AREA, As (ft^2)	c (ft)	ε_s	DES MOMENT, Mn (lbf*ft)
A	2490.5	1.660	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
B	2322.4	1.548	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
C	2490.5	1.660	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
D	2054.7	1.370	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
1	2620.6	1.747	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
2	814.0	0.543	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
3	2999.0	1.999	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
5	2414.8	1.610	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
6	542.6	0.362	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68
7	542.6	0.362	1.6	0.3	216.0	2.0	215.8	#8	6.0	0.0833	0.0055	0.0329	0.071	9.089	61350695.68

Table 27: Foundation Reinforcement Spacing

GRID	LENGTH, l1 (ft)	REQ SHEAR, Vu (lbf) <	ONE-WAY, ΦVn (lbf)	b0 (ft)	REQ SHEAR, Vu (lbf) <	TWO-WAY, ΦVn (lbf)	BAR SPACING, S (ft) <	MAX SPACING (ft)	MIN STEEL AREA, As (ft^2)	CLEAR SPACING (ft)	DEV LENGTH, l_d (ft)	l_r (ft)	l_{ext} (ft)	HOOK LENGTH, l_{dh} (ft)	HOOK SIZE
A	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05	~~18.974~~	~~90 DEG STANDARD HOOK~~
B	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
C	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
D	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
1	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
2	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
3	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
5	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
6	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-
7	0.300	720.0	392982.6	867.0	-70467003.8	425894859.6	0.2	1.5	0.006	0.2	0.047	0.3	0.05		-

Table 28: Bar Sizing Chart

BAR SIZING CHART

US BAR	ACTUAL DIAMETER (ft)	AREA (ft^2)
#2	0.0208	0.0003
#3	0.0313	0.0008
#4	0.0417	0.0014
#5	0.0521	0.0022
#6	0.0625	0.0031
#7	0.0729	0.0042
#8	0.0833	0.0055
#9	0.0940	0.0069
#10	0.1058	0.0088
#11	0.1300	0.0108
#14	0.1411	0.0156
#18	0.1881	0.0278

Table 29.1: Header Design

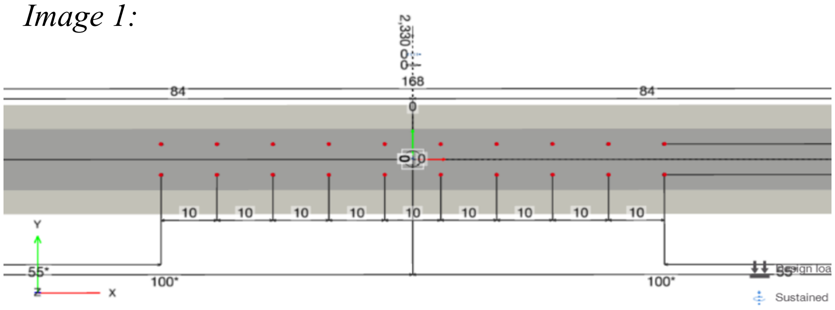
OPENING HEADERS

Apparatus Door Height:	14	ft
Apparatus Door Width:	14	ft
Police Door Height:	7	ft
Police Door Width:	9	ft

Table 29.2: Header Design

IMAGES	OPENING LOCATION	GRID	LOAD APPLIED (plf)	DOOR WIDTH (ft)	PLATE HEIGHT (ft)	ANCHOR	ANCHOR SIZE (in)	ANCHOR SPACING (ft)
1	APPARATUS BAY GARAGE DOOR	C	2490.4725	14	1	HIT-HY 200 V3	3/4	0.83
2	POLICE BAY GARAGE DOOR	8	0	9	1	HIT-HY 200 V4	4-Mar	1.67

Image 1:



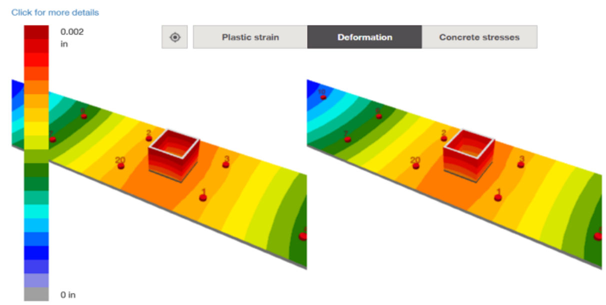
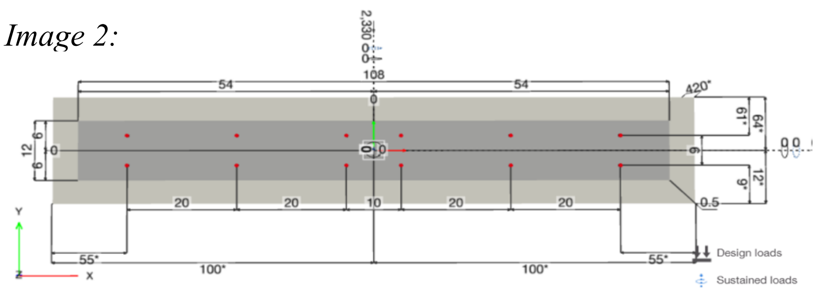


Image 2:



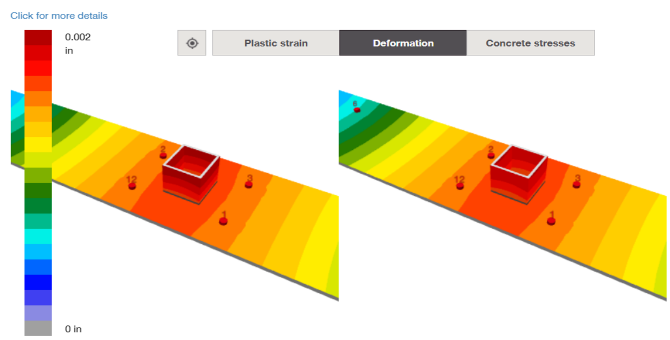


Table 30: Loads Summary Table

LOADS (ASCE 7-16)		
RISK CAT.	IV	
SOIL	B	
WIND	118	Vmph
SNOW	25	psf

Table 31: Roof Members Summary Table

ROOF MEMBERS								
GRID	MEMBER	TRIB WIDTH (ft)	DEAD LOAD (plf)	SNOW LOAD (plf)	WIND LOAD (plf)	SPACING (ft)	MEMBER THICKNESS (ft)	DEFLECTION (in)
1-2	Vulcraft 32LH07 Joist:	6	101.5	150	-83.49	6	2.7	1.688
2-3	Vulcraft 12K1 Joist:	5	76.25	125	-69.575	5	1.0	0.2988
3-4	Vulcraft 12K1 Joist:	5	76.25	125	-69.575	5	1.0	0.3989
2-4	Vulcraft 12K5 Joist:	5	78.35	125	-69.575	5	1.0	0.6949
4-6	Vulcraft 12K5 Joist:	5	76.25	125	-69.575	5	1.0	0.7081
6-7	Vulcraft 14K4 Joist:	6	92.2	150	-83.49	6	1.2	0.65861

Table 32: Walls and Slab Summary Table

WALLS AND SLAB			
GRID	DEAD LOAD (plf)	LIVE LOAD (plf)	WIND LOAD (plf)
A	581.4	3119.5	1792.7925
B	387.6	0	1857.25
C	581.4	3119.5	1792.7925
D	387.6	0	1589.5875
1	581.4	8725.0	1922.9366
2	581.4	12091.7	0
3	387.6	6008.3	2533.9172
5	387.6	5204.2	1949.7028
6	387.6	0	0
7	387.6	1368.8	0

Table 33: Slab Thickness Summary Table

SLAB THICKNESSES			
TRUCK BAY:	8	ft	8'-0"
CORRIDOR:	4	ft	4'-0"

Table 34: Wall Footings Summary Table

WALL FOOTINGS					
GRID	WIDTH, B (ft)	THICKNESS t, (ft)	REINFORCEMENT	NUMBER OF BARS	HOOK SIZE
A	1.60	2.0	#8	6	0
B	1.60	2.0	#8	6	0
C	1.60	2.0	#8	6	0
D	1.60	2.0	#8	6	0
1	1.60	2.0	#8	6	0
2	1.60	2.0	#8	6	0
3	1.60	2.0	#8	6	0
5	1.60	2.0	#8	6	0
6	1.60	2.0	#8	6	0
7	1.60	2.0	#8	6	0

Design Renderings and Models

Figure 25: Exterior isometric view facing Southwest

Figure 26: Conference room

Figure 28: Kitchen / Day Room View 1

Figure 29: Kitchen / Day Room View 2

Figure 30: City Hall office

Figure 31: Reception / Vestibule Area